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OF THE

UNITED STATES FISH COMMISSION.

VOL. VIII,

FOR

1888.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1890.

JOINT RESOLUTION authorizing the Public Printer to print reports of the United States Fish Commissioner upon new discoveries in regard to fish-culture.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Public Printer be, and he hereby is, instructed to print and stereotype, from time to time, any matter furnished him by the United States Commissioner of Fish and Fisheries relative to new observations, discoveries, and applications connected with fish-culture and the fisheries, to be capable of being distributed in parts, and the whole to form an annual volume or bulletin not exceeding five hundred pages. The extra edition of said work shall consist of five thousand copies, of which two thousand five hundred shall be for the use of the House of Representatives, one thousand for the use of the Senate, and one thousand five hundred for the use of the Commissioner of Fish and Fisheries.

ADVERTISEMENT.

UNITED STATES COMMISSION OF FISH AND FISHERIES,
Washington, D. C.

Congress, by joint resolution of February 14, 1881, authorized the printing of an annual bulletin for the publication of new observations, discoveries, and applications relating to fish culture and the fisheries. The previous numbers of this bulletin have been composed chiefly of short articles, extracts from the official correspondence, and translations of foreign papers. The increased operations of the Fish Commission during 1888 have made it possible, however, to apply the bulletin for that year almost exclusively to the results of the Commission's work, and the present volume will be found to contain much original material of great importance to the different fishery interests. A few changes have also been made in the printing of the volume which are considered to be advantageous. The size of the page has been slightly enlarged to afford the necessary space for suitable illustrations, and the unbound edition of the volume has been issued in the form of completed papers instead of by signatures as heretofore, thereby permitting of a more judicious distribution of its several parts. The present bulletin is the eighth of the series.

MARSHALL McDONALD,
Commissioner.

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BULLETIN OF THE UNITED STATES FISH COMMISSION, VOLUME VIII, FOR 1888.

1.—EXPLORATIONS OF THE FISHING GROUNDS OF ALASKA, WASHINGTON TERRITORY, AND OREGON, DURING 1888, BY THE U. S. FISH COMMISSION STEAMER ALBATROSS, LIEUT. COMDR. Z. L. TANNER, U. S. NAVY, COMMANDING.[1]

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[1] This first report upon the explorations of the steamer *Albatross* along the western coast of North America contains the earliest positive information that has been obtained respecting most of the ocean fishing grounds of that important region. Its publication, it is hoped, will tend to stimulate the fishing interests in the North Pacific Ocean, and, at the same time, give substantial evidence as to the relative values of the different grounds that have been studied. Future investigations will be directed toward completing the detailed examination of the same region, and toward extending the researches farther north into Bering Sea, and farther south along the coasts of Oregon and California. The report has been compiled from the reports of Lieut. Commander Z. L. Tanner, commanding the steamer *Albatross*, and of Mr. Charles H. Townsend, naturalist, and Mr. A. B. Alexander, fishery expert of the same steamer, as explained on page 17. The introduction was written by Mr. Richard Rathbun. MARSHALL MCDONALD, *Commissioner*.

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A.—INTRODUCTION.

1. PREVIOUS KNOWLEDGE RESPECTING THE FISHING GROUNDS OF THE NORTH PACIFIC OCEAN.

Although it had been known for many years that the Pacific coasts of North America were abundantly provided with choice varieties of edible fishes, it was not until 1880 that even the economic species inhabiting that region were thoroughly studied and classified, and the Alaskan cod determined to be the same as the cod of the North Atlantic. The first cod brought to San Francisco from the North Pacific region were taken in 1863 off the island of Saghalien, in the Ochotsk Sea, by a vessel which discovered them by accident. Two years later seven vessels were engaged in this fishery, and in 1866 they began to fish in the neighborhood of the Shumagin Islands, on the Alaskan coast. The largest number of vessels that took part in this industry prior to 1880 was twenty-one, in 1870; while the largest catch was made in 1879 by thirteen vessels.

The absence of large and convenient markets has hindered the development of the ocean fisheries on the Pacific coast, notwithstanding that their practically unlimited resources have been widely known and frequently discussed. But with the completion of several railroads, affording the means of transporting fresh produce into the interior of the country, with the prospect of establishing a large and lucrative trade in salt cod and other species with the markets of South America and Asia, and, not least important, with the advent of New England fishermen, a renewed and stronger interest has sprung up in relation to these same fisheries, which seems destined to exert a marked influence upon the future welfare of the Pacific States and Territories.

Until the summer of 1888, however, no systematic investigations had been made to determine the extent and character of any of the fishing grounds located in the North Pacific Ocean. Prof. George Davidson, in the Alaska Coast Pilot for 1869, mentions several shallow off-shore soundings, indicating the existence of banks, on some of which he found cod to be abundant. In the report of the United States Department of Agriculture for 1870, Mr. William H. Dall has brought together all of the information that was obtainable at that time respecting the fishing grounds and food-fishes of Alaska. The same subject was further elaborated and brought down to 1880 by Dr. T. H. Bean, in two important papers which have been published by the U. S. Fish Commission.[1] The fishing grounds between the Straits of Fuca and Lower

[1] Tarleton H. Bean. The Fishery Resources and Fishing Grounds of Alaska. <The Fisheries and Fishery Industries of the United States, by George Brown Goode and a staff of associates. Section III, pp. 81-115. Washington, 1887.

The Cod Fishery of Alaska. <Idem. Section V, pp. 198-226. Washington, 1887.

California were also reported upon in 1880 by Dr. David S. Jordan, who was able to procure but few data concerning them, although many portions of this coast were otherwise well known.[1]

The following account of the Alaskan grounds is extracted from Mr. Dall's report:[2]

"The most fruitful of the Alaskan fishing grounds are considerably to the north of the limit of the migrations of the cod, and may be said to extend northwest from Yakutat or Bering Bay along the coast and the line of the Kadiak and Aleutian Archipelagoes. The cod banks are generally in the vicinity of land, yet off-shore banks have been and will continue to be discovered, though the fishermen endeavor to retain the secret of such discoveries. Such banks are usually to be looked for in the direction of the trend of the adjacent islands or in lines parallel to that trend. The soundings of Portlock, Vancouver, and the U. S. Coast Survey expedition prove the existence of a comparatively shoal bank extending along the southeastern coast of Afognak and Kadiak, with a deep pocket (no bottom at 90 fathoms), 25 miles east of St. Paul. The shoalest water found upon this bank by Mr. Davidson, of the U. S. Coast Survey, was 45 fathoms. It probably extends along the southeast shore of Kadiak. Belcher caught cod and halibut off Cape Greville, the eastern point of Kadiak. South by east 14 miles from the eastern end of the easternmost point of the Trinity Islands, Vancouver found bottom at 50 fathoms, and 15 miles south of Ukamok at 75 fathoms. Thirty-five miles east of the south end of the island of Niuniak, the most southern of the Shumagin Group, Mr. Davidson obtained bottom at 40 fathoms, and 9 miles southeast of the Sannakh Reef at 35 fathoms. Near this last-named locality Cook caught over one hundred halibut, ranging from 20 to 100 pounds each; he therefore called it Halibut Island. Mr. Davidson discovered a fine cod bank about 65 miles southeast (true) from the middle of Akutan Pass and 40 miles south-southeast from Unimak Pass. Here the water has a depth of 60 fathoms, with pebbly bottom. Many fine cod were caught, of which one was 36 inches long, 23 inches in girth, and weighed 27 pounds.

"Some of the vessels are said to commence fishing along the coast north of latitude 54° 40′ north, and to work northward along numerous banks which they have found. The fish are taken in from 15 to 40 fathoms, the very best fish in the deepest water. The banks along the Gulf of Alaska, around the Kadiak Group, and part of the Aleutian Chain have an area of not less than 45,000 square miles, with a depth of not over 50 fathoms. If the fishing depth extends to 100 fathoms there is little doubt that the cod-fishing area will reach 100,000 square miles. In addition to the fisheries of the Great Bank the cod are reported to run in great numbers in and around the entrance of Hamilton Bay, near the western part of Frederick Sound. Lisiansky caught them with hook and line in Sitka Sound, Portlock abundantly at Port Etches, and Belcher near Cape Chiniak."

After discussing the in-shore cod-fishing grounds along the Alaskan coast, Dr. Bean states that "extended areas of soundings on which cod assemble in great masses

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[1] David S. Jordan. The Sea Fishing Grounds of the Pacific Coast of the United States from the Straits of Fuca to Lower California. <The Fisheries and Fishery Industries of the United States, etc. Section III, pp. 79, 80. Washington, 1887

[2] The Food Fishes of Alaska. <Report of the Commissioner of Agriculture for the year 1870, pp. 375–392.

are present in the Gulf of Alaska, but they have been but little investigated, and their limits and characteristics are imperfectly known." He then describes each of the off-shore fishing banks known to exist in this region at that time, giving in some detail the incidental and unconnected observations by which they were distinguished. From this account the following summary has been prepared:

Portlock Bank.—Known chiefly from a single series of soundings extending in a northeasterly direction from the eastern end of Kadiak Island, about 115 miles, with more numerous soundings near the land. A few widely separated soundings indicated the extension of the bank along the southeastern side of Kadiak Island, where Albatross Bank has recently been developed by the Fish Commission. The extent and outline of these banks were wholly unknown.

Shumagin Bank, formerly called Simeonoff or Seminoffsky Bank, was indicated by only two accurate soundings off shore. This bank had, however, been resorted to by fishing vessels from which further information of a general nature was obtained. Its length was estimated by different persons at from 10 to 40 miles.

Sannakh Bank was located by two positions.

Davidson Bank, south of Unimak Pass, was known solely from the observations of Prof. George Davidson, of the U. S. Coast Survey, who made a number of soundings upon it in depths of 50 to 60 fathoms, and established its character as a fishing bank by making several successful trials for cod.

Single soundings are recorded by Dr. Bean south of Unalashka Island, south of Umnak Island, and south of Amchitka Island; and he also describes many grounds near the shore, especially in the neighborhood of settlements. Most of the fishing has been done on these in-shore areas "at such distances as may be traversed by canoes and dories."

The following extract from Dr. Jordan's report states concisely the condition of the ocean fisheries between the Straits of Fuca and Lower California at the time of his investigations in 1880:

"Except the salmon fisheries of the Sacramento and the Columbia, and the ocean fisheries in the immediate neighborhood of San Francisco, the fisheries of the Pacific coast exist only as possibilities. For the most part only shore fishing on the smallest scale is done, and no attempt is made to discover off-shore banks, or to develop them when discovered. * * * Between the rocky headland of Point Reyes and the entrance to the Golden Gate is a long stretch of smooth sandy bottom at a considerable depth. The bottom here swarms with flounders, and a mode of fishing is pursued analogous to the trawl net of the Atlantic—the fishing of the paranzella. This mode of fishing is doubtless possible outside of the kelp at many places along the coast, but the markets elsewhere are too small to make it profitable, excepting on a few small reefs in the neighborhood of the Farallones where rock cod abound, and at the mouth of Monterey Bay; and beyond this stretch of deep water now fished by the paranzella, we can hardly say that any definite off-shore fishing grounds exist south of the Straits of Juan de Fuca. Off the mouth of the Straits of Fuca, about 8 miles northwest of Cape Flattery, there is an extensive halibut bank where the Indians take halibut in large numbers, and which may some time become of importance to the white people."

2. PLANS AND NARRATIVE OF THE CRUISE.

Plans.—The steamer *Albatross* was dispatched to the Pacific coast for the purpose of investigating the ocean fishing grounds adjacent to the territory of the United States, and with a view to furnishing accurate information respecting their positions, characteristics, and resources, to the American fishermen. Barring the fact that they are much less resorted to at present than are the corresponding grounds upon the Atlantic coast, there was greater need of subjecting them to a careful survey, as even their outlines and surface contours had never been determined, while the same features of the eastern grounds have been known to a large extent for many years. The steamer *Albatross* is especially adapted for the different branches of this class of work, having all the most approved appliances for sounding, dredging, and fishing, many of which have originated or been perfected in the service of the Fish Commission. She was commanded by Lieut. Commander Z. L. Tanner, U. S. Navy, who had been in charge of all of her operations on the Atlantic coast. Mr. Charles H. Townsend, who had had several years' experience in Alaska, acted as naturalist, while fishery matters were attended to by Mr. A. B. Alexander, formerly of the Gloucester (Mass.) fishing fleet.

Considering that the season was well advanced before it was possible to begin active work, it was decided to send the *Albatross* directly to Alaska, where good weather for her operations could not be expected to continue beyond the summer months, after which she would return to the coasts of Washington Territory, Oregon, and California. The region selected for exploration was to the south and southeast of the Aliaska Peninsula and the easternmost of the Aleutian Islands, comprising the entire width of the submerged continental plateau between the island of Unalashka and the longitude of Prince William's Sound, as the principal known fishing banks were contained in this area. Lines of soundings were to be run over as large a part of the region as possible, with the object of locating all of the elevations of the bottom which might properly be designated as banks. The latter, wherever discovered, were to be carefully sounded over in order to determine their extent, outline, and surface contour, and the character of the bottom. The richness of the bottom as dependent upon the abundance of animal life, indicating good feeding grounds, and the actual presence, abundance, and size of edible fishes, especially the cod, were to be ascertained by frequent dredgings and by the use of hand lines and trawl lines. Attention was also to be paid to the surface-schooling fishes, to the important question of the bait supply, to the history and present condition of existing fisheries, and to all other matters bearing upon these subjects.

When the weather became unfavorable for continuing the work in the Alaskan region, the steamer was to return south, and, after refitting at Seattle, begin upon the same basis the exploration of the coasts of Washington Territory and Oregon.

Narrative.—The steamer *Albatross* left San Francisco, Cal., for Alaska July 4, 1888, at 9.30 a. m. Thirty live lobsters, being part of a shipment sent to California from the New England coast in June, were taken on board and carried as far as Trinidad Head light-house, California, in about latitude 41° N., where they were planted in a favorble locality which had been recommended by Prof. George Davidson. Being detained by head winds on the way to the coaling station at Departure Bay, Vancouver Island, it was considered prudent to make a short stop at Esquimalt, situated at the southeastern extremity of the same island, where a small supply of coal was obtained from Her Britannic Majesty's dock-yard. The coaling of the ship at Departure Bay was finished July 11, and she immediately proceeded northward by way of the inland passage between Vancouver Island and the mainland. An anchorage for the night was made in Tribune Bay. Seymour Narrows were passed the next morning just as the tide was beginning to ebb, which caused strong eddies and whirls, but the passage was made without difficulty. Stops were made the same day at Alert Bay and Fort Rupert for the purpose of obtaining a supply of clams to use as bait on the northern fishing grounds. A large number were secured at the latter place, where the steamer also anchored for the night.

Leaving Fort Rupert July 13, the steamer passed through Goleta Channel and thence into the open sea, where a course was laid in the direction of the Shumagin Islands. July 19 a line of deep-sea soundings was begun in a depth of 2,550 fathoms, latitude 52° 15′ N., longitude 156° 37′ W., and carried during that and two succeeding days, 390 miles N. 88° W. to off Unalashka Island. A line of soundings was run from the end of this series to the mouth of Kiliuluk Bay, Unalashka Island, and the investigation of the Alaskan fishing grounds was then begun. The details of this work are fully explained in a subsequent part of this report, and only the general progress of the steamer and the principal points of interest visited need be mentioned in this connection. The researches were carried northeastward from the vicinity of Unalashka to the reported position of Pamplona Rocks, the most time being spent in those regions where banks had been reported by the fishermen or where their existence had been conjectured upon other evidence.

Ten or eleven days were spent in the vicinity of Unalashka and Unimak Islands, including Davidson Bank. Soundings were carried through Unimak Pass and off the northern side of Akun and Akutan Islands to Iliuliuk Harbor, Unalashka, where a supply of coal was obtained and where opportunity was given to study the fisheries and the in-shore fishing grounds of the region. The reported positions of Lenard Rock and Anderson Rock south of the Sannakh Islands were examined July 30, and on the following day the steamer arrived at Humboldt Harbor, Popoff, one of the Shumagin Islands. At this place the services of Capt. Paul M. Pavloff, a well-known pilot of the coast, were secured. Subsequently, Eagle Harbor, Nagai Island, and Yukon Harbor, Big Koniushi Island, were visited. About six days were spent in the region between the Sannakh Islands and the Shumagins, and on Shumagin Bank, the exploration of which was completed August 6. From the Shumagin Islands soundings were carried to Mitrofania Island and Bay on the mainland, and thence to Lighthouse Rocks, Chirikoff Island, and the Trinity Islands, the *Albatross* arriving at Old Harbor, on the southern side of Kadiak Island, August 10. The development of Albatross Bank occupied five days, and on the 14th the harbor of St. Paul, at the eastern end of Kadiak Island, was reached. The steamer was detained here until the 20th in coaling and in studying the fisheries and shore fishing grounds, beginning the investigation of Portlock Bank August 21. On the afternoon of the 24th an anchorage was made off Middleton Island, which was visited the next day for the purpose of determining its precise position and the character of its surroundings. From this point the *Albatross* proceeded to one of the reported positions of Pamplona Rocks, in latitude 59° 03′ N., longitude 142° 40′ W., where a thorough search was made for these supposed dangers to navigation, but no trace of them was found within 20 miles of this locality. Having finished this examination, a course was laid down the coast, sounding and dredging stations occasionally being made on the way until September 1, when the steamer entered Goleta Channel and proceeded through the inland passage to Departure Bay, making night anchorages in Alert Bay and Tribune Bay. After coaling at Departure Bay the voyage was continued to Seattle, Wash. Several casts of the beam trawl were made during the inland trip from Goleta Channel southward.

It was September 6 when the *Albatross* arrived at Seattle, where she was detained until the 17th of the same month, undergoing a few necessary repairs. The examination of the coasts of Washington Territory and Oregon was then begun. During the progress of this work visits were paid to Port Townsend, Neeah Bay, Victoria, Barclay Sound, and Departure Bay, the last three places being on Vancouver Island. The first trip lasted until October 1, during which time the explorations were carried on along the outer coast from Barclay Sound, in the north, to off Shoalwater Bay, Washington Territory, in the south. Four days were spent at Seattle, after which the work was continued southward from Shoalwater Bay to Heceta Bank, Oregon, a visit also being paid to Astoria, at the mouth of the Columbia River. San Francisco was reached October 21.

3. SUMMARY OF RESULTS.

ALASKA.

As previously explained the steamer *Albatross* was sent to Alaska chiefly for the purpose of developing the off-shore fishing grounds occurring upon the submerged continental border south of the Aliaska Peninsula and the easternmost of the Aleutian Islands. Work was begun in the neighborhood of Unalashka Island and carried thence eastward to the reported position of Pamplona Rocks, in latitude 59° 03′ N., longitude 142° 40′ W. Although much foggy weather was encountered, making it difficult at times to locate the sounding stations with accuracy, the investigations were vigorously pushed and most successful results were accomplished. When detained in port for the purpose of coaling or to escape bad weather, attention was paid to the in-shore fishery resources and to the practical fisheries, respecting both of which subjects important information was obtained. In the report following this summary will be found a complete detailed account of all of these explorations, the brief outline of results here given having reference only to the off-shore grounds.

The five banks whose positions were indicated by older surveys, namely, Davidson, Sannakh, Shumagin, Albatross, and Portlock Banks, were more thoroughly examined than were the intervening areas, some of which, however, may, upon further examination, prove to contain fishing banks of equal value, and not inferior in size to at least the smaller of the banks mentioned. Good fishing was obtained at nearly all localities where trials were made with hand lines, whether upon defined banks or upon the more level grounds between them, and it is natural to infer that the entire submerged plateau from off Unalashka Island to Fairweather Ground is one immense fishing bank, limited upon the outer side only by the abrupt slope, which may be said to begin about the 100-fathom curve. Equally good fishing can not be expected to exist in all parts of this area, some places being more favorable for the feeding and spawning of the cod and halibut than others, and as a rule the larger fish have to be sought for in the deeper waters. This important tract of fishing ground can best be compared with the succession of well-known banks which skirt the southern border of the British Provinces on the eastern coast of North America from the Gulf of Maine to beyond Newfoundland, but its total area is much less.

HYDROGRAPHY OF THE ALASKAN FISHING GROUNDS.

Vicinity of Unalashka.—One line of soundings was made in approaching Kiliuluk Bay from the south, and another from the same bay in a southeasterly direction to the 100-fathom curve, which was traced eastward to Davidson Bank. A third line was also carried along the inner edge of the plateau from the entrance to Akutan Pass to Davidson Bank. These soundings were not sufficient to demonstrate the existence of a defined bank in this region, but it was estimated that an area of about 2,000 square geographical miles to the westward of Davidson Bank was suitable for fishing. The width of the plateau at this place varies from 15 to 24 miles inside of the 100-fathom line. Beyond this line the bottom drops off very suddenly here as elsewhere along this part of the Alaskan coast, a depth of 1,961 fathoms having been found within 34 miles of Unalashka.

Davidson Bank.—This bank was discovered over twenty years ago by Prof. George Davidson, of the U. S. Coast Survey, who made a number of soundings upon it in depths of about 50 fathoms, and found cod abundant in some places. Its outline and surface contour were established by the *Albatross* with considerable accuracy. The bank lies south of Unimak Island, and extends westward from the neighborhood of the Sannakh Islands to about the longitude of the southern entrance to Unimak Pass (about longitude 164° 40′ W.). Its eastern end seems to be continuous with the shoal water surrounding the Sannakh Islands; its area was estimated at about 1,600 square miles. The greatest width of the submerged plateau off Unimak Island is 45 to 50 miles. Depths less than 50 fathoms were found over a large part of the bank, 41 fathoms being the shoalest water discovered. Between this shallow area and the islands to the north and northwest of it depths of 50 to 72 fathoms occur.

Sannakh Bank.—The shoal water at the eastern end of Davidson Bank was traced some distance eastward along the southern edge of the Sannakh Islands, and between those islands and the reported positions of Lenard and Anderson Rocks; but still farther eastward on the same line of soundings (longitude 162° 22′ W.) a depth of 60 fathoms was found. Sannakh Bank begins immediately to the northeastward of this position, and covers an estimated area of about 1,300 square miles. Its outline and surface contours were established by the *Albatross*. It lies to the east and southeast of the islands of the same name, is somewhat elongated in shape, and trends in a general way northeast and southwest. A small area having depths of 30 to 37 fathoms occurs near the center of the bank. A depth of 63 fathoms was found between it and the Sannakh Islands, and depths of 75 to 82 fathoms exist off the northern edge in the direction of the Sandman Reefs.

Between Sannakh Bank and the Shumagin Islands.—In this area about 1,800 square miles, more or less adapted to fishing, were partly surveyed, the depths ranging from 38 to 74 fathoms. This region is free from the hidden dangers which render Sannakh Bank unsafe to those who are not well acquainted with its surroundings.

Shumagin Bank.—This bank lies to the south and southeast of the Shumagin Islands, and its outer margin follows approximately the trend of the coast line formed by the adjacent islands. It has been traced westward to about longitude 159° 52′ W., but probably extends farther in that direction. East of the Shumagin Islands it reaches north to the latitude of Big Koniushi Island. Its width inside of the 100-fathom curve varies from 15 to 35 miles, while its area has been estimated at about 1,800 square miles. The depths over a large part of the bank are less than 50 fathoms, and the bank is not separated from the islands by deep water.

Shumagin Islands to Kadiak Island.—Only a single series of soundings was carried across this wide area to the eastward of Shumagin Bank, with a double line extending from the neighborhood of Light-house Rocks to Mitrofania Bay. These soundings were insufficient to demonstrate the full value of this region, but they indicated the existence of several fishing banks the outlines and characteristics of which must be left for future investigations. The extent of the area thus partly developed was estimated at about 4,400 square miles.

Albatross Bank.—This bank lies off the southeastern side of Kadiak Island and extends the entire length of that island and also in front of the Trinity Islands. At the eastern end it is practically continuous with Portlock Bank. Along some portions of the coast, as in the neighborhood of Sitkalidak Island, the bank is separated from the land by comparatively deep water, while in other places shoal water intervenes. The 100-fathom curve is distant 25 to 45 miles from the land, inside of which limit there is an estimated area of 3,700 square miles. The existence of this bank was predicted by Prof. George Davidson upon the evidence of a few isolated soundings, which were the only ones that had been made previous to the investigations of the steamer *Albatross*, from which it has derived its name.

Portlock Bank.—This is the largest single bank that has yet been discovered on the Alaskan coast, its area inside of the 100-fathom curve being about 6,800 square miles, or only 1,600 square miles less than that of George's Bank, the second largest of the great banks of the western Atlantic. It extends northeastward from Kadiak Island, in the direction of Middleton Island, a distance of about 120 miles, and is irregular in shape. Isolated soundings of 68 to 81 fathoms occur near Kadiak Island, at the western end of the bank, but there are no indications of a marked or extensive depression between the bank and the land.

From Portlock Bank the soundings were carried to Middleton Island, the position of which was ascertained by a careful series of observations on a clear day. The reported position of Pamplona Rocks, in latitude 59° 03′ N., longitude 142° 40′ W., was next visited, but only deep water was found within a radius of 20 miles of this locality. The *Albatross* then proceeded to Washington Territory.

Character of the bottom on the banks.—Sand was the predominant material composing the bottom on these several banks, a gray sand being the most common. This was combined in many places with pebbles, gravel, or broken shells, which were also recorded separately in some localities. Mud rarely occurred upon the banks or anywhere inside of the 100-fathom line. Rocks were not found upon Davidson Bank, but on Sannakh Bank they compose a large part of the bottom, even in the deeper soundings. Rocky patches are numerous on Shumagin and Albatross Banks, but were observed only at the extreme western end of Portlock Bank, near Kadiak Island. In the region between Sannakh Bank and the Shumagin Islands the bottom consists of sand, mud, pebbles, gravel, and rocks, but the last-mentioned material occurs only in the neighborhood of the islands and of Sannakh Bank. In the corresponding area between the Shumagin Islands and Kadiak Island fine sand was most abundant in depths less than 100 fathoms, with the admixture in places of pebbles, gravel, and broken shells, and occasional patches of mud and coarse sand. Green and blue mud usually composed the bottom in depths over 100 fathoms, but sand and rocks were also recorded.

Off Unalashka sand was traced down to a depth of 228 fathoms, with mud at 261 fathoms. Black sand was found in 342 fathoms just off Davidson Bank, while mud occurred in 435 fathoms off Sannakh Bank, with rocky patches at depths of 265 and 464 fathoms. Sand and rocks composed the bottom off Shumagin Bank, in 105 to 119 fathoms. Off Albatross and Portlock Banks gray sand was discovered in 298 fathoms and black sand in 594 fathoms. Muddy bottom, however, occurs in places close to the 100 fathom line, but in the pocket which indents the southwestern end of the latter bank, with depths of 102 to 166 fathoms, the bottom consists entirely of sand. A rocky spot was found off Albatross Bank, in a depth of 485 fathoms.

RESULTS OF DREDGINGS AND FISHING TRIALS ON THE ALASKAN GROUNDS.

Dredging trials.—The beam trawl and the naturalists' dredge were frequently used upon the banks in order to determine the richness of the bottom as feeding grounds for fish. Nearly all the trials were very successful, resulting in the collection of a large amount of material bearing upon the natural history of this new and important region. The examination and identification of this material will, however, require considerable time, and until that has been done it will be impossible to report upon it fully, or, in fact, to state more than its general character and value. As was to be expected, the assemblage of forms strongly recalls the fauna of the great fishing banks of Eastern North America, and many of the species from these two northern regions will probably be found to be identical on both sides of the continent. The more conspicuous features of the hauls were the fishes, crustaceans, mollusks, and echinoderms. Edible fishes, crabs, and shrimps were frequently taken, the last-mentioned group often in great numbers. The dredging operations were entirely subordinated to those of sounding, as it was considered most important to first determine the outlines and contours of the banks, but the results were ample to prove the exceeding richness of the grounds with respect to the lower forms of animal life, upon which their value for fishing entirely depends. The details of the natural history work, so far as they can be given at this time, will be found in the main body of this report in connection with the discussion of each of the fishing banks.

Trials for fish.—The trials for fish on the Alaskan banks and other off-shore grounds were made entirely with hand lines. Cod and halibut were the principal species taken, and are the only ones to which we need refer in this connection. Six to nine lines were generally used at each trial, which occupied from fifteen minutes to something over an hour each, according to circumstances. Salt clams and salmon were chiefly employed as bait, and pollock, sculpins, and cod occasionally. The depth at which the fishing was done ranged from 27 to 84 fathoms, and every variety of bottom observed upon the banks was tried. A complete record of all the captures made, showing the number of individuals of each sex taken, and their average weight and length, will be found at the end of this report.

The fishing trials made by the *Albatross*, as every bank fisherman will understand, do not furnish positive or conclusive results with respect to the average size of the fish inhabiting the banks. The large cod, as a rule, are the last to be attracted by the bait, being "tolled" around the ship by the activity of the smaller fish in finding a new source of food. As time was too valuable, in the case of the *Albatross*, to permit of long stops at any single position, the records concerning the size of fish taken are less gratifying than might have been. A length of 28 inches is taken as the standard size for off-shore fish on the Atlantic coast, and all under this size command a lower price in the markets. Out of twenty captures of cod recorded by the *Albatross*, the average size of the fish attained this standard in only six instances; it was rarely below 24 inches, and generally above 25 inches. The trials were usually made during the progress of or subsequent to a sounding or dredging haul, the steamer often drifting with the tide and changing the ground before the lines had touched bottom. By anchoring, and especially by remaining some time in each position, much better results would undoubtedly have been obtained.

Halibut were secured at nearly every trial; a record of their size and abundance will be found in the description of each fishing ground, and also in the tabular statement above referred to.

In four trials made off Unalashka Island, aggregating eighty-five minutes, twenty-two cod were taken, averaging for the several trials from 21 to 28¾ inches in length. In one instance, on Davidson Bank, twenty-five cod averaged 28 inches, and in another, twenty-one cod, 24½ inches. Eighteen cod captured on Sannakh Bank averaged 23½ to 25 inches in length. The cod taken off Unga, one of the Shumagin Islands, had an average length of 30 inches; on Shumagin Bank, of 26½ inches, and near the Chirikoff Island of 23⅘ inches. Several trials were made on Albatross Bank, two of which were unusually successful. One was off Tugidak, the westernmost of the Trinity Islands, in 37 fathoms, where forty-seven cod were captured in thirty-eight minutes, and the other off Dangerous Cape, Kadiak, in 39 fathoms, where the capture amounted to sixty-nine cod in fifty minutes. At the former locality the fish averaged 28½ inches in length, and at the latter 30¾ inches, in both instances being above the eastern standard. Pair after pair of cod were hauled up in quick succession at each of these localities, and they were seizing the bait as actively at the close of the trials as at the beginning. Only one large catch of cod was made on Portlock Bank, in a depth of 36 fathoms, where thirty individuals, averaging 27 inches in length, were taken in the course of eighteen minutes.

Bait.—The bait question is one that will occasion no concern at present. The fishermen generally have no trouble in securing, during the progress of their work, all the bait they need, and several species of bottom-fish, taken in connection with the cod, prove sufficiently attractive for the latter species. It is therefore customary, in fitting out, to provide only a sufficient quantity of salt herring or salt clams to make the first few baitings, relying thereafter upon the supply of halibut, sculpins, or pollock captured on their own hooks. The yellow-fish (*Pleurogrammus monopterygius*) is generally considered to form the best bait that can be secured in these waters; but this species was not encountered by the *Albatross*. Sculpins, however, are regarded with scarcely less favor by the local fishermen, and they are everywhere abundant.

Salt salmon was also found to be very efficacious by the *Albatross*. There are times, however, when the cod prefer other kinds of bait than can be taken by means of the hook, such as squid, lant, or capelin, but all of these species are abundant in their season, in close proximity to the fishing grounds, and can readily be secured in nets.

WASHINGTON TERRITORY AND OREGON.

Halibut banks off Cape Flattery.—No hydrographic work was done north of Cape Flattery, as the contour of the bottom in that region had previously been determined with sufficient accuracy for the purposes of this preliminary survey. The dredging and fishing appliances were used, however, in several localities.

A well-known halibut bank, resorted to by the Indians, begins close to the shore in the vicinity of Cape Flattery, and extends thence northwestward some 15 miles with depths of 35 to 75 fathoms. Halibut are abundant here from early in the spring until the middle of June, when the bank becomes infested with dogfish and sharks. It was in this locality that the Gloucester schooner *Mollie Adams* obtained its fares of fresh halibut which were shipped to eastern markets during 1888. The bottom was found by the *Albatross* to be exceedingly variable, consisting of rocks, sand, mud, and shells, and the dredging appliances suffered severely, but all of the hauls were successful, demonstrating that the bottom is exceedingly rich in the lower forms of animal life. Two trials for fish with trawl lines were made on this bank, one in 40, the other in 59 fathoms. In the former four halibut, averaging 47¾ pounds in weight, and in the latter two halibut, averaging 55 pounds in weight, were captured. Several sharks and dogfish were also secured. It was considered that a vessel properly equipped might pick up a good fare of halibut at this season, in a comparatively short time, but the fish were very much less abundant than they are reported to be in the spring. It has been shown, however, by the experience of the *Mollie Adams* that successful summer trips for halibut may be made to more northern localities. This schooner left Seattle July 24, on a fletched halibut cruise, and, after trying in several places, found the fish abundant off the southern extremity of Queen Charlotte Islands, in depths of 30 to 45 fathoms. The vessel continued on these grounds until September 8, fishing during nineteen days, and securing a fare of 150,000 pounds. About half of the halibut taken were large enough for fletching, the remainder being used as bait or thrown away. The crew received $175 each as their share of the proceeds, or at the rate of about $9 for each fishing day. Two such trips could probably be made in the course of a season, while the fletched trips to Greenland or Iceland from New England ports consume an entire season. One of the chief obstacles to the financial success of the fresh halibut fishery on the Pacific coast is the high price which the fishermen have to pay for ice, but it is expected that better arrangements will be possible in the future.

The work of the *Albatross* was extended from the bank off Cape Flattery to the neighborhood of Barclay Sound, Vancouver Island, where the bottom was found to be less rich than farther south. The trawl lines were set in four separate localities, with depths of 24 to 66 fathoms. The total catch amounted to five halibut, one black cod, one cultus cod, thirty-nine dogfish, and seven sharks, but the indications were that good halibut fishing might be found in this region in the spring.

Another halibut bank known to the Indians occurs off Flattery Rocks and between those rocks and Cape Flattery. Only one halibut, weighing 140 pounds, was taken on the trawl lines, the catch consisting here, as elsewhere, mainly of sharks and dogfish. The bottom in all places where it was examined was composed of sand. While the Indians visit this bank in the spring it is not known whether the halibut are sufficiently abundant to encourage vessel fishing.

After the numerous fishing trials made by the *Albatross* on this part of the coast, both with trawl lines and hand lines, it became evident that sharks and dogfish had taken possession of the grounds to the almost entire exclusion of edible fishes. In the spring these pests are rarely seen, but it is not known at what time in the fall or winter they disappear, as there has been no fishing done during those seasons, and no investigations had been made prior to the visit of the *Albatross*.

The outer coast of Washington Territory.—Hydrographic soundings were carried on systematically along the entire outer coast of Washington Territory and as far south as Tillamook Rock, Oregon. The locality of certain fishing banks reported to exist some 60 to 75 miles southwest of Cape Flattery was visited, but no traces of the banks were found. Down to Gray's Harbor the soundings inside of the 100-fathom line indicate a nearly uniform bottom of gray sand. A bank reported by the Indians was, however, discovered and developed by the *Albatross* off Gray's Harbor. The bank begins about 15 miles southwest (magnetic) from Point Chehalis and extends thence about 20 miles in a southwesterly direction. It has an extreme width of about 12 miles, and the bottom consists of sand, rocks, and mud. The dredging trials showed a rich bottom, and by means of the trawl and hand lines thirteen red rockfish, two black cod, and several sharks were captured.

Coast of Oregon.—The trawl lines were set on the fishing grounds about Tillamook Rock, a short distance south of the mouth of the Columbia River, taking only seven dogfish, but the dredges brought up evidences of a rich bottom, indicating that good fishing might be obtained there at some seasons.

Heceta Bank, which had been partly surveyed before, was further developed by the *Albatross* and found to have a length of about 20 miles and a width of about 10 miles. The bottom is rocky, alternating with patches of clay and pebbles, and supports a richer fauna than was discovered anywhere else to the south of Cape Flattery. One halibut, weighing 10½ pounds, one black cod, one dogfish, and one shark were the only fish taken on the trawl lines. The finding of halibut at this locality gives promise that the bank may prove of some value during the early part of the year. It is not resorted to at present, and the fishermen are unacquainted with its resources.

RICHARD RATHBUN.

B.—REPORT OF THE EXPLORATIONS IN ALASKA.[1]

4. DEEP-SEA SOUNDINGS SOUTH OF THE ALEUTIAN ISLANDS.

Approaching the Aleutian Islands, sounding was begun July 19 in latitude 52° 15′ N., longitude 156° 37′ W., 2,550 fathoms, the bottom consisting of brown ooze. This was the first of a series of ten soundings, extending N. 88° W. 390 miles, and made to further develop a remarkable submarine depression discovered by the U. S. S. *Tuscarora* in 1874 to the southward of the Aliaska Peninsula and the easternmost of the Aleutian Islands. The soundings of the *Tuscarora* revealed a depression simply, but geologists have predicted the existence of a submarine trough, running parallel to the islands and extending probably their entire length, to the sounding of 4,037 fathoms made by the *Tuscarora* off Attu Island. The *Albatross* soundings, supplementing those of Captain Belknap, developed this predicted trough to the extent of 400 miles. Its direction, where determined, is S. 65° W. and N. 65° E., nearly parallel with the trend of the islands, the center being 60 miles from the Shumagins and 100 miles from the southwestern extremity of Unalashka. It is about 30 miles in width between the 3,000-fathom lines, with a maximum depth of 3,820 fathoms in latitude 52° 20′ N., longitude 165° W.

Having crossed the trough and reached the normal depth west of it, the *Albatross* ran a line to the island of Unalashka, in the vicinity of Kiliuluk Bay, developing the contour of the slope and locating its position with reference to the land, on the afternoon of July 21. At 5.30 p. m. that day a sounding was made in 28 fathoms off Kiliuluk Bay.

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[1] These reports have been compiled from the three separate reports of Lieut. Commander Z. L. Tanner, U. S. Navy, Mr. Charles H. Townsend, and Mr. A. B. Alexander, covering the different branches of the work prosecuted during the cruise, all of which were, however, carried on under the direction of Lieutenant-Commander Tanner. No material from other sources has been added. The original reports were in narrative form. They have been combined, rearranged, and in large part rewritten, in order to present the results of the explorations in more convenient form for reference. The account of the natural history work was furnished by Mr. Townsend; that relating to the fishing trials and the fisheries by Mr. Alexander, while Lieutenant-Commander Tanner is responsible for the hydrographic results, including the charts of the fishing grounds, the narrative of the cruise, sailing directions, and most other matters not specified above. The detailed report of the latter will be published in the annual report of the U. S. Commissioner of Fish and Fisheries for 1888.

All bearings mentioned in this report are "true" unless otherwise stated.

5. UNALASHKA ISLAND TO UNIMAK ISLAND.

HYDROGRAPHIC WORK, DREDGINGS AND TRIALS FOR FISH.

Hydrographic work.—The general contour of the slope approaching Unalashka Island from the south was developed in the manner described above. Leaving Kiliuluk Bay on the afternoon of July 21, the *Albatross* ran a line of soundings in a southeasterly direction, a distance of about 20 miles to the 100-fathom curve, which was traced approximately 95 miles northeasterly to latitude 53° 42′ N., longitude 163° 57′ W., depth 95 fathoms, on the southern edge of Davidson Bank. Subsequently four lines of soundings were made inside of the 100-fathom curve between the Aleutian Islands lying to the eastward of Unalashka and the region of the Sannakh Islands, in part crossing Davidson Bank. A line was also run through Unimak Pass, off the southwestern end of Unimak Island, and thence from off the northwest cape of the latter island in a southwesterly direction to the north head of Akutan Island. After coaling at Iliuliuk, soundings were begun July 28 at the southern entrance to Unalga Pass, and carried thence in the direction of Davidson Bank.

Depths of 30 to 72 fathoms were found in Unimak Pass, 71 fathoms at the southern entrance, and 80 to 85 fathoms at the northern entrance.

Dredgings.—Four dredgings with the beam trawl were made in this region in close proximity to the land. Two hauls were made off the north head of Akutan Island at distances of 2 and 6 miles from land, in depths of 56 and 72 fathoms, the bottom consisting of black sand. One was off the southern entrance to Akutan Pass, in 45 fathoms, broken shells and pebbles, and the fourth was 10 miles farther to the eastward, off Rootok Island, in 54 fathoms, sand, broken shells, and pebbles. The fishes taken to the northward of Akutan Island were, "cusk," stellate flounders, sea ravens, sculpins, and several small specimens of the family *Agonidæ*.

At the two stations to the southward of Akutan Island there were secured several species of flounders, a kind of lump-fish, a scaled sculpin, several species of *Agonidæ*, one ray, and other small forms. Of invertebrates, crustaceans (especially crabs and shrimps), mollusks, and echinoderms were exceedingly abundant in most of the hauls, and other groups were largely represented.

Trials for fish.—The first trial for fish was made as the steamer approached Unalashka, about 15 miles south of the entrance to Kiliuluk Bay in 84 fathoms; bottom, black sand and pebbles. One line, baited with salt clams, was put over at this station, and the bait was seized almost as soon as the lead touched bottom, an 11-pound cod being secured. At three subsequent hydrographic stations during the day, on the slope between Unalashka and the 100-fathom line, the bottom consisting of sand, further trials were made, using from two to eight lines at a time. These trials were all successful, and at one station a chicken halibut weighing 15½ pounds was captured. The total catch for the day was twenty-two cod, one halibut, two flounders, and two sculpins. The average weight of the cod ranged from 8 to 11¾ pounds; the average length, from 21 to 28¾ inches. Shrimps and small fish-bones were found in the stomachs of the cod, and a partly digested fish in that of the halibut.

Directly off the southern entrance to Akutan Pass, in a depth of 45 fathoms, the bottom consisting of pebbles and broken shells, no success was had, but only one line, baited with salt clams, was used for twenty minutes. Ten miles to the eastward of this point, in 54 fathoms, sandy bottom, six lines, baited with clams and salmon, caught two cod, three halibut, and one flounder.

Off-shore fishing grounds.—The area lying between the longitude of Ugomok Island, at the southern entrance to Unimak Pass, and that of Kiliuluk Bay (longitude 164° 55′ to 167° W.), and between the coast line and the inner edge of the steep submarine slope, gives promise of affording important cod and halibut fisheries, but its characteristics are as yet very imperfectly known. Its extent, inside of the 100-fathom line, is estimated to be about 2,000 square geographical miles.

South of Unalashka the 100-fathom line is distant 15 to 24 miles from the coast, approaching nearest to Cape Prominence, near the center of the island, and receding from the land toward the eastward. Off Tigaldi Island it is distant about 25 miles from land. Beyond the 100-fathom curve the depths increase rapidly, 1,961 fathoms having been found about 34 miles off the nearest point of Unalashka Island.

The only soundings made on this area are two lines between Kiliuluk Bay and the 100-fathom line, which is developed to the eastward as far as Davidson Bank, and one line along shore from Akutan Pass to off Ugomok Island. The bottom consists chiefly of sand, varying in color from gray to black, and with broken shells, pebbles, and gravel in places. Sand was traced on the edge of the slope to a depth of 228 fathoms, but in 261 fathoms green mud was discovered. These few soundings do not indicate the existence of a defined bank in this area, separated from the coast by deeper water, but such an elevation may occur in its unexplored portion.

Two dredgings only were made in this region, and they were both close inshore, as follows: off Akutan Pass, in 45 fathoms, and off Rootok Island, in 54 fathoms. They indicate an exceedingly rich bottom, as previously explained. All of the trials for fish described above were also made on different parts of this ground.

UNALASHKA HARBOR.

Approaching Unalashka Harbor from the northeast.—"The volcano of Akutan, 3,332 feet in height, became prominent as we approached the island of that name (on the northern side), although the summit was enveloped in fog. The whole visible portion of the island was covered with a luxuriant growth of grass which could be seen surrounding great patches of snow still remaining in the gorges at an elevation of 1,000 feet or more; but there was not a tree of any kind to be seen.

"Two hauls of the beam trawl were made off the northern extremity of Akutan. We then laid a course for Cape Cheerful, about S. 55° W., 24 miles distant. It was not visible until we were nearly up with Kalekhta Point, when it came out of the fog with such remarkable distinctness that it appeared close at hand in comparison with Kalekhta, not one-third the distance from us, but just visible through the mist. Appearances were so deceptive that it was only after cross-bearings had been taken that we could convince ourselves that we were not several miles out of position.

"Priest Rock, near Kalekhta Point, is nearly as high as the point itself, is very conspicuous and an unmistakable landmark when open of the point, but in approaching from the northward it does not begin to open until it bears about S. 67° E. Needle Rock, lying off the northwest extremity of Amaknak Island, near Ulakhta Head, is a small pinnacle which has been mistaken for Priest Rock when the latter has been obscured by fog or mist, and has led vessels to the westward of the island into Captain's Bay, instead of Iliuliuk, the port to which they were bound. It may be said that cross-bearings would make such a mistake impossible, but it too often happens in this region that anchorage must be made on a momentary view of one point only. Priest Rock once recognized, there should be little difficulty in reaching Unalashka, as a direct course leads to the outer harbor.

"We anchored in the inner harbor of Iliuliuk at 3.15 p. m., July 23, entering without the least difficulty, the channel having been buoyed by the Alaska Commercial Company. The steamer *St. Paul*, belonging to the company, was at the wharf, preparing for a trip to the Seal Islands; and at the mooring buoy was the schooner *Angel Dolly*, with a cargo of walrus hides which she had taken in Moller Bay."

Unalashka Harbor to the Pacific Ocean, through Unalga Pass.—"Fog and rain prevailed, with intervals of partially clear, pleasant weather, during our stay in port. We left Iliuliuk at 9 a. m., July 28, after several hours' detention by a dense fog, which, however, had begun to lift at intervals, enabling us to see land at a distance of half a mile. Rounding Kalekhta Point, we stood for the southwest extremity of Unalga Island and through the pass of that name, which is to be preferred to all others for a steamer bound to or from Unalashka, particularly in thick weather.

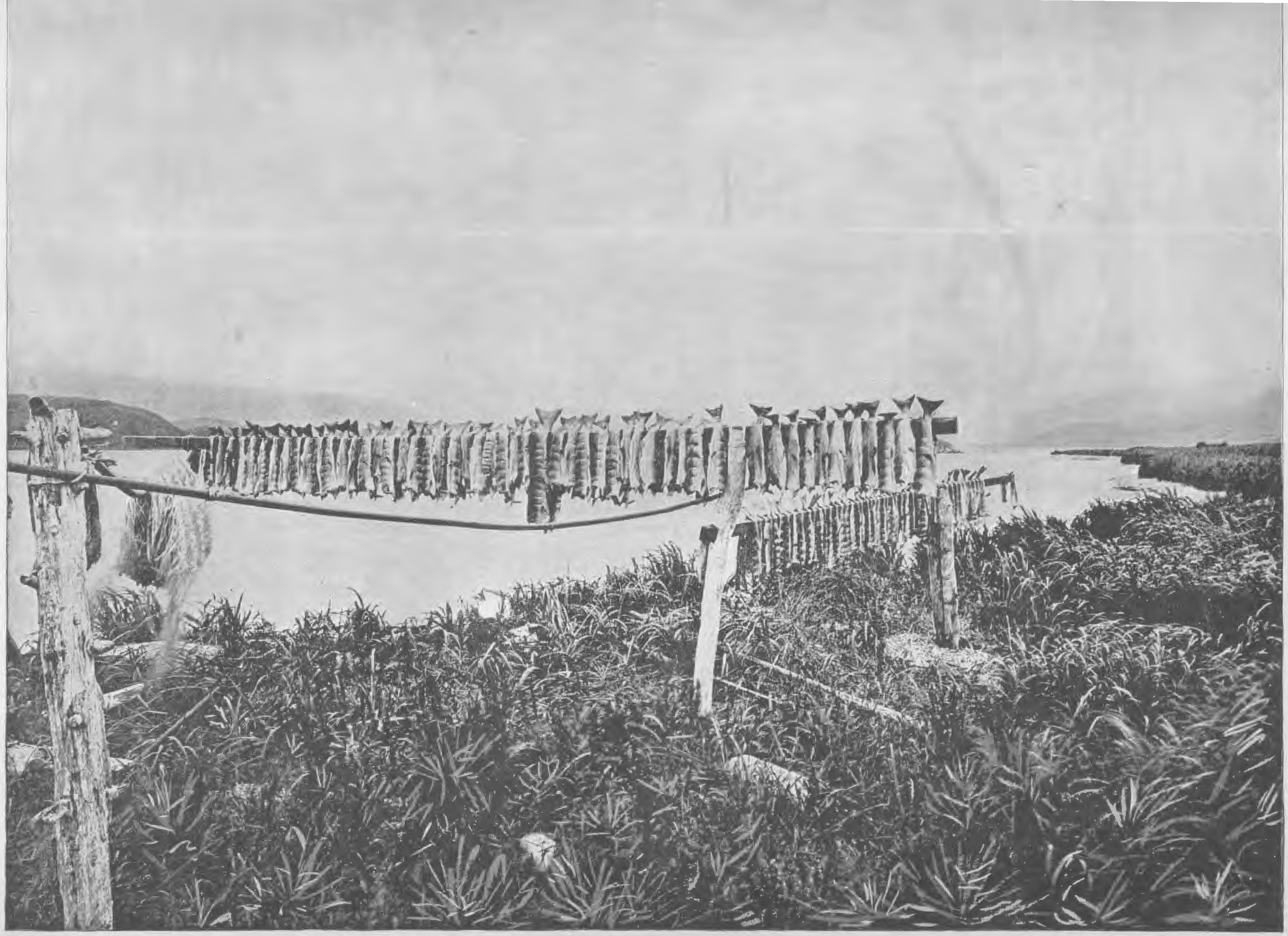
"The distance through is short, and there are no hidden dangers, the rocks bordering the shores on either side being close to the land and above water. The tide rushes through the narrows with great force, causing heavy rips, and at times overfalls, but it was quite smooth when we passed out near high water. A vessel bound in would make the Signals, Egg Island, and the Old Man, lying off Cape Burka, all of which can be approached with comparative safety, the distance from the last-mentioned to the southeast extremity of Unalga Island not exceeding 4 miles. Once in the pass, a vessel has only to keep Unalga Island in sight until passing its southwest end, when it is about 2 miles to Erskine Point and about 3½ miles to Kalekhta Point.

"There is a rock off Erskine Point which in thick weather might be mistaken for Priest Rock, but it may be recognized by another one between it and the point, having a flat top and showing smallest at the base. In approaching Kalekhta Point, Priest Rock will begin to open out at WSW. ¼ W. (magnetic).

"A full-powered steamer may use this pass at any stage of the tide, if time is an object; but under ordinary circumstances it would be advisable to enter it near slack water. We found 30 fathoms at the southern entrance to the pass in mid-channel, and 36 fathoms 2 miles north of Old Man Island.

"It is not intended to include sailing directions for the Aleutian Islands in this report, and my only excuse for describing this pass so much in detail is that there is no published information concerning it, as far as I know, and it would naturally be avoided by a stranger unless he had some such information as I have given."

Collecting in the harbor and vicinity.—Shortly after the *Albatross* came to anchor in Iliuliuk Harbor, several flounders and a specimen of the Alaskan pollock (*Pollachius chalcogrammus*) were caught on hand lines baited with salt clams. The three following days were spent in seining about the harbor, and nearly every suitable spot for that purpose was visited. On two occasions about half a boat load of salmon were taken in the seine in a little cove on the northern side of the harbor, near where the ship was anchored. Two species were included in the catch, the humpback salmon (*Oncorhynchus gorbuscha*), and the dog salmon (*O. keta*).



NATIVE METHOD OF DRYING SALMON (UKALI) AT UNALASHKA, ALASKA. (See page 22.)

The seining within the harbor was everywhere successful, but the few hauls made at or near its mouth were unproductive, due probably to the fact that in these places the water deepens rapidly from the shore, and the sea becomes rough whenever the wind blows up the harbor. The natives take cod in these exposed situations, but no trials for bottom-fish were made by the *Albatross* outside of the harbor. A diligent search was made for clams, but only about half a bucketful was obtained. These were placed in a tub and covered with mud, in which they lived for nearly three weeks. Squid are said to be abundant at times in different parts of the harbor, lying concealed beneath the sea-weed, but, although constantly searched for, only a single individual was observed during the stay in port. Failing to obtain a sufficient quantity of clams for use as bait, about two-thirds of a barrel of salmon slivers were salted for that purpose, and subsequently they proved to answer effectively in fishing for cod. Considering the present abundance of salmon in this region, their use as bait is not now regarded as an extravagance. Several hauls of the seine were made at the head of Captain's Harbor, where salmon were found to be as abundant as in Iliuliuk Harbor.

Oncorhynchus gorbuscha was the principal species of salmon taken by the *Albatross* party, a few specimens only of *O. nerka* being secured. The red spotted trout (*Salvelinus malma*) was seined both in the bay and in the fresh-water lake, and was everywhere abundant. Other common species were the *Pleuronectes stellatus* (starry flounder), *Lepidopsetta bilineata*, *Hemilepidotus jordani*, and *Clupea mirabilis* (herring). Among the smaller fishes were several specimens of *Murænoides ornatus*, varying in color from light yellow to dark red. Sticklebacks (*Gasterosteus*) abounded in the fresh-water lake.

Large collections of marine invertebrates were obtained from the shores in this region.

Fishing Notes: Fishing gear.—The wooden halibut-hooks described by Petroff, Turner, and others are still used by the natives of Unalashka. The regular cod-hook is, however, employed in the cod fishery. The fishing lines are of various sizes, and are made of any suitable material which comes to hand—cod-line, sail-twine, and even pieces of old string tied together. Pieces of lead, old spikes, bolts, and stones serve as sinkers. Drag seines are used for capturing salmon. They are from 20 to 50 feet long, and about 5 feet deep, with the mesh ranging in size from 6 to 9 inches. These seines are rudely constructed, having inflated bladders or blocks of wood as floats, and pieces of lead or stones as sinkers. They are generally handled by the boys and superannuated men of the village, who do not accompany the seal hunters on their summer voyages.

Cod bait.—Sculpins, flounders, salmon, and clams are used for cod bait, whichever of these species is most easily obtained at the time being employed. It is also stated that smoked bacon is sometimes put to the same use and serves equally as well.

Boats.—Dories are mostly used about the harbor for ordinary fishing purposes, but when long distances are to be traversed the favorite bidarka is generally employed. In connection with the bidarka the double paddle is invariably used on fishing trips; but it is stated that in sea-otter hunting the single paddle is preferred by the skillful hunters.

Use of cod and halibut by the natives.—Cod and halibut are not sought for by the Indians and creoles of Iliuliuk for commercial purposes, and they are only taken to supply home wants. Large quantities are never kept on hand, but a short fishing trip to Captain's Harbor, or some other favorite ground, generally satisfies the immediate demands.

Preparation of ukali.—On the beach, at the head of Captain's Harbor, the preparation of ukali was observed. When the seine is hauled the salmon are at once killed by breaking the backbone just back of the head, to prevent their thrashing around and becoming injured or covered with dirt. The Indians then proceed to split them, holding the fish by the gills in the left hand. A long sharp knife is inserted just below the nape-bone, and drawn thence close along by the backbone to within about 2 inches of the tail. Reversing the fish, the same cut is made on the other side, and a final stroke of the knife severs the backbone close to the tail, thereby detaching the edible portions from the head, bones, and viscera. The two slivers being connected at the tail may then be thrown over a line or frame to dry. In dry weather the slivers are cut apart and the curing is done upon flakes similar to those used for cod.

At the time of the *Albatross's* visit the Aleuts were engaged in catching and drying the salmon in this manner in considerable numbers. The drying frames were usually protected by a grass-thatched roof. When not so protected it is the custom to bunch the fish together upon the poles at night and cover them with canvas, or take them indoors.

Advantages of Unalashka for the establishment of fishing stations.—Many places in the neighborhood of Unalashka are well suited to the construction of buildings, wharves, marine railways, weirs, and other structures necessary to the formation of a fishing station. The numerous bays and other indentations of the coast, as well as the narrow passage-ways between the islands, afford convenient shelter to vessels during stormy weather, and the nearness of the island to the fishing grounds, both north and south of the Aleutian Chain, specially adapts it as a fishing center. Should the climate prove too damp for the thorough drying of the fish, they could be landed here from the fishing vessels, and after being partly cured could be carried to Puget Sound or San Francisco for final treatment.

Favorable grounds for planting lobsters.—The sea-bottom in this region appears to be exceedingly well suited to the habits of the Atlantic coast lobster, and it is probable that they would live and multiply if a colony were once established here. They would find ample protection and an abundance of food in the many coves and among the rocks and islands with which the region abounds.

6. NOTES ON THE COD FISHERY OF BERING SEA.

While at Humboldt Harbor, Shumagin Islands, the schooner *Arago*, owned by Lynde & Hough, of San Francisco, arrived in port from a cod-fishing trip in Bering Sea with a fare of 103,000 cod. She had been absent from San Francisco since April 12, began fishing May 18, and left the grounds July 12. The *Arago* is of 176 tons burden and carries twenty-one men and twelve dories. She is greatly inferior in type to the poorer class of off-shore fishing vessels on the eastern coast, and would not command a crew from Gloucester or Portland. She is thirty years old and was built at Goose Bay, Cal. The floor timbers used in her construction were taken from an English bark which was wrecked at that place.

No trawling is done in Bering Sea, "dory fishing" being the only method followed. During the season of 1887 the schooner *Constitution* tried trawl fishing, but soon aban-

METHOD OF PROTECTING SALMON FROM THE RAIN, WHILE DRYING, BY MEANS OF A GRASS-THATCHED ROOF, UNALASHKA, ALASKA. (See page 22.)

doned it on account of the sea fleas (Amphipod crustaceans), which were very abundant on the bottom, and devoured or injured the fish before the lines could be hauled. Trawl lines were again tried this season by the *Arago*, but with no better success, and they were obliged to return to hand-line fishing.

Mr. Edwin Torbin, first mate of the *Arago*, states that they found the best fishing in latitude 56° 40′ N., 10 to 15 miles off shore, in depths of 19 to 24 fathoms, sandy bottom. A few herring were taken along for the first baiting of the lines to secure halibut, after which the latter species was exclusively used as bait. Mr. Torbin has engaged in fishing on the banks both to the south and north of the Aliaska Peninsula, and considers Bering Sea cod superior to the others. Fogs and rains are also much less prevalent during the fishing season in Bering Sea than to the south of the peninsula.

A bank lying about 20 miles to the northward of Unimak Pass has yielded some of the largest cod taken in Alaska, and is occasionally resorted to by the fishing vessels. It is called "Slime Bank" by the fishermen, who report that it is covered at a fathom or two above the bottom with a dense layer of slimy *Medusæ*, which generally prevents the hooks reaching bottom in a clean condition. The nature of this peculiar phenomenon is unexplained, but it may be due to a dense growth of large algæ. Cod are said to respond quickly to the bait when it is not covered with slime.

Only two vessels were fishing in Bering Sea during 1888, and it is customary to make only a single trip to that region during a season. This year the *Dashing Wave*, of San Francisco, contemplated starting upon a second trip, but the attempt was finally abandoned. The gear employed by these fishermen is similar to that used by the hand-line dory fishermen on the Western Bank, but it is not so neatly rigged. The fishing leads are made by the crews of the vessels, and therefore do not compare in finish with those of New England. The lines are not tarred, and soon show signs of wear. Patent swivels are apparently unknown; none of the crew of the *Arago* had ever seen or used them; but after the method of working them, and their advantages, had been explained the fishermen expressed their intention of giving them a trial next year. The dories correspond in shape and size with those used upon the eastern coast, the only perceptible difference noticed being that the stem, timbers, and planking are a trifle heavier. They are manufactured in San Francisco by Lynde & Hough. Galvanized-iron rowlocks are used instead of thole-pins.

7. DAVIDSON BANK.

Hydrography.—Davidson Bank, so named in honor of Prof. George Davidson, of the U. S. Coast and Geodetic Survey, who first reported it, lies south of Unimak Island, and extends westward from the vicinity of the Sannakh Islands to about the longitude of the southern entrance to Unimak Pass (longitude about 163° 18′ to about 164° 40′ W.). Its area inside of the 100-fathom curve is estimated to be about 1,600 square miles.

The 100-fathom line was located approximately by the steamer *Albatross*. It makes a rather strong outward bend in about longitude 164° W., where it is distant 45 to 50 miles from the nearest point of Unimak Island.

Five lines of soundings were run across this region inside of the 100-fathom line. The shoalest water discovered was 41 fathoms, in latitude 54° 06′ N., longitude 164° 17′ W.; but depths less than 50 fathoms were found over a considerable area, the center of which is about latitude 54° N., longitude 164° W. A depth of 43 fathoms was sounded on the southeastern part of the bank, within about 8 miles of a depth of 342 fathoms. Between the shoaler area of the bank and the adjacent land to the north and west the following depths occur: Toward Unimak Island, 51 to 72 fathoms; toward Ugomok Island, 52 fathoms; toward Tigalda Island, 50 to 61 fathoms. The sounding of 41 fathoms above mentioned is the nearest to land of any less than 50 fathoms made upon the bank, excepting in the direction of the Sannakh Islands. It is about 20 miles from Seal Cape, Unimak Island, and about 22 miles from Ugomok Island. A depth of 63 fathoms was found directly off Promontory Cape, Unimak.

Toward the eastward the shoal area of the bank extends close to the Sannakh Islands, if it is not continuous with them, depths of 25 to 44 fathoms being found near together over a small area, just to the southwest of the islands. This shallow water (43 to 44 fathoms) also continues part way along the south side of the Sannakh Islands, midway between them and the reported positions of Lenard and Anderson Rocks.

A line of soundings extending S. 15° E., from off the northeastern end of Ugomok Island toward Davidson Bank, shows less depths than occur elsewhere between the shoaler part of the bank and the shore, which seems to indicate a deposit along this line from the swift currents of Unimak Pass.

The bottom upon the bank consists, in different places, of fine to coarse sand, pebbles, and gravel. Green mud was found at a depth of 95 fathoms, near the outer edge of the bank, and black sand in 342 fathoms just off the bank.

Dredgings.—The beam trawl was used once on Davidson's Bank, at Station No. 2845, latitude 54° 05′ N., longitude 164° 09′ W.; depth, 42 fathoms; bottom, coarse black sand. Among fishes, twelve specimens of *Hemilepidotus jordani*, and twenty or more specimens of *Lepidopsetta bilineata*, together with two or three small unidentified species, were taken. Shrimps and crabs were common, mollusks in small numbers, sea urchins and brittle stars very abundant.

Trials for fish.—Two trials for fish were made on Davidson Bank—one at dredging station No. 2845, the other at hydrographic station No. 1166. The former was in latitude 54° 05′ N., longitude 164° 09′ W.; 42 fathoms; coarse black sand; clams and salmon being used as bait. The weather was foggy, southerly and easterly winds prevailing. Twenty-five cod were caught here in a period of twenty minutes, the bottom being fairly alive with them and the bait seized as rapidly as it touched bottom. The average weight of the fish was 11¾ pounds, the average length 28 inches. The other trial was made on the eastern end of the bank, in latitude 54° N., longitude 163° 45′ W.; 45 fathoms; fine sand; salt clams being used as bait. While the fish seemed to be plentiful they did not bite as well as usual, a fresh breeze causing the ship to drift rapidly to leeward. Eight lines were in use for about an hour, taking twenty-one cod and one halibut during the drift. The halibut weighed 6½ pounds; the cod averaged 11¾ pounds in weight and 24½ inches in length.

Davidson Bank is said to be annually visited by large schools of herring, squid, and other pelagic species, moving from deep water toward the coast, and fishing vessels furnished with suitable gear might obtain large quantities of surface bait with little trouble.

8. SANNAKH ISLANDS TO THE SHUMAGIN ISLANDS, INCLUDING SANNAKH BANK.

REPORTED DANGERS SOUTH OF THE SANNAKH ISLANDS.

Lenard Rock and Anderson Rock.—"We were under low speed during the night and early morning of July 31, awaiting daylight, to approach reported dangers—the first, Lenard Rock, in latitude 54° N., longitude 163° 12′ W., and the second, Anderson Rock, in latitude 54° N., longitude 162° 47′ W., the latter showing above water. We intended passing over the positions given, and supposed we had done so until some hours later, when we found that we were about 12 miles N. 57° E. out of our reckoning. The low speed at which we ran all night and the prevalence of a moderate southerly breeze probably account for the unusual effect of current upon our positions. At 7.45 a. m. we left the above station, and stood S. 7° E., 10 miles, finding bottom at 51 and 464 fathoms, the latter S. 52° E., 3 miles from the reported position of Anderson Rock. We saw no indications of shoal water, but that proved nothing, as we were enveloped in so dense a fog that we were unable to see more than a quarter of a mile, most of the time, and probably not to exceed one-half mile at any time while we were in the vicinity.

"The rock may be in or near the position assigned it, but, considering the influence of the current on our course from Promontory Cape and the absence of any indication of shoal water in our last two soundings, it seems possible that the rock seen by Captain Anderson might have been one of the outer rocks on the Sannakh Reefs."

SANNAKH BANK.

Hydrography.—The shoal-water area of Davidson Bank (43 to 44 fathoms) was traced eastward between the Sannakh Islands and the reported positions of Lenard Rock and Anderson Rock, in a single line of soundings, extending about half the length of the former group. In about the same latitude as this line of soundings, but farther to the eastward (latitude 54° 08′ N., longitude 162° 22′ W.), a depth of 60 fathoms was found. Immediately to the northeastward of this position is an extensive shoal area, called Sannakh Bank. It lies to the east and southeast of the Sannakh Islands, is somewhat elongate in shape, and trends in a general way northeast and southwest. Four lines of soundings, approximately parallel with this trend, were run through the region containing this bank. A small area with soundings of 30 to 37 fathoms is about central in latitude 54° 20′ N., longitude 161° 53′ west.

Directly north of this shallow water, in the direction of the Sandman Reefs, depths of 63 to 82 fathoms were found; but it is bordered on the southeast, south, and southwest by a considerable area having depths of 40 to 60 fathoms. The connection between the bank and the islands of the same name was not determined, nor was the 100-fathom curve on the southern side developed, but near the southwestern end a depth of 435 fathoms was found close by 67 fathoms.

The estimated area of the bank was 1,300 square miles. Much of the bottom was found to be rocky. Sand, pebbles, gravel, etc., also occur.

Dredging.—No dredging was done on the main part of Sannakh Bank, but the beam trawl was used at Station No. 2846, about 15 miles south of Sannakh Island (latitude 54° 08′ N., longitude 162° 44′ W.), 44 fathoms, gravel bottom. The net came up with many specimens of the red rockfish, *Sebastichthys*, and of *Lepidopsetta bilineata*. One skate was also taken. Several species of shrimps were very abundant, and hermit crabs, pectens, other mollusks, ascidians, and echinoderms were common.

Trials for fish.—Three trials for fish with hand lines were made on or near Sannakh Bank. The first was at dredging station No. 2846, about 15 miles south of Sannakh Island, 44 fathoms, gravel bottom, seven lines in use for fifteen minutes taking ten cod and two halibut, with clams and salmon for bait. The halibut averaged 14½ pounds in weight, the cod 11 pounds in weight and 23½ inches in length.

The second trial was made at hydrographic station No. 1213, about 12 miles south of Caton Island, latitude 54° 12′ N., longitude 162° 17′ W., 47 fathoms, the bottom consisting of sand and fine gravel. Nine lines were kept over about half an hour, being baited as in the previous trial, with the addition of sculpin on one of the hooks, and six cod and one halibut were taken. The average weight of the cod was 8½ pounds, their average length 25 inches. The halibut weighed 30 pounds, and was "white." This was the largest specimen that had been taken up to this time; but large halibut, it is said, are seldom caught on these in-shore banks.

The third trial was at hydrographic station No. 1239, about 12 miles a little south of east of Caton Island (latitude 54° 23′ N., longitude 161° 56′ W.), depth 34 fathoms, the bottom consisting of pebbles. Nine lines, baited with salt clams and salmon, were kept down for fifteen minutes, securing two cod and five halibut, the former averaging 8½ pounds in weight and 23¾ inches in length, the latter 9¾ pounds in weight. The largest halibut weighed 22 pounds. The stomachs of these fish contained fragments of squid and a few small partly digested fish.

Remarks.—Some of the best fishing grounds in this region will probably be found about Sannakh Bank. The Sannakh Islands are, however, a dangerous group, with few safe harbors or anchorages, and the proximity of the bank to this inhospitable region will detract somewhat from its value, at least until the class of fishing vessels visiting it are prepared to lie out occasional gales without seeking a harbor.

But little attention is now paid to the bank. Mr. Collam, of Popoff Island, one of the Shumagin Group, is said to be the only person who engages in fishing there at the present time. He built a small fishing station on Sannakh Island in 1886, and has a small schooner of about 20 tons burden, which fishes in the neighborhood of that island, and carries the catch to Pirate Cove, Popoff Island. Several trips are made each season.

The cod caught in the vicinity of the Sannakhs are considered by many fishermen to be superior in quality to those found about the Shumagins, being pronounced by them less watery. The Sannakh cod are said to be plump and very firm meated, and do not shrink so much in curing. Very few of these fish, however, find their way to market.

FISHING GROUNDS BETWEEN SANNAKH BANK AND THE SHUMAGIN ISLANDS.

The region between Sannakh Bank and the Sandman Reefs on the west, and the Shumagin Islands on the east, was partly explored and shown to be suitable for fishing, but its precise value in that respect can only be determined after a more thorough examination has been made. The area of this ground is roughly estimated at 1,800 square miles.

Three lines of soundings were continued across the region in a northeasterly direction from the vicinity of Sannakh Bank to the Shumagin Islands. The northernmost line extended from near Pinnacle Rock, off the Sandman Reefs, to the southern end of Unga Island, and showed depths of 38 to 74 fathoms; the second line extended from the northern end of Sannakh Bank to near Falmouth Harbor, Nagai Island, with depths of 45 to 64 fathoms; and the third line from the southern end of the same bank to Bird Island, in the southern part of the Shumagin Group, with depths of 40 to 72 fathoms. The 100-fathom curve was developed at only one point, just off the southernmost line of soundings. The bottom was found to be exceedingly variable, consisting in different places of sand, mud, pebbles, gravel, and rocks, the latter occurring only near Sannakh Bank on the one side, and near the Shumagin Islands on the other.

Dredgings and trials for fish were made only in the neighborhood of the Shumagin Islands, and will be described in connection with that group. Such trials as were made, however, on the edges of the ground showed a rich bottom.

This region possesses many advantages over Sannakh Bank from the absence of hidden dangers and its proximity to safe harbors.

Fishing vessels have not been in the habit of resorting to it, however, for the reason that an abundance of cod has always been found nearer the Shumagin Islands and upon Shumagin Bank. More thorough investigations will probably indicate the existence of defined banks or areas of rich feeding bottoms for cod and halibut.

SANDMAN REEFS.

Corrected positions for some of the rocks and islands.—A sounding of 74 fathoms was made at hydrographic station No. 1233 (latitude 54° 52′ N., longitude 161° 17′ W.), August 3, at 10.18 a. m., the position being located by cross-bearings of the large and more important islands to the northward and westward. "The weather was clear at the time and we could see land at a great distance, particularly to the northward and westward, where the snow-capped peak of Pavloff's volcano was distinctly visible. Deer Island and most of the smaller islets and rocks of the Chernaboura Group were in sight, and directly ahead of us was a small pinnacle-shaped island, not more than 10 miles distant, far from its position on the chart. Changing the course a little to bring it on the starboard bow, we steamed ahead a few miles, when breakers, and a moment later rocks, were reported on the port bow, still more out of position than the island. Subsequently Hay Island was located by cross-bearings and found to be several miles out of place on the published charts.

"The following are the positions we assigned to the rocks and islands mentioned above, based on cross-bearings and the noon position of the ship, when the latitude was determined by meridian altitude of the sun, and the longitude by chronometer:

"Low Rocks, latitude 54° 45′ N., longitude 161° 28′ W.

"Pinnacle Island, latitude 54° 45′ N., longitude 161° 35′ W.

"Hay Island, latitude 54° 39′ N., longitude 161° 53′ 30″ W."

BELKOVSKY BAY AND VICINITY.

Abundance of cod.—Mr. Pavloff, who acted as pilot for the steamer *Albatross*, states that the cod have been increasing in abundance during the past four years in the vicinity of Belkovsky, on the mainland, opposite the Sandman Reefs. Formerly cod were not caught in that region during the winter months, but now they are abundant at that season. This increase Mr. Pavloff attributes to the present abundance of sculpins, which first made their appearance in the fall and winter from six to eight years ago. Sculpins of various species occur at other seasons, but they now arrive on the in-shore grounds in large numbers in the early fall and remain until late in the spring, being especially plentiful during the winter. Only enough cod are taken at Belkovsky for local consumption, there being no regular fishery in that region at present.

Cod banks in the vicinity.—To the north of the Sannakh Islands and west of the Sandman Reefs is a large unexplored area on which cod and halibut are reported to be abundant by the natives.

Method of hunting sea otters at Belkovsky.—In this locality the people depend chiefly upon the hunting of sea otters for a living. These animals are taken by means of bows and arrows, rifles, and gill nets. Gill nets are only employed in the winter, and are not used by the Indians, who find them too expensive. These nets are from 14 to 20 fathoms long, and 12 feet deep, with a 10-inch mesh. Some are made of single and others of double twine, the latter being most durable. The former cost from $10 to $15 each, the latter about $5 extra. They are knit by the Indian women. When gill nets were first introduced into this region by the Americans, the Indians manifested no surprise, saying that they had been employed many years before all along the Aleutian Islands, but that their use had been prohibited by the Russians a long time ago. Subsequent inquiry at Kadiak threw no light on this subject. If gill nets were formerly used by the Indians and Russians in pursuit of the sea otter they no doubt learned how destructive these appliances were, and took the necessary precautions to prevent the extinction of this important fur-bearing animal.

The Indians only hunt for sea otter in calm weather, as they can not capture them when the sea is rough. Several weeks may pass without a favorable opportunity, but a constant watch over the favorite hunting grounds is kept up from the hills and prominent places in the vicinity. At the first indications of fair weather word is passed around and the bidarkas are quickly manned and silently leave the shore in the direction of their prey. Gill nets can be hauled and set in weather which would not be regarded as suitable for hunting with the bow and rifle, and in consequence of the adoption of this method of capture, in recent years, it is claimed that the sea otter is fast becoming exterminated, and unless some restrictive measures are adopted, will soon be a thing of the past.

9. SHUMAGIN ISLANDS.

HYDROGRAPHIC WORK, DREDGINGS, TRIALS FOR FISH, ETC.

Hydrographic work, etc.—But little hydrographic work was done to the north and west of Nagai Island; sounding and dredging stations were made in mid-channel of Popoff Strait, 69 fathoms, mud and rocks; off the southern entrance to the same strait, 110 fathoms, mud; and south of the entrance to Falmouth Harbor, Nagai Island, 48 fathoms, fine gray sand. The lead was also cast in 18 fathoms at the mouth of Eagle Harbor, and in 34 fathoms close by Sea Lion Rocks. These rocks are about 100 feet high, and can be safely approached to within one-half mile. They are the resort of sea lions and birds.

August 4 a sounding was made 2 miles N. 34° W. from the center of Bird Island, in the southern part of the group, depth 21 fathoms, the bottom consisting chiefly of broken shells. The beam trawl and trial lines were put over at the same place. A successful haul was made with the former, but for the first time since the arrival of the *Albatross* in this region no fish were taken on the hand lines. Another rich cast with the beam trawl was made 4 miles N. 48° W. from the last station, 35 fathoms, gray sand; but the trial lines used in a depth of 25 fathoms, gray sand, midway between the Twins and Near Island, captured only two sculpins. A depth of 27 fathoms was found 3 miles N. 22° E. from the last station, 26 fathoms 5 miles S. 78° E., 37 fathoms 4 miles N. 40° E., or at the southern entrance to the strait between Spectacle and Big Koniushi Islands. The trial lines took one halibut in the last position. The experience above described demonstrated the absence of cod in August in a region where they are found in great numbers at other seasons of the year. During the winter this region is a favorite fishing ground.

A sounding of 57 fathoms was made in mid-channel, abreast of the north end of Spectacle Island, and another of 39 fathoms off the north end of Peninsula Island. The beam trawl was cast with good results in 58 fathoms, Cape Thompson bearing S. 76° E., distant 5 miles, and a sounding was subsequently made in 23 fathoms about mid-channel of the passage between the cape and Castle Rock.

Dredgings.—The beam trawl was used in six different places among the Shumagin Islands, disclosing an exceedingly rich bottom fauna. The results of this work have been grouped under two series of three stations each. The first three stations were as follows: No. 2847, about 2 miles south of the entrance to Falmouth Harbor, Nagai Island, 48 fathoms, fine gray sand; No. 2848, midway between Unga and Nagai Islands, 110 fathoms, green mud; No. 2849, between Unga and Popoff Islands, 69 fathoms, green mud. At these stations the following genera of fishes were represented by several specimens each, viz: *Hippoglossoides*, *Pleuronectes*, *Lepidopsetta*, *Atherestes*, *Sebastichthys*, *Lycodes*, *Hemilepidotus*, *Raia*, *Cyclopterus*, besides which there were a number of unidentified forms. The different groups of marine invertebrates made each a large showing, shrimps, crabs, amphipods, worms, gastropod mollusks, scallops, mussels, brachiopods, ascidians, and echinoderms being specially abundant.

The three other stations were in the southeastern part of the group, as follows: No. 2850, north of Bird Island, 21 fathoms, broken shells; No. 2851, midway between Bird Island and Nagai Island, 35 fathoms, gray sand, broken shells; No. 2852, at the north end of the passage-way between Nagai and Big Koniushi Islands, 58 fathoms, black sand. Flounders, sculpins, eelpouts, and species of *Agonidæ* were very abundant. Shrimps, crabs, and the lower crustacea were taken in large numbers. Scallops, mussels, and gastropods, among the mollusks, and sea urchins, star fishes, and sea cucumbers, among the echinoderms, were very numerous.

Trials for fish off the shore.—At hydrographic station No. 1227, about 13 miles south of Unga Island, latitude 54° 56′ N., longitude 160° 33′ W., depth 52 fathoms, nine hand lines were kept over twenty-five minutes, securing nine cod, averaging 11 pounds in weight and 30 inches long, and three flounders (*Atherestes*). These were the largest cod yet taken, being on an average 2 inches longer than the standard eastern size. Just north of Bird Island, in a depth of 21 fathoms, broken shells, nine lines were used for twelve minutes without success. One halibut weighing 4 pounds was the only result of a brief trial made in 37 fathoms, just west of the southern end of Big Koniushi Island, the character of the bottom at this spot not being indicative of a rich fauna.

General character of the islands.—The general aspect of the Shumagins is mountainous, with numerous streams rushing down the mountain sides, often forming cascades of great beauty. Copious rains and a humid atmosphere favor the rank growth of grass, ferns, and flowers, which cover the islands during the summer months and give the impression of great fertility when viewed from a distance. There is no timber on the islands larger than alder bushes, but the beaches are lined with drift wood in sufficient quantities to supply the probable demand for many years.

Few dangers about the islands.—There are but few outlying dangers about these islands, and as a rule the shores can be approached within half a mile or less with safety. There are many secure harbors in the group, and vessels can find anchorage almost anywhere near the land in 10 to 20 fathoms. The region about Simeonoff is an exception, however, and should be navigated with great caution as there is foul ground surrounding the island.

Islands and Bays in Nagai Strait; corrections.—Several inaccuracies were observed in U. S. Coast and Geodetic Survey Chart No. 806. Among the most important may by mentioned the following:

(1) Spectacle Island is about 3 miles long, high and rounded at both ends, and connected by a narrow strip of low land near the center. A deep bight on the eastern side, and a prominent point projecting to the westward, give it the general form of a pair of spectacles, from which it derives its name.

(2) Peninsula Island is placed on the chart N. 35° E., about 2½ miles from its correct position. It lies directly mid-channel of the strait, and is, in fact, the projection shown on the west side of Big Koniushi Island. A low spit makes off from the east side of the former, but there is a passage between the two islands.

(3) The bays on Big Koniushi Island, north and south of Peninsula Island, are much deeper than shown on the chart.

HUMBOLDT HARBOR, POPOFF ISLAND.

Approaching Humboldt Harbor.—"Entering Popoff Strait we saw nothing until up with Barloff Bay, when the high and bold headlands forming its southern shore emerged from the fog not more than 400 yards distant. Thence to Egg Islands the course was clear, and after making them the fog partially lifted ahead, Sand Point and Arch Rock being visible. When up with Sand Point the station of Lynde & Hough was seen, and at 12.34 p. m., July 31, we anchored off the wharf in 12 fathoms. Humboldt Harbor has been surveyed by the U. S. Coast and Geodetic Survey (Chart No. 814). The holding-ground is good, and it affords excellent protection from all winds. There is a wharf at which ships' boats can land at all times of the tide."

Collecting in the harbor.—Beaches suitable for seining are less numerous here than in Iliuliuk Harbor, Unalashka, but two seines were kept in almost constant operation during the stay in port, securing an abundance of fishes, although not a great variety of species. *Salvelinus malma* was seined in great numbers in the harbor, and was also taken with hook and line in the fresh-water creek. Many young codfish were secured at each haul of the seines, but flounders, mostly *Lepidopsetta bilineata*, exceeded all other fishes in abundance, both adult and young specimens being taken. The pollock (*Pollachius chalcogrammus*), a large sculpin (*Hemilepidotus jordani*), and the young of a species of *Hexagrammus* were common, and also many small species which have not yet been identified. A single *Limanda aspera* was taken with a hand line from the ship's side. A conspicuous feature of the seining at this locality was the abundance of large medusæ, sea urchins, and star fishes that dragged ashore. Cod-fishing with hand lines from the ship was always successful. The hooks at this anchorage frequently became entangled with sea-pens (*Pennatula*), of which more than a dozen fine specimens were secured. Clams are said to be plentiful, but none were obtained, the tides not serving right. The tides at this place are greatly influenced by the direction and force of the winds, which sometimes retain the water at high or low tide level for a considerable period.

Fishery Notes; Salmon fishing.—Humboldt Harbor would furnish shelter to a large fleet of vessels. A fishing station established in 1887 by Lynde & Hough, of San Francisco, offers the only inducement at present for people to settle here, and there are now but few inhabitants. Six fishermen are employed at the station, and up to date they had caught and prepared for shipment 300 barrels of salt salmon. The fish are taken in drag seines and gill nets. The seines measure from 20 to 125 fathoms long and 2½ to 3 fathoms deep, and have a mesh of about 2½ inches. The floats are made of wood, the sinkers of pieces of lead hammered into the required shape by the fishermen, and then bent around the foot-line. The salmon did not "strike" at Humboldt Harbor and the adjacent bays this year until the middle of June; they usually appear early in May. They continued to be unusually abundant until the latter part of July, but suddenly disappeared when the rainy season began, about a week before the arrival of the *Albatross*. A second school, which is expected to arrive about August 20, generally remains until the last of September.

Dories are used by the Indians for general fishing, but bidarkas are employed here as at Unalashka for long cruises in search of seals and sea otters. In hunting these mammals the single paddle is preferred, as it enables the Indians to approach nearer their game without disturbing them, otherwise the double paddle is used. Kiaks are not employed about the Shumagins.

PIRATE COVE, POPOFF ISLAND.

Fishery notes.—Cod fishing is now carried on in the vicinity of this harbor almost exclusively by means of dories, only one vessel having been engaged here in actual fishing during the present season. Most of the schooners had been sold, and those retained are used for freighting. The grounds resorted to are all within a short distance of the harbor, where dories are more convenient than larger craft. Trawls are chiefly employed, and during good weather they are hauled two and three times a day, but the fish are not dressed until the last haul for the day has been made. Cod fishing continues throughout the year. In summer, when the salmon are running, cod are not abundant, but they reappear in incredible numbers as soon as the salmon leave. During the winter strong southeasterly gales may prevent the hauling of the trawls for a number of days at a time, but there is no period of the year when they can not be used at least several times a week. This is in marked contrast with the climate of the Grand and Western Banks, off the Atlantic coast, some ten degrees farther south, where the fishing vessels are often compelled to lie to for a week, and sometimes for a fortnight, with their dories lashed upon the deck.

Vessels of suitable type and construction might engage in fishing in the Shumagin region during the entire year. They would not be compelled to ride out heavy gales on the banks, as do the fishing vessels of the Atlantic coast, endangering lives and property. The numerous bays, harbors, and small islands in close proximity to most of the fishing grounds afford convenient shelter. If winter fishing is ever carried on to a great extent on the Pacific coast by vessels sent out from San Francisco, however, a very different class of vessels from that now in use will have to be constructed in order to weather the severe gales encountered on the passage up and down the coast.

EAGLE HARBOR, NAGAI ISLAND.

The harbor.—The *Albatross* reached Eagle Harbor, on the west side of Nagai Island, August 2. This harbor offers good shelter to fishing vessels, and is in close proximity to many small fishing spots. It has no inhabitants, the high lands which descend on all sides close to the water's edge leaving no level ground upon which to plant a settlement. There is, however, a small beach or spit extending off from the southern side of the entrance to the harbor which is suited to the dressing of fish, the mending of nets, etc.

A vessel may anchor anywhere in the harbor in from 15 to 20 fathoms, and in the cove on the northern side she would find perfect protection from the sea, where she could haul out for repairs, fill her water casks, or gather drift wood on the beaches. The south cove has a narrow, tortuous entrance, too shoal for anything larger than a ship's boat at low water, but a vessel drawing 6 or 8 feet could be warped or towed in at high tide, and once inside would be as secure as in a dock.

Trials for fish.—A cod trawl containing four hundred hooks was baited and set in 16½ fathoms of water across the mouth of the harbor, where it was allowed to remain four hours. The inner end of the trawl lay on rocky ground, but on hauling it up it was found that it soon ran off into muddy bottom. The catch consisted of six cod averaging 8½ pounds each, three halibut averaging 5 pounds each, and a large number of flounders and sculpins. The last-named species had no doubt prevented a larger catch of cod and halibut, by taking the bait as soon as the hooks reached bottom.

Young cod attracted by the electric light.—During the evening the electric light was used at the surface with surprising success, attracting thousands of young cod, measuring about 3 inches long, which swarmed about it. With a single haul of the dip-net a hundred specimens were landed on deck. Some of these were placed in one of the aquaria, but they lived only a few days, being devoured by the larger fish confined with them.

YUKON HARBOR, BIG KONIUSHI ISLAND.

On August 8, a night anchorage was made at Yukon Harbor, but no shore investigations were attempted. A trial for cod was made with hand lines, but only one specimen was taken; flounders (*Lepidopsetta bilineata*) were so abundant that they seemed to drive all other species away. Hundreds of flocks of auks were flying about the harbor, and a boat being lowered several specimens were shot.

ALASKAN METHODS OF CURING COD COMPARED WITH THOSE OF NEW ENGLAND.

Mr. Ivan Petroff, in his "Report on the Population, Industries, and Resources of Alaska," page 69, states that "a peculiarity of the Alaska codfish industry is that the fish is not cured in the vicinity of the banks. The cod is only cleaned and pickled on board of the carrying craft, taken down to San Francisco and there pickled anew, being finally taken out and dried in quantities to suit the market. Expert fishermen located on the Shumagin Islands and at Kadiak claim that the fish could be cured on the spot as well as it is done at Cape Ann and other Atlantic cod-fishing stations. It is difficult to understand the reason for the process adopted by these San Francisco firms. The repeated pickling certainly does not serve to enhance the quality of the Shumagin codfish, and it is probably owing to this fact that the eastern codfish commands a higher price in the markets of the Pacific coast."

Mr. Petroff's statements are somewhat misleading, as the New England fishing vessels which visit the East coast fishing banks on "salt trips" bring back their catch in precisely the same condition as do the vessels sent out from San Francisco to the fishing grounds of Alaska and the Ochotsk Sea. The eastern cod are much larger in size than the average fish which have hitherto been obtained in the North Pacific, and the greater care exercised in curing them may account for their more inviting appearance. To these qualities possessed by the Atlantic cod, combined with the universal prejudice in favor of supplies coming from old and well-known sources, is due the higher price which these fish command in the markets of the Pacific coast.

THE LAY OF THE ALASKAN FISHERMEN.

The lay of the Alaskan fishermen differs considerably from that of the New England fishermen. The captain is paid a stated sum per month and has no share in the cargo. The mate receives a monthly salary, and also a certain sum for every thousand fish caught. Each of the crew receives $25 per thousand fish; splitters, $50 per month; salters, $40 per month; cooks, $60 per month. On the return from a trip the crew has nothing more to do with the vessel, taking no part in the discharging of the cargo, which is done entirely at the expense of the owners. The cod livers are never saved, and a profitable portion of the fish is thereby thrown away.

THE YELLOW-FISH.

Mr. Pavloff states that the yellow-fish (*Pleurogrammus monopterygius*) varies in size in different places. Those taken at Unalashka are much smaller than those found at Atka Island and on the fishing grounds south of the Aleutian Chain. They are not abundant about Belkovsky. None were secured by the *Albatross* during its cruise. This species is regarded by those who have eaten it as superior to any other on the coast of Alaska as an article of food.

The yellow-fish usually approach the Shumagin Islands about the latter part of August, and remain in that region in immense schools until the beginning of cold weather, when they retire to the deep water south of Shumagin Bank. They can probably be caught by the same methods employed in the mackerel fishery on the Atlantic coast. They are distributed along the coast for many hundred miles, and occur in incredible numbers. Some years they appear earlier than others. Vessels fitted with boats and purse seines, after the fashion of the eastern mackerelmen, could readily obtain large fares. The few shipments sent to market have brought good prices, some lots having sold for as high as $28 per barrel. A lucrative business could probably be started with the San Francisco markets.

10. SHUMAGIN BANK.

Hydrography.—This bank lies south and southeast of the Shumagin Islands, and its outer margin follows approximately the trend of the coast line formed by the adjacent islands. It has been traced westward to about longitude 159° 52′ W., but probably extends farther in that direction. Its width within the 100-fathom curve, to the south of the group, is from 15 to 22 miles to the nearest outlying islands. Southeast of Simeonoff Island the width increases to between 30 and 35 miles. East of the Shumagins the bank extends north to about the latitude of Big Koniushi Island. Its area inside of the 100-fathom line is estimated at about 1,800 square miles. The bank is not separated from the Shumagins by deep water. Depths of 35 to 38 fathoms were found directly off Simeonoff Island, and from these positions the water deepens more or less regularly in a southeasterly direction towards the edge of the bank, with deeper spots sometimes intervening.

The western extension of the bank was not so thoroughly surveyed as the eastern portion. About midway between the islands and the 100-fathom line depths of 35 to 49 fathoms occur. A sounding of 115 fathoms was made 7 miles beyond a depth of 43 fathoms, indicating a very steep slope on this part of the bank. The northern boundary of the eastern portion of the bank was not fully determined. A line of soundings extending 38 miles southeast from Cape Thompson, at the northern end of Big Koniushi Island, showed depths of 47 to 114 fathoms, the former depth being found at only one place. A short distance farther north 97 to 103 fathoms were found within 30 miles of the shore, along a line of soundings running east, a little north from Cape Thompson. The character of the bottom on the bank varies greatly, sand, pebbles, gravel, broken shells, mud, and rocks being found in different places. Rocky patches were of frequent occurrence, even in comparatively deep water.

The work in this region was done in pleasant weather, when some portions of the adjacent islands were in sight most of the time, permitting of the positions being verified by cross-bearings from the land.

Trials for fish.—The beam trawl was not used on Shumagin Bank, but two trials were made for fish with hand lines. One was at hydrographic station No. 1286, on the western part of the bank, about 5 or 6 miles southeast of Chernaboura Island (latitude 54° 42′ N., longitude 159° 24′ W.), 35 fathoms, rocky bottom; the other at hydrographic station No. 1266, on the eastern part of the bank, about 15 miles east of Simeonoff Island, 46 fathoms, gray sand and broken shells. At the former station nine lines were employed for thirty-five minutes, taking eight cod, three halibut, and three sculpins. Salmon and pollock were used as bait. The cod averaged 8 pounds in weight and 26½ inches in length, the halibut 18⅗ pounds in weight. At the latter station one halibut, weighing 5 pounds, and three sculpins were taken.

Remarks.—This is one of the most important fishing banks in Alaska as it is also one of the best known. Its value is greatly increased from its proximity to the Shumagin Islands, where numerous safe and convenient harbors are available in case of storms. With the exception of Simeonoff Island and the reefs in its neighborhood, there are very few hidden dangers. The bottom is rich and fish are known to be abundant.

II. SHUMAGIN ISLANDS TO KADIAK ISLAND.

HYDROGRAPHY AND TRIALS FOR FISH.

Hydrography.—Only a few lines of soundings were made across this wide region, which, while they indicated the existence of several apparently rich banks, were insufficient to determine their extent and character. Beginning at a point 5 miles from Castle Rock, off the northern extremity of Big Koniushi Island, Shumagin Group, one line was carried 65 miles N. 84° E. to latitude 55° 25′ N., longitude 157° 28′ W., about 19 miles south of Light-house Rocks. Soundings were made at intervals of 10 miles, except at the end of the line, where the distance between the last two soundings was 5 miles. The water gradually shoaled from a depth of 103 fathoms near the Shumagins to 46 and 47 fathoms south of Light-house Rocks. From this point the line was continued to Mitrofania Bay, with depths of 53, 73, 73, 64, and 68 fathoms, the last being between Mitrofania Island and the bay of the same name; thence a line was run to Light-house Rocks with depths of 67, 44, 57, and 67 fathoms, 49 to 67 fathoms being found in the neighborhood of these rocks.

From Light-house Rocks the sounding was continued as follows: 33 miles S. 79° E., in 49, 48, 49, 50, 55, and 135 fathoms; 24 miles N. 31° E., in 137 and 119 fathoms, the last position being midway between the Semidi and Chirikoff Islands; 29 miles S. 36° E., in 89, 60, and 96 fathoms; 20 miles N. 23° E., in 57, 26, and 27 fathoms, terminating 6 miles S. 22° E. from the north end of Chirikoff Island, where a successful trial was made for cod. From this point a line was run 12 miles S. 34° E., sounding in 76 and 287 fathoms; 32 miles N. 28° E., in 89, 81, 76, 60, and 37 fathoms, the last position being 17 miles south from the south end of Tugidak Island, where cod were again found in abundance.

The soundings indicate a bank of considerable size in the region surrounding Light-house Rocks, but mainly to the south of these rocks, and extending to the eastward of latitude 157° W., and to the westward of latitude 158° W. It is probable, however, that good fishing will be found over a large part of the area included between the Shumagins and Kadiak. The extent of the area partly developed by the soundings is estimated at about 4,400 square miles.

Trials for fish.—On the morning of August 7 a trial for fish was made at hydrographic station No. 1317, latitude 55° 26′ N., longitude 157° 28′ W., about 19 miles south of Light-house Rocks, in 47 fathoms, green mud. The ship was hove to and allowed to drift for forty minutes, but no species of economic value were obtained. Salt salmon and pollock were used as bait. The bottom did not appear to be rich in food. The grounds in the immediate vicinity of Light-house Rocks can not be regarded as of any value to the fishermen while the large sea-lion rookery continues to exist there, as these animals feed chiefly upon fish, and keep the stock greatly reduced.

In the extreme eastern part of the area lying between the Shumagin Islands and Kadiak two trials for fish with hand lines proved unusually successful, and demonstrated that the bottom in this region is exceedingly rich. The first trial was at hydrographic station No. 1343, in the vicinity of Chirikoff Island, latitude 55° 49′ N., longitude 155° 20′ W., depth 27 fathoms, sandy bottom. The second trial was at hydrographic station No. 1350, about 16 miles south of Tugidak Island, one of the Trinity Islands, in latitude 56° 07′ N., longitude 154° 38′ W., 37 fathoms, sandy bottom. This last position is actually on the western end of Albatross Bank. At the former station with seven hand lines used for twenty-five minutes, fifteen cod were taken, averaging 9¼ pounds in weight, and 23⅝ inches in length; at the latter 47 cod were secured with nine hand lines in a little over half an hour, the average weight of these being 10 pounds, the average length 28½ inches. In the former instance pollock and cod were used as bait, in the latter walrus flesh and cod.

MITROFANIA BAY.

Approaches; character.—"The mainland was sighted soon after daylight, August 7, and Mitrofania Island at 8 a. m.; but we failed to recognize the latter for several hours, owing to fog-banks which hung over the land. We were up with the island at 1.30 p. m., and, leaving it on the port hand, steamed into the bay of the same name, anchoring off Long Beach at 2.48 p. m. in 15 fathoms, latitude 55° 58′ N., longitude 158° 47′ W. (approximately).

"Our anchorage was near the southwest extremity of a steep black-sand beach which lies back of the bay and extends in crescent form about 3 miles northeast and southwest. This beach is flanked on the eastern end by a nearly vertical cliff, 600 or 800 feet in height, made conspicuous by many strata of different-colored rocks, and on its western extremity by a precipitous mountain covered with a dense growth of alder bushes. An isolated rock lies near the base of the mountain, about 300 yards back of the beach, nearly rectangular in form, the sides being vertical, about 100 feet broad by 60 feet in height, and the top slightly rounded and covered with grass, ferns, and small bushes. Seen from a distance it had the appearance of a huge native sod house (barabara), with the roof overgrown with grass. An extensive valley lay back of the beach, in which were several ponds of fresh or brackish water, their shores being surrounded by a fringe of alder bushes. The land was covered by a rank growth of grass and wild flowers.

"Long Beach is a good anchorage except with winds from south to southeast, when a heavy swell rolls in. Better harbors are found on the east side of the bay.

"To make this anchorage leave Mitrofania and the small islands on the port hand, passing midway between them and the mainland, until well up with the sand beach. Then stand to the westward and anchor off the rock above mentioned, giving due attention to the lead, as the bank is steep."

Fishing; occupation of the natives.—Lines were baited and put over at the anchorage in Mitrofania Bay, in 27 fathoms, and in the course of a few minutes ten halibut were landed upon deck. The largest of these weighed 40 pounds, the smallest 4 pounds, the average weight being about 30 pounds. They were all "white;" the stomachs of some were empty, the others containing only a few crabs.

A settlement of creoles was established eight years ago on the northern side of the bay. These people were brought over from Kadiak Island by Mr. Pavloff, the pilot of the *Albatross*. Sea-otter hunting is their chief occupation, but cod, halibut, and salmon are also taken for home consumption. The numerous small streams and lakes of the vicinity abound in trout and other kinds of fresh-water fishes. Bears and deer roam among the hills and through the valleys. They are hunted by the Indians in winter to supply additional food and clothing.

LIGHT-HOUSE ROCKS.

Position and character.—"August 8, at 12.30 p. m., we anchored in 49 fathoms, 890 yards N. 28° E. from the largest of the Light-house Rocks. The group consists of several detached rocks, ranging from 90 feet in height and 500 feet in length to 10 feet in height, with two or three nearly awash, over which the sea was breaking. They are about 500 yards in extent, and can be approached within half a mile with safety. No two charts agree as to their location, giving it from latitude 55° 44′ to 55° 45′ N., longitude 157° 25′ to 157° 30′ W. It was our intention to verify their position, but a dense fog, which settled down soon after we left the mainland, prevented.

"Our run placed them in latitude 55° 43′ N., and longitude 157° 20′ W., but it was not sufficiently reliable to justify us in changing their position on the chart. Latitude 55° 44′ N., and longitude 157° 25′ W. is about the mean and not far from correct."

Sea-lion rookery.—A landing was made by the naturalists in order to examine the large rookery of Steller's sea lion (*Eumetopias stelleri*) which exists there. The weather was very thick at the time, a dense fog hanging low over the water, but the sea being smooth a landing was easily effected. Much care had to be exercised in moving over the slippery rocks, smeared with the oil derived from the carcasses of numerous large sea lions which had evidently met their death in combat with their own species. Several hundred of these animals were crowded together upon a very limited area. Thousands of murres were breeding wherever they could find ledges and crevices inaccessible to the seals, and there were also a few kittiwake gulls and fulmars in sight. As the party was landing the sea lions came tumbling down over the rocks in their eagerness to reach the sea. A few, whose retreat was intercepted, were seen to jump from their high positions directly into the water, apparently sustaining no injury from the plunge, although the distance was considerable, especially for such large animals. There were probably as many pups as adults in the herd, and occasionally a small body of these would detach themselves from the rest and swim some distance off shore. A couple of killer whales (*Orca*), attracted doubtless by the disturbance at the rookery and the large number of seals in the water, came up quite close to the rocks, causing the seals to gather nearer shore and cast evident glances of alarm toward the killers, whose dorsal fins showed not less than 4 feet above the surface. The *Orcas* moved actively about, but it was not positively seen that any of the seals were seized by them. On several occasions, however, when pressed too hard on the water side, the seals ventured to crawl out upon the rocks, only to plunge back into the sea at the least movement on the part of the *Albatross* party. A rifle ball was finally planted in the back of one of the *Orcas*, causing the precipitate departure of both of them. A fine bull sea lion, measuring over 13 feet long, was shot by Mr. Townsend, and its skin removed and preserved after some two hours' hard labor. As soon as the naturalists left the island the sea lions returned to their rookery. These rocks are entirely barren of vegetation.

12. KADIAK ISLAND.

THE TRINITY ISLANDS.

Character and surroundings.—"The fog lifted as we approached the land, giving us a very good view of the Trinity Islands. Tugidak and the western portion of Sithinak Island are low and apparently marshy, while the eastern part of the latter island is higher. They are surrounded by foul ground, and, in the absence of proper surveys, should be approached with caution."

OLD HARBOR, KADIAK.

The harbor and its surroundings.—The *Albatross* arrived at Old Harbor (latitude 57° 11′ N., longitude 153° 13′ W.), in the channel separating Sitkalidak from Kadiak Island, on the afternoon of August 10, and anchored in 7 fathoms, off an Indian village called by the natives Three Saints. It lies about 4 miles to the northward of the Bay of Three Saints, the beautiful harbor of Lisiansky Bay intervening. The country surrounding Old Harbor is mountainous, with a narrow belt of comparatively level land, on which the village stands, near the water. It is covered with a luxuriant growth of grass and flowers during summer. Alder bushes grow to greater size than on the islands farther to the westward, and, in the sheltered valleys, the poplar is found of sufficient size to make it valuable to the natives in building their houses, and for other purposes. The rugged mountain range, sometimes called the backbone of Kadiak, was in sight, and the great gorges, still filled with snow and ice, lent an arctic hue to the otherwise summer aspect.

The village of Three Saints.—The village is scattered along the shingle beach, and consists of about thirty sod houses, or barabara, thatched with dried grass, and a few log buildings. The houses have the usual accompaniment of fish racks on which salmon were hung to dry. There are about two hundred and fifty Indians at this place, but most of the young men were absent at the time of the *Albatross's* visit, on hunting and fishing trips. The people in the village were engaged in drying salmon for their winter food supply, and a few were also in the employ of the salmon fishery near by.

Trials for fish.—The waters of the vicinity are everywhere filled with salmon, which seem to congregate in greatest abundance close to the sand bars and small rocky capes which project into the harbor. A short distance from the mouth of the harbor, in the vicinity of Two Headed Island, cod are also plentiful. Seining was carried on in the harbor, but not many species of fish were obtained there. The light seines also suffered severely from the presence of so many large salmon, which it was difficult to avoid taking in them. In addition to the salmon some of the same shore fishes taken at Unalashka were secured.

Directions for entering Old Harbor.—"To enter Old Harbor, make Two Headed Island (miscalled Two Headed Cape on Coast Survey Chart No. 702), which has two irregularly rounded peaks, and is easily recognized. Leave it on the port hand, and if the weather is clear Black Point will be seen, showing darker than its surroundings. There is a small islet about 200 yards in prolongation of this point, and one-fourth of a mile further on is a rock just above water, which marks the outer end of a ledge extending from the point. Having passed this rock, a mid-channel course around the second prominent point on the starboard hand leads to the strait where Old Harbor is located, and off which lies the Bay of Three Saints and Lisiansky Bay. There is bold water in the strait, which is free from hidden dangers except near the land. Passing Old Harbor there is a narrow tortuous channel into Sitkalidak Strait through which small vessels have passed, but a stranger should not attempt it with a vessel drawing more than 8 feet."

PORT HOBRON, SITKALIDAK ISLAND.

Fishing station.—While at Old Harbor a call was received from Mr. Ivan Petroff, manager of the Alaska Coast Fishery Company's station, recently established at Port Hobron some 10 or 12 miles to the northward and eastward of Old Harbor. Subsequently a party from the *Albatross* visited the station and found it located in a snug harbor on the north side of Sitkalidak Island, in the second deep bay coming from seaward.

The quarters, mess-room, store-room, and kitchen are under one roof, and the curing house is at the water's edge, where boats or barges can load and discharge at half-tide. It is supplied with running water from a mountain stream, and everything was scrupulously clean and well arranged. A cooper shop, stable, and store-house are conveniently located, and in the harbor were several dories, barges, a fine schooner, and a steam-launch. This is the first season the station has been in operation, and they have thus far confined themselves to taking and salting salmon, but they intend starting a cannery eventually.

The fish are caught chiefly in a lake opposite the station, and about 1½ miles from salt water, in which the salmon enter in incredible numbers to spawn. Eighteen white men and a few Indians are employed to do the fishing. The fish are transported over a horse-railway to the beach, where they are transferred to barges or dories which deliver them at the curing house. Four hundred barrels of salmon had been secured during the preceding three weeks.

The visit to the station was made between the runs of salmon, and the entire force, except the coopers, was engaged in cutting and curing hay for the horses used there. The location seems to be well chosen, not only for salmon fishing but also for cod and halibut.

In 1883 Mr. Petroff built a fishing stand close to the Indian village at Old Harbor, where for a time large quantities of cod were cured and shipped to San Francisco.

ST. PAUL, KADIAK.

Collecting in the harbor.—During the week's stay at St. Paul or Kadiak village, hand-line fishing, seining, boat dredging, and shore collecting were carried on continuously. Many flounders (*Lepidopsetta bilineata*) were taken with the hand lines, but very little else, excepting a few "rock trout" (*Hexagrammus*), and dogfish (*Squalus acanthias*). *Hemilepidotus trachurus*, a species of flounder, not met with elsewhere during the cruise, was also obtained in this manner. Scarcely anything but salmon and flounders were secured by seining. Boat dredging in the bays near the village, and thence outward to a point 4 miles distant from the village, gave excellent results, and disclosed a rich bottom with many species of marine invertebrates different from those discovered on the outer grounds. The groups of crustacea, mollusks, echinoderms, anthozoa, hydroids, and sponges were all represented, and brachiopods of great size were obtained.

Shore collecting was productive of many interesting fishes and invertebrates. A small red star fish was abundant, and many small shells were found living upon the leaves of kelp. Numerous specimens of *Hemilepidotus trachurus* were taken by jerking them up by means of a sharp boat-hook as they lay upon the bottom in shallow places. They seldom moved if the hook was carefully inserted under them. This species is moderately abundant along the kelp line of the shores, and it is not difficult to secure a dozen or more specimens in an hour's time by the method described above. It proved a nuisance at Kadiak by taking all the bait set for codfish. The variations in color in this fish are remarkable, no two individuals being precisely alike in this respect. They also appear to assume the tints of the rocks and sea-weeds among which they live. The prevailing color is a rusty red on the upper parts, laid on in irregular blotches, and varied with brown or black. There is no variation with respect to the uniformly spotted under surface. Two or three specimens only of the black rockfish (*Sebastichthys*) were taken while at Kadiak.

A gill net set in the harbor gave no results. A cod trawl was set across the northeast entrance to the harbor, and a haddock trawl across the southeast entrance. In the first trial a few dogfish and sculpins were obtained; in the second two silver-side salmon, two cod, one halibut, and a large number of dogfish. The halibut was "white."

Advantages of the neighborhood for fishing.—The inhabitants of St. Paul and the adjacent islands do very little fishing for cod, but are now turning their attention chiefly to sea-otter hunting, which they find more profitable. It is stated that cod fishing has never been engaged in to so great an extent by the people of Kadiak as by those of the Shumagin group, although there are many excellent in shore fishing grounds in this region which are easily accessible. A small bank located about 10 miles from William's Reef, in a south-southeast direction, has an abundance of cod. Another bank equally as good lies 6 or 8 miles off Cape Pillar, but there are many such spots all along the coast, and many of them are close to the shore. Fishing can be carried on without intermission during five or six months of the year, and bait is always abundant.

Capt. H. R. Bowen, formerly of Gloucester, Mass., but now residing in St. Paul, thinks that fishermen with a limited amount of capital can establish themselves more readily in a lucrative business on Kadiak Island than elsewhere in Alaska. Since his first arrival at St. Paul, Captain Bowen has paid several visits to Gloucester; but no amount of persuasion on his part could induce any of the New England fishermen with whom he talked to move to Alaska, where, in his opinion, they could live just as comfortably and with less exertion.

The Indian sea-otter hunters of St. Paul are taken by steamers and small sailing vessels of the Alaska Commercial Company to the hunting grounds, where they are landed. At the expiration of the season they are brought back, and if the season has been a favorable one they will then have a considerable amount of money due them. Pay day to the Indians is one of the principal events of the year. They show little prudence, however, in the use of money, and often squander their entire earnings in the course of a few days.

Large schools of herring strike the coast in the vicinity of St. Paul about the middle of August, but very few had been taken up to the time of the arrival of the *Albatross*, August 14. They are sometimes exceedingly abundant in Shelikoff Strait, between Kadiak Island and the mainland, and several factories have been established along the borders of the strait for the purpose of extracting their oil. Ground sharks, which are also numerous in this strait, are likewise captured for their oil. A few herring are found in Cook's Inlet, where codfish are said to be increasing in abundance every year, being attracted there it is thought by the offal from the salmon canneries in Shelikoff Strait, which is carried into the inlet by the tides. Halibut have been taken in small numbers at the head of Cook's Inlet, and dogfish are very numerous along the coast from the northeast entrance to Shelikoff Strait to Prince William's Sound.

Notes on the fisheries and fishing vessels.—The weather at Kadiak was unexceptionally fine during 1888 up to the middle of August, there having been less fog and rain than for many years past. Cod could have been successfully dried, but in most years this would not be possible, as moist weather generally prevails.

Besides the Indians, there are at St. Paul about twelve or fifteen white men of various nationalities who engage in sea-otter hunting throughout the year. The white hunters have small schooners of about 25 tons burden, in which they make long voyages. The crew consists of two to four men, and occasionally one or two Indians are taken along. They use rifles chiefly during the summer, but in winter, when stormy weather prevails, gill nets are exclusively employed. Some of these hunters are very skillful, and several thousand dollars have been earned by a single individual in a season. Captain Anderson, one of the most successful hunters of St. Paul, and, in fact, of Alaska, landed fifty sea-otter skins as the result of one trip during the present season, receiving for them $100 each. The gill nets are the same as those employed at Belkovsky, and have already been described. Gill-net fishing for sea otters is expensive for the reason that the nets last only a very short time, one month being considered the extreme limit of service for a net in constant use. The short life of the nets is due, not to actual wear, but to neglect on the part of the hunters to properly care for them. After having remained down a few days they become covered with slime and sea-weed, and when taken up they are merely dried and cleaned, no preservative being used upon them. When told of the method of salting the seines, pursued by the mackerel fishermen of the eastern coast, whereby their nets are sometimes kept in good order for several years, much surprise was manifested, and that plan will now probably be tried by some of the Alaskan hunters.

Most of the sailing vessels of Alaska are schooner-rigged. The mainsail is generally triangular in shape, resembling the "riding" sail used by the Grand Bank fishermen. This prevents the use of a main gaff, however, which detracts greatly from the beauty of the rig. It is claimed by those who employ it that this pattern of sail is much safer in squally and otherwise rough weather, and that with it there is less danger of carrying away the main-boom or mainmast in jibing. Its advantages are also said to be greater than those of the ordinary pattern in approaching the many dangerous bays and headlands on the Alaskan coast. It is possible that this style of mainsail may be better adapted to stormy weather, as it presents less area to the wind, but in an ordinary sailing breeze it labors under a great disadvantage in going to windward with schooners carrying a gaff to their mainsails. Furthermore, the New England fishermen enter harbors on the Atlantic coast which are fully as dangerous as any in Alaska. The topmast of these schooners is a continuation of the mast above the eyes of the rigging. Should the topmast be carried away close to the rigging, an entirely new mast would have to be put in. No light sails are carried except a main-stay-sail, which is set from the deck. A jib and a fore-stay-sail comprise the head sails. The masts are far enough apart to admit of a fair-sized foresail, which is essential on account of the small size of the mainsail. These little schooners are excellent sea boats, from the fact that they are very deep in proportion to their size, and therefore draw a good deal of water. They have a considerable dead-rise and drag-line. The wood chiefly used in their construction is Alaskan spruce and pine. The fastenings are of iron, galvanized iron having been employed during late years. The construction of these vessels, so far from ship-building centers, and with so few facilities at hand, reflects much credit on their designers and builders.

The inhabitants of St. Paul, both Indian and Russian, use dories for general purposes about the harbors and islands. They are constructed by the Indians and creoles employed by the Alaska Commercial Company, out of spruce and cedar. They approximate in shape and general appearance to the Salisbury dory, but must be regarded as inferior to it, although of comparatively good workmanship. The bows and arrows, paddles, and various other articles used in connection with them are made by the Indians, and exhibit much skill and ingenuity.

The hooks and lines employed for catching cod about St. Paul are of a primitive type. Pieces of lead of various sizes, but of no particular shape, are used as sinkers. The hooks are fastened to the lines above the lead, without the intervention of snoods. None of the wooden hooks used by most Indians for catching halibut were observed at this place.

Directions for entering St. Paul Harbor.—"In coming from the southward make Ugak Island, then Cape Greville (known locally as Chiniak Point). The east or seaward side being free from dangers can be approached with safety, but a ledge of rocks, which makes off to the northward, must be left on the port hand. The rocks are above water, and being prominent should be cleared without difficulty if the cape has been sighted, and no vessel would attempt to pass inside without seeing it. The lead should be used in thick weather, as the outer limit of Portlock Bank is well defined and from 35 to 40 miles distant. Having cleared the rocks off the cape, stand west-northwest (magnetic) for Long Island, which will carry a vessel about three-fourths of a mile outside of the Outer Humpback. If it is not seen the island will be the next landfall, and can be approached with comparative safety. Outer Humpback should be seen if the weather is suitable for a stranger to make the harbor, in which case pass within one-fourth to one-half a mile, leaving it on the port hand, and steer W. ½ N. (magnetic) for the south end of Popoff Island. When the passage between Wooded Island and Long Island is shut in, steer N. by W. ¼ W. (magnetic) for the channel, passing 100 yards from the point of Wooded Island, off the settlement. Continue the course until the store-house on the wharf at St. Paul opens out, then stand in for the anchorage off the astronomical station (Coast and Geodetic Survey Chart No. 776), anchoring in about 13 fathoms.

"The Wooded Island side of the channel should be favored to avoid a reef on the west side, and the course continued to clear a rock about one-eighth of a mile off the north end of Holiday Island, which is not shown on the chart.

"To enter the inner harbor, keep the crib lying just off the end of the wharf, open about 50 feet from Near Island until nearly up with it, keeping as close as practicable until inside of the reef, then steer for the wharf. A vessel should enter with the tide running a little flood, which sets to the northward. The channel is very narrow, and a stranger should not attempt it without a pilot. It is high water at the wharf, full and change, at 1 hour."

13. ALBATROSS BANK.

Hydrography.—Albatross Bank lies off the southeastern side of Kadiak Island, and extends the entire length of that island, and also in front of the Trinity Islands at the southwest. It is continuous with Portlock Bank at the eastern end, there being no intervening depression between the two. The 100-fathom curve was located approximately in two places—opposite the Trinity Islands by one sounding, and opposite Sitkalidak Island, near the center of the Kadiak coast, by four deep soundings. At the former locality this curve was distant about 25 miles from the nearest point of Tugidak Island, and at the latter from about 42 to 45 miles from land. The total area of the bank inside of the 100-fathom curve is estimated to be about 3,700 square miles.

The depths are irregular, the main portion of the bank being in some places separated from the land by comparatively deep water, while in others shoal water intervenes. Two lines of soundings were run outward from Sithinak Island, one of the Trinity Islands. One, extending southwesterly from that island, shows 28 fathoms within about 3 miles of the land, followed by 54, 75, 66, and 159 fathoms; the other, extending southeasterly, has depths of 23, 52, 46, 52, and 88 fathoms. A depth of 71 fathoms was found 5 miles northeasterly from Two Headed Cape, and 111 fathoms 5 miles southeasterly from that position, followed in the same direction by 60, 44, 46, 38, and 347 fathoms. Four miles southeasterly from Dangerous Cape, 53 fathoms were discovered, followed 3 miles further out in the same direction by 86 fathoms, and then by 44, 49, 58, and 485 fathoms. A line extending off from Ugak Island begins with 25 and 45 fathoms, and another off from Cape Greville shows in succession 81, 57, 39, 71, and 75 fathoms.

The greater number of soundings indicate depths between 40 and 60 fathoms. Beyond the 100-fathom line the slope is very abrupt. All varieties of bottom occur, sand being most prevalent, and rocky patches common.

Dredgings.—The beam trawl was used in a depth of 159 fathoms, sandy bottom, about 28 miles south of the Trinity Islands, in latitude 56° N., longitude 154° 20′ W. (station 2853). Large quantities of fishes, crustaceans, worms, mollusks, echinoderms, and sponges were taken; an especial feature of the haul consisting of over one hundred specimens of a fine large free crinoid, which came up in excellent condition.

Two successful hauls of the beam trawl were also made off the island of Sitkalidak, south of Kadiak. The first station (2854) was located about 7 miles south of the western part of Sitkalidak Island, in 60 fathoms, sandy bottom; the second station (2855) directly off the southwestern end of the same island, in 69 fathoms, green mud. Fishes of many kinds were especially abundant in both hauls. The crustaceans were represented chiefly by an abundance of shrimps and hermit crabs; mollusks were unusually plentiful, about 3 bushels of the larger and commoner forms being obtained; and echinoderms of all classes were also common.

Trials for fish.—At hydrographic station No. 1350, about 16 miles south of Tugidak Island (latitude 56° 07′ N., longitude 154° 38′ W.), 37 fathoms, sandy bottom, nine hand lines were kept in use a little over an hour, resulting in the capture of forty-seven cod, having an average weight of 10 pounds each, and an average length of 28½ inches. Walrus meat and cod were used as bait. Pair after pair of cod were hauled up in quick succession, and at the close of the trial they were biting as freely as in the beginning. This locality holds out exceptional inducements to fishing vessels, which, judging from the experience of the *Albatross*, might obtain large fares in an incredibly short space of time. Good harbors are within easy reach of the place, fine weather generally prevails excepting during the foggy spells of summer, and bait of many kinds may be taken on the grounds.

About 33 miles southeast of Sitkalidak Island (hydrographic station No. 1372, latitude 56° 51′ N., longitude 152° 50′ W.) several halibut were taken with hand lines in a depth of 37 fathoms, sand and broken shells.

A third trial for fish was made on the inner part of Albatross Bank at hydrographic station No. 1392 (latitude 57° 16′ N., longitude 152° 22′ W.), about 5 miles east of Dangerous Cape, Kadiak Island; depth, 39 fathoms; bottom, black sand and gravel. Nine hand lines, baited with salt salmon, were employed for fifty minutes, during which time sixty-nine cod and one halibut were taken. This was the best trial made on the Alaskan grounds, both as regards the rapidity with which the fish took the bait and their size and quality. The cod averaged 12 pounds each in weight, and 30¾ inches in length. Their stomachs were well filled with food, and they were more thrifty looking than any previously taken. A photograph of the entire lot, as it lay upon the deck, was secured. The spot where these fish were captured is a favorite fishing ground of the inhabitants of St. Paul, Kadiak, and large fares could be obtained in a short time by trawl or hand-line fishing.

At the next hydrographic station (No. 1393), 11 miles northeast of Dangerous Cape, 25 fathoms, rocky bottom, a brief anchorage was made, and cod and halibut were taken in abundance with the hand lines.

Remarks.—There are many excellent harbors and convenient anchorages in close proximity to this bank, which make it one of the most desirable fishing grounds which has yet been surveyed on the Alaskan coast. It has been resorted to for some years by a few fishermen who locate the rich spots which they have found by bearings from the land.

14. PORTLOCK BANK.

Hydrography.—This is the largest of the Alaskan banks that have been surveyed up to the present time. Its area inside of the 100-fathom line is about 6,800 square miles, that of George's Bank, the second largest bank on the eastern coast of North America, being about 8,400 square miles. Its outline, as indicated by the 100-fathom curve, is irregular. It extends northeastward from Kadiak Island to about longitude 148° 30′ W., a distance of from 110 to 120 miles, and is widest at the western end, where its width equals that of Albatross Bank and Kadiak and Afognak Islands combined. Neither its northern nor southern boundary was positively determined, however, in this region. Depths of 76 to 99 fathoms were found in the direction of Kenai Peninsula, 97 fathoms occurring 16 miles south of Point Gore, the nearest point on the mainland to which soundings were made.

Between longitudes 150° and 151° W. the bank abruptly narrows, and thence maintains a width of 35 to 45 miles to its eastern end. There is a broad indentation, with depths of 102 to 166 fathoms, on the southern side; depths of 105 to 122 fathoms occur just off the northern border, and 106 to 761 fathoms off the eastern end, close to the 100-fathom curve.

On the afternoon of August 23, in making the most northern soundings in longitude 151° and thereabouts, the Chugatz Islands, Point Gore, and Pye Islands were in sight, and cross-bearings were frequently taken to verify positions. Many snow-capped mountains were visible on the mainland, and in Nuka Bay an immense glacier extended apparently to the water's edge.

The soundings made by the *Albatross* between longitude 150° W. and the eastern end of the bank, inside of the 100-fathom line, show depths of 66 to 99 fathoms. Old soundings of 45 and 63 fathoms were not verified, although not shown to be inaccurate. Between longitudes 150° and 151° W. two soundings of 37 fathoms occur near the central part of the bank, while on the southern part depths of 40 to 72 fathoms were found. Between longitudes 151° and 152° W., the latter marking approximately the western boundary of the bank and the coast line, the depths, according to the soundings of the *Albatross*, range from 20 to 81 fathoms, the latter occurring near the land; but there are no indications of a marked or extensive depression between the bank and the shore.

Gray sand prevails over most of the bottom, mixed with pebbles, gravel, and broken shells in places, and with occasional patches of mud, and some rocky spots on the western part of the bank.

Between the eastern end of the bank and Middleton Island depths of 87 to 902 fathoms are shown by the single series of soundings made by the steamer. Two soundings of 87 and 101 fathoms, about midway between the two, indicate a small raised area surrounded by much deeper water.

Corrections.—Two lines of soundings on the southwestern part of Portlock Bank indicate shoaler water in that region than is marked upon the published charts of the Coast and Geodetic Survey, whose soundings are given on the chart accompanying this report in conjunction with the soundings of the *Albatross*. The two lines in question are as follows: One beginning in latitude 57° 52′ N., longitude 151° 47′ W., off Chiniak Harbor, and extending thence south 51° E. 50 miles, with soundings of 47, 30, 33, 35, 38, 42, 48, 57, and 72 fathoms; the other beginning in latitude 57° 26′ N., longitude 150° 06′ W., in 200 fathoms, and extending N. 51° W. 63 miles, with 59, 51, 43, 40, 36, and 78 fathoms. This work was done in fair weather, and it seems to prove the extension of Portlock Bank to Cape Greville without the intervening depression so generally found in this region near the land. The last sounding noted above, 78 fathoms, was made at dredging station No. 2856, which was occupied at noon. The latitude was obtained by meridian altitude of the sun, the longitude by chronometer, and both verified by bearings of the land, all of which showed Marmot Island to be improperly placed on Coast Survey Chart No. 702, by which its nearest point should have been 9 miles distant, yet the surf could be seen breaking on the beach not 5 miles away.

Dredging.—Three successful hauls of the beam trawl were made on Portlock Bank, as follows: Station 2856, latitude 58° 07′ N., longitude 151° 36′ W., about 15 miles east of Pillar Cape, Kadiak Island, in 68 fathoms of water, bottom gray sand, black specks; station 2857, in latitude 58° 05′ N., longitude 150° 46′ W., about 42 miles east of Pillar Cape, 51 fathoms, gray sand and broken shells; station 2858, in latitude

58° 17′ N., longitude 148° 36′ W., on the eastern edge of the bank in 230 fathoms, blue mud and gravel. A large quantity of material was secured at each of these stations. At the two former ones the results were similar to those obtained on Albatross Bank, but at the latter many new forms were taken which belong to deeper water. The principal fishes captured at station 2858 were *Glyptocephalus pacificus*, *Sebastichthys* sp. (red rockfish), and a red species of *Sebastes*.

Trials for fish.—Several trials for fish were made on Portlock Bank with hand lines, both rich and poor bottom being found in different localities.

The first trial was at hydrographic station No. 1421, latitude 57° 57′ N., longitude 151° 08′ W., about 35 miles east of Spruce Island, Kakiak, depth 36 fathoms; bottom, gravel and broken shells. At this place thirty cod and one halibut were taken with nine hand lines in eighteen minutes, salmon being used as bait. The cod averaged 8½ pounds in weight and 27 inches in length; the halibut weighed 10 pounds.

The second trial was at dredging station No. 2857, latitude 58° 05′ N., longitude 150° 46′ W., about 15 miles northeast of the last position, depth 51 fathoms, gray sand and broken shells. Although large quantities of specimens of the lower animals were obtained at this place in the beam trawl, the fishing was not successful, only two cod and four flounders (*Atherestes*) being captured on the hand lines. It is possible that the ship drifted from the rich ground before the lines were put over. A large number of whales were seen during the afternoon of this day, August 22.

A third trial was made at hydrographic station No. 1436, latitude 58° 23′ N., longitude 150° 32′ W., on the northern part of the bank, depth 37 fathoms; bottom, broken shells. Eight hand lines were kept out eighteen minutes, but here again the results were poor, only three cod, averaging about 5½ pounds each in weight, being taken.

The region in which the second and third trials were made is seldom if ever visited by the fishermen, and is therefore practically unknown.

Remarks.—This bank is destined to be recognized as a valuable fishing region, but the vessels that frequent it must go provided with ground tackle, in order to ride out such storms as they may meet with, unless fishing on the western end. A large part of the bank is too far distant from the shore to warrant their heaving up and seeking a harbor at the approach of every gale.

15. MIDDLETON ISLAND TO PUGET SOUND.

MIDDLETON ISLAND.

Approaching the island.—Middleton Island was sighted about 2 p. m., August 25, and late in the afternoon of the same day the *Albatross* anchored about a mile to the northward in 12 fathoms, near the point indicated on the Coast Survey chart, the north end of the island bearing N. 52° E., and the south end S. 27° W. This anchorage was off the outer limit of kelp, which seemed to extend the entire length of the island, from one-half to one and one-half miles from the beach. The ship was on the weather shore, where a moderate northwest wind and strong tide caused a heavy surf, so that landing was deferred until the next morning.

The rock mentioned in the Alaska Coast Pilot as lying 3 miles southwest (magnetic) from the north point of the island, and north-northwest (magnetic) from the anchorage was not seen, and, if it exists, is below the surface, where rocks may be encountered almost anywhere around this desolate island. The swell was so heavy that no soundings were made except in the immediate vicinity of the anchorage.

Observations of the tides during the night showed a velocity of 2 to 3 knots per hour, the flood setting to the northward and eastward, and the ebb in the opposite direction.

August 26 began with a moderate breeze from the southwest, veering to northwest, northeast, and east-southeast, with clear weather, except for two hours in the early morning. The surf was still too heavy for landing, and being anxious to get observations on shore, as well as to give the naturalists an opportunity to examine the region, the ship was got under way and steamed to the southern end of the island. When about to anchor in 10 fathoms the keel came in contact with a rock, but she was backed off without damage and anchored in 15 fathoms, about 3 miles distant from land, the northern end of the island bearing N. $\frac{1}{2}$ E. (magnetic), and the southern extremity NE. $\frac{3}{8}$ N. (magnetic). Captain Tanner, the navigator, and a party of collectors immediately landed.

Geographical position.—The following observations were taken to ascertain the position of the island: Two sets of equal altitudes of the sun for longitude, one meridian altitude, and six ex-meridian altitudes of the sun for latitude, the artificial horizon being used. They were made under favorable conditions and are reliable. The observation spot is one cable to the westward of the southeast extremity of the island, and is marked by a pile of stones on the beach above high water, the mean of all the sights placing it in latitude 59° 23′ 36.7″ N., and longitude 146° 19′ 33.4″ W.

Characteristics and surroundings.—Middleton Island is between 7 and 8 miles long, N. 22° E., and S. 22° W., with reefs extending 2 miles or more north and east of it, and between 3 and 4 miles off the southern end. The anchorage is on the west side, and an approaching vessel should keep well outside of the kelp, as rocks may exist anywhere near the island, which is a terminal moraine, composed of mud, clay, and gravel, with huge bowlders thinly scattered about over the surface, on the beaches, and on ledges above and below the water.

The southern end has perpendicular cliffs of mud and clay from 30 to 80 feet in height, the greatest elevation, toward the center of the island, being about 120 feet above the sea. The strata on this side dip from 30° to 40° about northwest (magnetic). The general appearance of the island is flat, and, the soil being impervious to water, numerous ponds are formed by heavy rains, and the entire surface is moist, almost boggy, covered in summer with a rank growth of grass, flowers, etc., but with no trees.

A band of about fifty fur seals was observed upon the rocky reef on the eastern side of the island. In the spring the island is visited by Indians in pursuit of seals and sea otters, and large parties are sometimes encamped there for several weeks at a time. During recent years, however, it is stated that the island is less resorted to than formerly for that purpose. It has no permanent inhabitants. The high cliff is difficult of ascent, but a means was found of reaching the top, where, near its edge, the puffins have excavated long underground passage-ways, which gave the pedestrians some uncomfortable walking, as the thin crust of earth covering the burrows was not sufficiently strong to withstand their weight. In the interior they encountered level ground, covered with a rich growth of tall grass and other moisture-loving plants, concealing many sluggish little rivulets which slowly tended toward the shore. Search was made for fossils in the beds of clay and gravel, but none were found.

Fishing.—Two trials for fish were made near the island. The first was at the anchorage on the western side, in 12 fathoms of water; but the strong southerly tide which was running at the time swept the leads from the bottom. No edible fish were taken, but dogfish were abundant. At the anchorage off the southern end of the island, while the naturalists were on shore, the sailors captured the two largest halibut that were taken by the *Albatross* on the Alaskan coast. One weighed 42 pounds, the other 61 pounds. Salt salmon was used as bait.

MIDDLETON ISLAND TO PAMPLONA ROCKS.

Hydrographic work.—Leaving Middleton Island at 3 p. m., August 26, the *Albatross* sounded in 22 fathoms, latitude 59° 19′ N., longitude 146° 23′ W., and then running S. 53° E. from that position sounded at a distance of 5 miles in 141 fathoms; thence 10 miles in 620 fathoms, and 20 miles in 2,425 fathoms.

The course was then changed to N. 74° E., for Pamplona Rocks. The day ended with clear, pleasant weather, and smooth sea, which continued on the 27th. Forty miles from the last station a sounding was made in 2,224 fathoms; 27 miles farther, in 2,138 fathoms, and 17 miles still farther in 1,528 fathoms. Changing the course to S. 51° E., the ship ran 17 miles to one of the positions assigned to the rocks; thence S. 16° W. 3 miles, and sounded in 1,763 fathoms; east 5 miles, and S. 28° W. 7 miles, to another reported position, where a depth of 1,745 fathoms was found; N. 70° E. 9 miles, sounding in 1,675 fathoms; N. 84° E. 10 miles, 1,500 fathoms, and S. 43° E. 10 miles, 1,548 fathoms.

Position of Pamplona Rocks.—"The position assigned to Pamplona Rocks on Coast Survey Charts 701 and 702, Hydrographic Office Chart No. 527, and the Alaska Coast Pilot, is latitude 59° 03′ N., longitude 142° 40′ W.; but Coast Survey Chart 960 places them in latitude 59° 35′ N., longitude 142° 04′ W.

"I considered it highly important that these dangers should be located in the interest of commerce as well as the fisheries, and as time would not permit an examination of both localities, we selected that which seemed to have the weight of evidence in its favor. The weather was remarkably clear, and the search was made during the middle of the day, with a lookout on the top-gallant yard, his line of vision extending 10 miles or more on either hand, without detecting any sign of rocks or shoals. The soundings were regular and gave no indication of shoaling water, so that it may be stated positively that the rocks do not exist within 20 miles of the assigned position.

"Coast Survey Chart No. 960 places them nearer land, where 40 to 50 fathoms are found in their vicinity, and where rocks, banks, or a ledge, as these dangers are called by different authorities, might be expected to exist. The snow-clad heights of Mount St. Elias, from 90 to 100 miles distant, were visible during the day, and many snowy peaks of less magnitude could also be seen from time to time."

PAMPLONA ROCKS TO PUGET SOUND.

Hydrographic work and narrative.—Leaving the locality where search was made for Pamplona Rocks, a course was laid for the northern end of Vancouver Island. On August 28 two soundings were made, the first, 50 miles S. 43° E. from the last station (latitude 58° 17′ N., longitude 140° 35′ W.), in 1,815 fathoms, gray ooze; the second, 50 miles farther in the same direction, 1,778 fathoms, brown and gray ooze.

During the three following days soundings were made as follows:

Latitude 56° 35′ N., longitude 137° 55′ W., 1,433 fathoms;

Latitude 55° 20′ N., longitude 136° 20′ W., 1,569 fathoms, accompanied by dredging;

Latitude 54° 02′ N., longitude 134° 34′ W., 1,571 fathoms;

Latitude 52° 32′ N., longitude 133° 05′ W., 1,601 fathoms; 25 miles SW. ½ S. (magnetic) from Cape St. James, 1,099 fathoms;

Latitude 51° 23′ N., longitude 130° 43′ W., 876 fathoms, accompanied by dredging;

Latitude 51° 14′ N., longitude 129° 50′ W., 204 fathoms, accompanied by dredging;

Latitude 51° 09′ N., longitude 129° 07′ W., 83 fathoms;

Latitude 51° 01′ N., longitude 128° 25′ W., 52 fathoms.

The last station was off the northwestern extremity of Vancouver Island, where an anchorage was made on the night of August 31. From there the ship proceeded by way of the inner passages between Vancouver Island and the mainland to Seattle, Wash., where she arrived September 6, having made several stops on the way for the purposes of sounding, dredging, coaling, etc.

Sounding and dredging stations were made in Queen Charlotte Sound, off the southern entrance to Goletas Channel, depth 238 fathoms; in the Gulf of Georgia, off Fraser River, 67 fathoms; in the southern part of Washington Sound, 48 fathoms; and off the northern entrance to Admiralty Inlet, 40 fathoms.

Night anchorages were made in Alert Bay, Tribune Harbor, and Burrows Bay, and a supply of coal was taken in at Departure Bay. Burrows Bay is a good harbor, and is protected from all but southerly winds.

On the trip to Alaska during the first part of July the steamer *Albatross* made the same inner passage, but no hydrographic or dredging work was done. While going through, however, stops for various purposes were made at Esquimalt, Departure Bay, Tribune Bay, Alert Bay, and Fort Rupert, at all of which places collections and observations of greater or less extent were made, as explained further on.

Dredging.—Two casts of the beam trawl were made in deep water on the way south from Pamplona Rocks to Vancouver Island. The first was at station No. 2859, latitude 55° 20′ N., longitude 136° 20′ W., to the eastward of Prince of Wales Island; depth, 1,569 fathoms; bottom, gray ooze. The second was at station No. 2860, latitude 51° 23′ N., longitude 130° 34′ W., off Cape St. James, Queen Charlotte Islands, 876 fathoms, green mud. Both of these hauls developed a rich deep-sea fauna, and a large number of interesting specimens were obtained. Among fishes the genus *Macrurus* was represented by several species and over a hundred specimens, a large species of *Lithodes* (deep-sea spiny crab), several species of shrimps, several genera of echinoderms and *Umbellula* were very abundant.

At station 2861, latitude 51° 14′ N., longitude 129° 50′ W., 204 fathoms, the assemblage of forms was more like those obtained on the deeper parts of the Alaskan fishing banks. Both fishes and invertebrates were taken in great abundance, and among the latter were several specimens of a species of *Anthomastus*, which was here seen for the first time.

Station 2862 was in Queen Charlotte Sound, off the southern entrance to Goletas Channel, Duncan Island bearing ENE. ½ E. (magnetic); Noble Island, N. ¼ W. (magnetic); depth, 238 fathoms; bottom, gray sand and mud. The trawl came up with a heavy load of mud, which detained the ship two hours or more, as it was necessary to tow it through the water until relieved of sufficient weight to allow of its being landed on deck. This proved to be an exceedingly rich haul, the bulk consisting of sponges, of which there were several bushels. Fishes, crustaceans, and brachiopods were also abundant, the latter group being represented by apparently three species.

Three dredgings were made between Departure Bay and Puget Sound, as follows: No. 2863, in the Gulf of Georgia, off the mouth of Fraser River (latitude 48° 58′ N., longitude 123° 10′ W.), 67 fathoms, fine sand; No. 2864, in the southern part of Washington Sound (latitude 48° 22′ N., longitude 122° 51′ W.), 48 fathoms, mud, sand, and broken shells; No. 2865, off the northern entrance to Admiralty Inlet (latitude 48° 12′ N., longitude 122° 49′ W.), 40 fathoms, pebbles. At the two former stations a large quantity of material was obtained, but at the last the trawl capsized and only a few specimens came up. Fishes, mollusks, crustaceans, annelids, echinoderms, and hydroids were abundant. Two bushels of large red shrimps, representing several species, and a few cup corals, were secured at station No. 2864.

FORT RUPERT, VANCOUVER ISLAND.

July 12 the *Albatross* called at Fort Rupert, or Beaver Harbor, for the purpose of obtaining a supply of clams, to be used as bait on the Alaskan grounds. Clams are unusually plentiful in this locality, and with a force of fifteen sailors ten bushels were dug at one low tide. Three species occur here in about equal abundance. The large gaper clam (*Schizothærus*) is obtained by digging deeply at lowest water mark. *Saxidomus nuttallii* (quahog) and the little *Tapes staminea* are usually only 6 or 8 inches below the surface, and may be found anywhere between high and low water mark. During unfavorable fishing seasons the salmon cannery at Alert Bay has put up clams, obtaining its supplies from Beaver Harbor. The chief occupation of the Indians is hunting and fishing. All the furs they obtain are sold to Mr. Robert Hunt, who pays for them in flour, clothing, and other necessary articles. Money is sometimes demanded, but not often.

Discovering the object of the visit of the *Albatross*, the Indians brought many clams alongside the ship in their graceful canoes. An entire canoe load was obtained in exchange for articles of barter of most trifling value. There are at Fort Rupert only two white settlers and about one hundred Indians.

ALERT BAY, VANCOUVER ISLAND.

Short stops were made at Alert Bay both going and returning. There is an Indian village at this place, and also a salmon cannery, where, up to September, 46,000 cases of salmon had been put up.

Salmon are sometimes very abundant about the bay and neighboring islands, and are fished for chiefly with seines and gill nets. The fishermen are paid 5 cents each for all the salmon landed at the cannery. The Indians of the village are principally occupied in fishing for the cannery. A few of them use spears for this purpose, and at times they do fairly well, frequently earning as much as $5 a day. At the time of the first visit to the cannery, July 11, seven or eight hundred of the Suk-kegh salmon (*Oncorhynchus nerka*) were piled upon the floor.

DEPARTURE BAY, VANCOUVER ISLAND.

Collecting.—A delay of two days while coaling at Departure Bay, July 10 and 11, was utilized to advantage in seining along the neighboring shores, during which many interesting fishes and marine invertebrates were secured. The larger fishes obtained were *Ditrema laterale* (blue perch), *Damalichthys argyrosomus* (white perch), *Micrometrus aggregatus*, *Sebastichthys paucispinis*, *Ophiodon elongatus*, and *Chimæra colliei.* The first four species were taken in considerable numbers at each haul of the seine. *Ditrema* and *Micrometrus* are highly esteemed as pan fish. From one adult specimen of *Damalichthys argyrosomus* thirty young ones were obtained, one of which lived in the aquarium on board the ship for two days. The young were much compressed laterally; body above lateral line faint purplish, below more inclined to silvery; fins transparent, pinkish, very soft and membranous, larger in proportion to size of body than in the adult. This species was not found with its young later in the season. The great rise and fall of tide which occurs in this region, amounting to about 15 feet, makes it very easy to collect the marine invertebrates along the shores. The large many-armed star fish (*Pycnopodia helianthoides*) is abundant at Departure Bay.

Fishery notes.—There are only a few fishermen at Departure Bay, all of whom are Italians. They fish chiefly for dogfish, which school in vast numbers in the bay and in the neighboring indentations of the coast during the winter months. As spring approaches the dogfish migrate to the Gulf of Georgia to feed upon herring and other small fish. About the first of December a large school of herring seeks the waters of Departure Bay, closely pursued by the dogfish. At this time the Italians begin their fishing, which is actively continued until March, when the herring leave the bay for deeper water. Gill nets only are used for the capture of dogfish. They are 40 fathoms long, from 20 to 25 feet deep, and have a 6-inch mesh. They are made of hemp and cost from $12 to $15 each. The floats are of cork and have the same size and shape as those used on the mackerel purse seines; they are obtained in San Francisco.

The rainy season begins in November and lasts until February. The prevailing winter winds are from the southeast. Strong northerly winds, however, occasionally sweep down the coast during that season, and at such times the dogfish generally leave the bay for a few days, or until the wind changes back. Salmon are most abundant in September. Spring salmon strike the coast in November, and are caught during the winter months; a few are occasionally taken in the dogfish nets. No halibut are caught at this place, but skates are numerous. Cod seldom enter the bay, but are found outside in deeper water. Those taken are not large, averaging about 5 pounds each. They are not often fished for and are not considered of much commercial value.

It has not, apparently, occurred to the Italian fishermen that the herring, so abundant in Departure Bay, is a valuable oil-producing fish. A few have been smoked for the local trade, and it is stated that during the coming winter this method of preparing them will be attempted on a much larger scale. Dogfish oil brings 50 cents per gallon at Nanaimo, and "ratfish" oil (the oil from *Chimæra colliei*), 75 cents per gallon. These oils are used by the Wellington Coal Company for lubricating purposes. The fishermen carry on their business on a small island in the bay, and at times they realize considerable profit from it. Three dollars per day is said to be regarded as fair wages. They are very primitive and uncleanly both in their way of living and in their methods of extracting the oil. With proper facilities the preparation of herring and dogfish oil in this locality might be made a profitable business. There are numerous islands along the inner coast of Vancouver Island, where dogfish try-works could be established, and the fishing continued during the entire year.

A few Indians fish in the bay chiefly for salmon, to supply the market at Nanaimo as well as their own wants. Their method of fishing is to troll with hook and spoon. They use dug-out canoes measuring from 12 to 20 feet in length, which, in their construction, show great attention to symmetry of outline, and much care and ingenuity in workmanship. They cost, when new, from $5 to $20 each, according to size.

The fishing boats used by the white men mostly range in length from 15 to 20 feet, and are both clinker and carvel built. Some are sloops, while others have a two-masted sprit-sail rig. They are all rudely constructed and are not neat in their appearance.

Fishing in Departure Bay and Harbor is seldom interfered with by the presence of ice during the winter months.

C.—REPORT OF THE EXPLORATIONS ON THE COASTS OF WASHINGTON TERRITORY AND OREGON.

16. NARRATIVE.

Returning from Alaska, the *Albatross* arrived at Seattle, Wash., on the afternoon of September 6, and was detained there until the 17th, in making a few repairs to her machinery. During the stay a visit was received from the mayor and city council, who inspected the steamer and expressed great interest in her work. September 17 the ship proceeded to Port Townsend, where a conference was had with Judge James G. Swan, of that place, relative to the fisheries of Washington Territory and the proposed investigations in that region. The Coast Survey steamer *McArthur* arrived at Port Townsend the same day, and an account of her soundings in the neighborhood of Cape Flattery was obtained, which resulted in a great saving of time and labor, as otherwise the *Albatross* would have been obliged to sound over a portion of the same ground.

The steamer left Port Townsend on the 18th, and, passing through the Straits of Fuca, began the examination of the outer coast, which, during this trip, covered the area lying between Shoalwater Bay (latitude 46° 31′) and the coast of Vancouver Island in latitude 49° N., including the halibut banks at the mouth of the Straits of Fuca. An anchorage for the night was made at Neeah Bay, September 24; the 26th and 27th of the same month were spent in Barclay Sound, Vancouver Island; and the *Albatross* returned to Port Townsend September 30, and to Seattle October 1, remaining four days for repairs at the latter place.

Leaving Seattle October 4, a short stop was made at Port Townsend, where, on the invitation of Captain Tanner, Judge James G. Swan joined the ship for a part of the second and final cruise before returning to San Francisco. A visit was made to Victoria, Vancouver Island, to obtain information respecting the recent attempts to establish a fishery for the beshowe or black cod, and the ship was also coaled at Departure Bay. Passing Cape Flattery on the evening of October 10, and sailing down the coast, operations were begun in the vicinity of Shoalwater Bay, and carried thence to the latitude of Tillamook Rock, Oregon, a short distance below the mouth of the Columbia River. The steamer entered the Columbia River October 14 and anchored off Astoria. Visits were received from Mr. F. C. Reed, State fish commissioner for Oregon; from the Hon. J. H. D. Gray, Colonel Taylor, and other prominent residents of Astoria, with whom the fishery interests of the region were discussed. Judge Swan left the *Albatross* at this place and returned to Port Townsend. The *Albatross* proceeded to sea on the 18th, made trials for fish and several dredgings about Tillamook Rock, and also a brief examination of Heceta Bank. From the latter region she sailed directly to San Francisco, where she arrived October 21.

17. PUGET SOUND AND THE STRAITS OF FUCA.

DREDGING AND FISHING TRIALS.

No soundings or dredgings were attempted by the steamer *Albatross* either in Puget Sound or directly in the Straits of Fuca, but two trials for fish were made in the latter region and two dredgings (stations No. 2864 and 2865) in the southern part of Washington Sound, as previously described. Important information respecting the fisheries and fishery industries of the region were, however, obtained.

Off Race Island.—October 19, after coaling at Departure Bay, a cod trawl was set in a depth of 101 fathoms, off Race Island, at the southeastern end of Vancouver Island, for the purpose of discovering the presence of beshowe or black cod, which were supposed to occur there. It was allowed to remain down only half an hour, at the end of which time it had secured forty dogfish, all the bait having been taken from the remaining hooks.

Neeah Bay.—On the evening of September 24 the halibut trawl was baited and set off Kaihsla Point, the inner buoy being in 20 fathoms, the outer in 25 fathoms. It was allowed to remain down until the following morning, but on hauling it only twenty-four dogfish and two skates were found. Halibut and beshowe are sometimes taken in close proximity to Neeah Bay earlier in the season. The last-named species is never abundant here, however; but some years it is sufficiently common in the spring to furnish the Indians of the vicinity with a considerable supply of food.

SEATTLE.

Fresh-fish markets and fresh trade.—Since the arrival of the schooners *Mollie Adams*, *Edward Webster*, and *Oscar and Hattie*, bringing with them New England fishermen, a conspicuous change is said to have taken place in the manner of presenting fresh fish for sale in the city markets. Previously the fish brought in for this trade, and which were chiefly caught by the Italian and Greek fishermen, were left in the bottom of their boats or thrown upon some convenient wharf exposed to dirt and flies until sold. Now there are six or seven well-kept markets in the city, where the fish have an inviting appearance. One of these is owned by a Mr. Butler, formerly of Gloucester, Mass., who is doing fairly well at retailing and shipping small quantities of fresh salmon to St. Paul and Minneapolis, Minn. Mr. Butler states that the demand for salmon by the eastern markets far exceeds the supply on account of the small catch at the present time. No other person in the city has attempted to ship fresh salmon to the inland cities. Strange to say, the fresh salmon consumed in Port Townsend are shipped there from Seattle.

During the two stops made at Seattle, from September 6 to 17, and from October 1 to 4, the fish markets were visited every morning, with the result of finding the following species exposed for sale: Columbia salmon (*Oncorhynchus chouicha*), silver salmon (*O. kisutch*), white perch (*Damalichthys argyrosomus*), perch (*Micrometrus aggregatus*), brown rockfish (*Sebastichthys maliger*), surf smelt (*Hypomesus pretiosus*), starry flounder (*Pleuronectes stellatus*), deep-water flounder (*Glyptocephalus zachirus*), flounders (*Psettichthys melanosticus*, *Parophrys vetulus*, and *Pleuronectes isolepis*), tom cod (*Microgadus proximus*), and a number of smaller and less valuable species. Salmon were the prevailing species at this season, being taken daily in the channels opposite the town by the Greek and Italian fishermen. There are several squads of these men who go out in large, unwieldy, broad-sterned boats, which they laboriously but patiently propel from the landings to the seining grounds at each high tide, whether in the day or night.

The salmon seemed to be sufficiently plentiful to supply the demands of the town and to keep the few canneries in this vicinity in operation most of the time. A favorite amusement of the towns-people is trolling for salmon, which is done with fair success directly in front of the city wharves. Many Indians also fish for salmon in dug-out canoes of their own manufacture.

The salmon fishermen and salmon nets.—There are about three hundred Austrian, Italian, Greek, and Scandinavian fishermen in Seattle and vicinity. The greater number of these are now engaged in fishing for the canneries, of which there are three within a radius of 5 miles of the city. Purse seines and gill nets chiefly are used for taking salmon in Puget Sound. Fish traps were introduced into the region in 1888 by a Mr. Felters, formerly a fisherman on the Great Lakes. Purse seines were first employed in the Sound two years ago, and it is stated that they were brought here by the Chinese. They do not differ materially from the mackerel seine of the eastern coast, except in the addition of an apron which is hauled under the bunt in pursing. Some of the seines, however, are said not to have the apron. These seines are 200 fathoms long, 25 fathoms deep in the bunt, and 20 fathoms in the wings; they have a 3-inch mesh. The twine used in their construction is of three sizes, Nos. 12, 15, and 18; No. 12 being used in the bunt, No. 15 at each side of the bunt, and No. 18 in the wings. The foot-line is heavily leaded, and the bridles are about 10 feet long. One and one-half inch Russian hemp is used for the purse line. The rings through which the purse line is rove measure about 5 inches in diameter, and are made of small-sized galvanized iron.

The Puget Sound fishermen claimed that this style of purse ring was superior to that used upon the mackerel seines of the eastern coast. They had given the mackerel purse rings fair trial and were forced to abandon them, as the purse line would invariably draw twine into the rings, thereby preventing the pursing of the seine. Schools of salmon were often lost from this cause. A subsequent examination of some of the condemned "Gloucester rings," as they were called, showed them to be of the small composition make, such as were employed at one time on the "shoal" or small seines. This kind of ring has not been in use by the mackerel fishermen for eight or ten years, having been given up by them for the same reason explained above. There is no apparent reason why the modern mackerel purse ring would not work to advantage on the salmon purse seines of Puget Sound.

The time is not far distant when the combination of Oriental ideas which now prevail in this region will give way to the modern improvements which the American fishermen are bringing with them to the Pacific coast. It will, however, probably take some time to overcome the prejudice which now exists against the introduction of new methods of fishing, as the Greek and Italian fishermen are very conservative and look with disfavor upon any change from the old ways.

The salmon boats, method of stowing the seines, etc.—The boats used in the salmon fishery are about 25 feet long and 7 feet wide, the greatest width being at the stern, which is square. The bottom is flat, but turns up slightly at the stern. These boats have three thwarts, adapted for two men rowing at each. About 8 feet of the after part of the boat is decked over, and upon this deck the seine is stowed. The method of stowing and throwing the seine differs somewhat from that followed in the mackerel fishery. The salmon seine being thrown over the stern of the boat, it has to be stowed fore and aft instead of athwartship. The corks are placed on the port side, the twine on the starboard side. The twine is thrown in a heap, not arranged neatly in "flakes" and "bits," as upon a mackerel boat, because the man who throws it is not particular to have it clear the stern so as not to retard the speed of the boat in going around a school. The result is that the oarsmen have an extra amount of work to perform.

The scow upon which most of the work is done, and which is considered indispensable in setting the seine, is 20 feet long by 8 wide, and at each end of it is an iron winch. These winches are used for the pursing up, the seine being pursed from the scow. There is a wooden purse davit, which is stepped into the side of the scow, and to which are attached two 3-inch wooden blocks, the purse line leading from them to the winches at either end. Eleven to fourteen men are required to set the seine—six at the oars, two at the seine, and two on the scow. Of those at the seine, one throws the corks, the other the twine.

The cost of a salmon seine, boat, and scow is from $1,200 to $1,300.

Method of fishing with the purse seine.—Starting upon a fishing trip, the boat, with its scow in tow, is rowed to a favorable locality where salmon are likely to occur, and, having anchored the scow, a lookout is kept for fish. As soon as a school is sighted the boat is shoved off, leaving one end of the seine attached to the scow. A circle is made around the fish, the boat returning again to the scow, when all hands jump aboard of it and commence to haul in on the twine and corks, two men standing at the winches and slowly taking in the slack on the purse line. It is not, however, until half the length of the seine has been pulled in that they begin to purse up in earnest. At this time the anchor rope is slacked off, and, all hands laying hold of the purse line, purse the scow into the middle of the seine. Were this done in the beginning, much hard labor could be saved. Time and labor would also be economized by slacking the anchor rope while the first half of the seine is being hauled in, instead of which the seine is hauled bodily through the water.

During the slow process of pursing a man stands at the davit with a long pole, having a block of wood called a "plunger" fastened to it. This is kept working up and down between the purse lines, for the purpose of frightening the fish away from the center of the net; and it is, no doubt, very effective in saving the school, as the bottom of the seine is left open from twenty-five to forty minutes, which is ample time for a salmon to find its way out.

From an hour and a half to two hours are required for setting, pursing up, and stowing the seine ready for another trial. On two occasions, when the operations were timed, they consumed on an average one hour and forty-five minutes. The result of both sets was fifty-odd salmon. As many as two thousand salmon were taken in this manner off Seattle at a single haul during 1886, but no such captures have been made since that year. Later in 1888 than the time of the above observations salmon became more abundant in the vicinity of Seattle.

Prices paid for salmon.—The fishermen receive from the canneries 25 cents for large and 10 cents for small salmon. Toward the latter part of the season prices are reduced. The proceeds of a sale are divided equally among the crew. The boats, seines, and all other gear employed are furnished by the canneries. Three hundred dollars is considered fair earnings for a season's work, the season beginning the 1st of August and continuing until the latter part of October.

Fish traps for salmon.—There are seven fish traps in Puget Sound, all of which were put down during the spring of 1888. Four are owned by Parker & Felters, proprietors of the Columbia River Cannery at Seattle, who were the first to introduce traps in this locality. Mr. Felters is of the opinion that these appliances will take the place of seines, as there is less expense attendant upon their management. One or two men are sufficient to tend them and keep them in repair. The fishermen about Seattle are strongly opposed to the building of traps, as threatening the future prosperity of the salmon fishery if they are used to any great extent. With the general introduction of traps, requiring much fewer men to carry on the work, the majority of the present fishermen would be forced to seek other employment during the salmon season; and, furthermore, the fishery would soon be broken up, at least to such an extent as to make it unprofitable to more than a very limited number of fishermen.

Up to September, 1888, the traps had taken a large proportion of the salmon brought to the Columbia River Cannery at Seattle. In addition to the traps, this cannery also has two drag and two purse seines fishing for it. The purse seines are used in the harbor of Seattle or in Dwamish Bay. Fishing is carried on both day and night, according as the tide serves. No attempts are made to fish excepting near the time of high water, when the larger catches can be made.

Salmon canneries.—Each cannery has a small steamer to visit the traps in different parts of the Sound, carrying out supplies and bringing back the nightly catch. The catch of salmon for 1888 was not large. Up to September 9 the Columbia River Cannery had put up 750 cases; the King County Packing Company, 600 cases; and the cannery at Dwamish Head, owned by Mr. George Myers, 1,200 cases. Mr. Myers has seven purse seines fishing for him, and has in his employ about forty men, mostly Chinese. He claims to have facilities for putting up 650 cases of salmon per day, and could average 450 cases per day with his present help if fish were sufficiently abundant. Nearly all the canning is now done under contract with Chinamen, who catch the salmon and prepare them ready for shipment at a specified sum per case. The price paid under this system during 1888 was 42 cents per case.

Many improvements have been made in canning machinery, the filling and sealing of the cans being now accomplished by means of automatic devices.

Decrease of salmon.—A Mr. Herrick, formerly connected with a cannery on Columbia River, but now in the employ of Parker & Felters at Seattle, claims from an experience extending over the past twenty years that salmon are rapidly decreasing in this region. This decrease is due not only to the great annual catch, but also to the presence of much floating refuse from the saw-mills of the neighborhood. Mr. Myers, of the Dwamish Head Cannery, on the contrary, considers that there has been no general decrease, and that there are no indications of the salmon becoming exterminated, as some predict. He has been connected with the fishery in Puget Sound for the past twelve years, and states that salmon are as abundant now as at any time in the past. They fluctuate in abundance, however, from year to year.

Size of salmon, etc.—Salmon run much smaller in Puget Sound than in the Columbia River. Mr. Herrick states that in the former region twelve salmon on an average are required to make a case, while in the latter three are sufficient for this purpose. A case of salmon contains forty-eight 1-pound cans. The greatest output for the United States in one year has been 1,000,000 cases, or 48,000,000 cans.

Proposed change in location of canneries.—As thirteen of the Columbia River canneries have been closed during the past year, it is probable that the production for this year will fall considerably short of the maximum reached in this fishery. The owners of many of the closed canneries talk of establishing themselves in Alaska, where the cost of catching and canning the fish will be very much less than on the Columbia River, and where their general expenses will be lower.

The winter fishery.—As soon as the run of salmon is over the fishermen seek other employment. Some engage in dogfishing, which begins in November and lasts until spring; others fish for cod, smelts, and other small species. Gill nets are used for the capture of cod and trawls for dogfish. The trawls are very heavy. The ground lines are made of six and nine thread manila, the gangings of 18 to 20 pound line, while the hooks are about the same that are used in the Atlantic coast halibut fishery. The anchors are exceptionally heavy, some weighing as much as 75 pounds, the average weight being about 50 pounds. A few of the fishermen in the Sound realize that lighter anchors and smaller gear generally would answer every purpose, and talk of adopting the eastern style of trawl, but the majority are prejudiced in favor of their present methods.

PORT TOWNSEND.

Port Townsend has a much finer harbor than Seattle, capable of sheltering a large fleet of vessels, and already has excellent wharf privileges, where vessels of deep draught can remain afloat at all times of the tide. There are also many places in the harbor well adapted to the construction of marine railways. With the development of the ocean fisheries on the northwest coast, especially in the event of the completion of the railroad to Port Townsend, now under construction, this harbor seems destined to become the center of an important industry, as it apparently possesses greater facilities and offers more inducements to the fishermen than any other place on Puget Sound.

VICTORIA, VANCOUVER ISLAND.

Local fish markets.—During the brief stay at Esquimalt in July advantage was taken of the opportunity to examine the fish markets of Victoria, which is only 3 miles away. It was observed that the fish stalls at that place were superior in most respects to those of any other city on the Pacific coast, the superiority appearing to be due mainly to the manner of handling the fish. The stalls were well supplied with ice and the fish looked fresh and wholesome, in marked contrast with the stalls of San Francisco, a city vastly larger and with equal resources, so far, at least, as possibilities for cleanliness and care in handling the catch are concerned. At this season, and again in October, when a second visit was paid to Victoria, there was an abundant supply of the following local species: Halibut, averaging probably 50 pounds each; flounders (*Pleuronectes stellatus*); rockfish (*Sebastichthys*), two species; rock-trout (*Hexagrammus*), three species; salmon, two species.

The halibut, flounders, and other marine fishes are caught in the Straits of Fuca, the fishermen using trawl lines of the same pattern that are employed in Puget Sound. Neither fresh nor salt codfish were seen in the markets, this species being replaced by the more abundant and more highly prized salmon. The fishing fleet consists of a few small vessels and boats, manned chiefly by Italians and Greeks.

THE BESHOWE, OR BLACK COD.

In October the naturalists had an opportunity of examining some of the so-called "black cod," or "beshowe," of the Indians, which had been recently landed by the fishing schooner *Theresa*, of Victoria. They were in pickle, and had been split down the back in precisely the same manner in which mackerel are dressed on the Atlantic coast. It is difficult to explain the reasons for having adopted this method of preparation. The labor of caring for a cargo of these fish in such a manner must have been very great, as the hard, bony head of the beshowe must interfere greatly with the operations of the splitter, which is not the case with the mackerel. This successful trip of the *Theresa* has occasioned renewed interest in this valuable species of food-fish, concerning which so much has been written during recent years, and several of those engaged in the fishing business at Victoria think seriously of immediately fitting out vessels for their capture. The *Theresa* fished in a depth of 210 fathoms, about 5 miles off the Queen Charlotte Islands, with a trawl line furnished with two hundred hooks. A part of the cargo was purchased from the Indians at the rate of 25 cents per fish. The entire fare brought in consisted of nearly three thousand beshowe, many of which weighed from 20 to 25 pounds each.

The Portland Oregonian, in speaking of this trip, says:

> The return of the schooner *Theresa* from the black-cod banks with a full catch has determined a number of others to engage in the fisheries. Epicures pronounce these fish delicious—superior to shad and infinitely superior to the tomcod. Consignments will soon be forwarded to eastern markets.

On the trip above described the *Theresa* had an Indian crew. She afterwards left on a second cruise with Newfoundland fishermen, and better results were expected.

In 1884 considerable interest was evinced in British Columbia respecting the beshowe, and several vessels were fitted out to go north. Little or nothing was accomplished, however, as those who were willing to engage in the business had no capital, and those who had did not care to risk it. The great depth at which these fish generally live, 150 to 200 fathoms, has undoubtedly had much to do with hindering the establishment of this industry, as the northwestern coast fishermen have never been obliged to go beyond a depth of 50 fathoms for their cod and halibut, and are totally unused to deep-water fishing.

18. OFF CAPE FLATTERY.

SOUNDING, DREDGING, AND TRIALS FOR FISH.

The region defined.—Under this title we include the outer coast from Flattery Rocks north to latitude 49° N., and the waters lying at the mouth of the Straits of Fuca.

Hydrographic work.—As the region above defined had already been surveyed to a sufficient extent for the purposes of this preliminary investigation, sounding operations were omitted by the steamer *Albatross*, excepting to the south of Cape Flattery. These soundings, however, having reference mainly to supposed off-shore banks, their discussion is deferred to the next section.

Dredging and fishing trials.—Three dredgings, all with the beam trawl, were made in the vicinity of Flattery Rocks, and between there and Cape Flattery. The first was at station No. 2866, 19 miles S. 40° W. from Flattery Light-house, 171 fathoms, gray sand; the second at station 2867, 17 miles S. 23° W. from Flattery Light, 37 fathoms, fine sand; the third at station 2872, 8 miles S. 40° W. from the same light-house, 38 fathoms, gray sand.

Near station 2867 the halibut trawl, baited with salt salmon, was set at 3 p. m. and hauled at 5 p. m., securing eight sharks, two dogfish, and one halibut, the latter weighing 140 pounds and measuring 5 feet 9 inches in length. A few hand lines were also tried in the same locality, one red rockfish and several dogfish being taken by them. A skate of halibut trawl, baited with salt salmon and red rockfish, was also set in the position of dredging station 2872, but only two sharks and one star-fish were taken on it. In the spring the Indians fish for halibut in this locality, but it is as yet impossible to say whether they are sufficiently abundant there to insure good fares to the vessel fishermen.

Three dredging stations were made September 24 on the halibut bank at the mouth of the Straits of Fuca, at distances of 10 to 12 miles northwesterly from Cape Flattery. These stations are numbered from 2873 to 2875, inclusive. The depths ranged from 27 to 40 fathoms, and the bottom was exceedingly variable in character, consisting in different places of rocks, shells, mud, and sand. The first trial was made with the beam trawl at No. 2873, depth 40 fathoms. The trawl was lowered, but caught at once on the rough rocky bottom, and the frame was lost, the wreck of the net coming up with the bridle. The tangles were then lowered in 27 fathoms, rocks and shells, the result showing a rich fauna, or "live bottom," in the vernacular of the fishermen. Another haul with the tangles (No. 2875) was made over the same ground with similar results.

The halibut trawl was set in the same position as the above dredging stations, the depth being 40 fathoms, and the bottom rocky. Salt salmon and red rockfish were used as bait. It was allowed to remain on the bottom about three hours, and when hauled up four halibut, two sharks, four red rockfish, and two star fish were found upon the hooks. The average weight of the halibut was 47¾ pounds; three were females and one was a male; they were all white. Gray halibut are seldom found in these waters.

The above operations were on the well-known bank where, in the spring and early summer, halibut are found in great numbers, and where the Indians for many years have procured their winter supplies.

September 25 work was continued in nearly the same locality as on the previous day. The beam trawl was cast at station No. 2876, 2 or 3 miles northeasterly from stations 2873 to 2875, and the trawl line, baited with salmon, red rockfish, and fresh halibut, was set at the same time. The depth was 59 fathoms, and the bottom consisted of black sand and mud. The beam trawl dragged but a few yards, when it caught on a rocky patch, parted the bridle stops, and came up tail first. It was, however, a successful haul, and many specimens were found in the net. The tangles were subsequently hauled over the same ground (station 2877) with good results, giving evidence of the richness of the bottom. The towing net, which was frequently used in this region, however, gave very little evidence of surface life. The halibut trawl remained on the bottom three hours, and the catch consisted of two halibut, one red rockfish, and nine dogfish, the average weight of the halibut being 55 pounds. Halibut were taken at every trial made off the Straits of Fuca, and, although there appeared to be no large body of these fish on the coast at this season, a vessel could readily have picked up a good fare in a comparatively short time.

On the afternoon of September 25 the trawl line was set and the dredge lowered in 66 fathoms, gravel and pebbles (station 2878), S. 48° W., 16 miles from Cape Beale Light-house, on the southern side of the entrance to Barclay Sound, Vancouver Island. The contents of the dredge, consisting for the most part of small mollusks, did not bear evidence of a rich bottom. The same bait was used upon the trawl line as in the previous trial, and the capture after two hours' time consisted of two beshowe or black cod, fifteen dogfish, two common sharks, and two ground sharks, one of the latter being hauled on board and photographed. Only a small quantity of surface organisms was taken in the tow nets.

Early on the following day two dredge hauls were made at stations 2879 and 2880, 27 miles N. 79° W. from Cape Beale, in 34 fathoms, rocky bottom, with about the same results as at station 2878, the bottom not being rich so far as the contents of the dredge indicated. A trial with the halibut trawl in the same locality, lasting about three hours, afforded one halibut weighing 25 pounds, two sharks, and three dogfish.

At station 2881, in the same neighborhood, but much nearer the coast, Cape Beale bearing S. 26° E., distant 26 miles, the dredge was cast in 24 fathoms, on a rough bottom, with fine gray sand in places. The results were not favorable to good fishing. The trawl line set in the same position took one halibut weighing 15 pounds, five dogfish, one shark, and one skate. The trawl, when it came up, was covered with "slime," which was contrary to expectations, as the dredging which preceded it indicated clean bottom. The ground probably varies greatly in this region, as in many other fishing areas, there being numerous distinct spots where the fish resort to feed and spawn.

September 27 and 28 were spent in Barclay Sound, and the following day a skate of halibut trawl was set in 60 fathoms of water, sandy and rocky bottom, 22 miles S. 14° E. from Cape Beale. The trawl was kept down about two hours, with the result of capturing sixteen dogfish, one beshowe or black cod, one cultus cod, and three small halibut. This spot would probably be a good one for halibut earlier in the season, before the dogfish set in, and is convenient to the Straits of Fuca. It requires examination in the spring or winter to determine its merits.

BARCLAY SOUND, VANCOUVER ISLAND.

The *Albatross* anchored September 26 in Barclay Sound, where she was detained by fog two days. A cod trawl, baited with halibut and salmon, was set one evening in a depth of 17 fathoms, and allowed to remain down over night. On hauling it the next morning, twenty-eight dogfish and one red rockfish were found upon the hooks. There are not many beaches suitable for seining in this sound, but a few were found on which a large variety of shore fishes was obtained. Salmon were seen darting about in every direction; they are said to be very plentiful at the headwaters of the sound, where they enter the creeks and inlets to spawn. A few fine large specimens were taken by trolling. Marine invertebrates are also very abundant, and many interesting forms were collected along the shore, among which were several species of starfishes and fine large specimens of *Lunatia lewisi* and *Haliotis kamtschatkensis*.

The only evidence of civilization about the sound was the light-house on Cape Beale, the Indian villages being mostly abandoned, and the occupants gone to the salmon canneries in the interior. Several canoe-loads were seen passing, a few came alongside, and occasionally one was seen trolling for salmon.

GENERAL RESULTS OF TRIALS FOR FISH ON THIS COAST.

After the numerous trials made for halibut on this part of the coast, both with trawl lines and hand lines, it became evident that sharks and dogfish had taken possession of the fishing banks at this season to the exclusion of food-fishes, while in the spring and early summer, when halibut are abundant, only a few of these pests are found. There has been no fall fishing heretofore, and consequently it is not known when the sharks and dogfish leave the grounds, and the halibut and other food-fishes return to them.

SEALING AND HALIBUT TRIPS BY GLOUCESTER VESSELS OFF CAPE FLATTERY, ETC.

The halibut fishery of the northwestern coast is destined to become an important industry. Until a year ago halibut were taken in this region only in small quantities to supply the local markets, and the fishery was carried on exclusively with open boats. Within the past year two or three large vessels from the Gloucester fishing fleet have obtained successful fares upon the Pacific grounds off Cape Flattery, shipping large cargoes of fresh fish by railroad to the markets of the Eastern States. With proper management this industry might have a rapid growth.

Halibut grounds.—The nearest bank to Puget Sound, where halibut are abundant, is located off Cape Flattery at the mouth of the Straits of Fuca, and extends from close in shore to some 12 or 15 miles off the cape, in depths of water ranging from 35 to 75 fathoms. From early in the spring until the middle of June halibut can be obtained on these grounds in paying quantities, but later in the season dogfish and sharks strike in, driving nearly all the edible fish away. During the summer more northern localities would have to be resorted to. This information is based upon the statements of Capt. Silas Calder, commanding the schooner *Mollie Adams*, and at the time this region was examined by the *Albatross*, the dogfish were found in full possession of all the important grounds.

A sealing voyage.—Shortly after her arrival in Puget Sound, the *Mollie Adams* was fitted out for a sealing voyage. She carried twelve sealing boats and a crew of twenty-six men, composed of fishermen from Gloucester, and sealers from Newfoundland. The boats were built by Higgins & Gifford, of Gloucester, Mass. Seven hundred seals were captured during the trip, the most of them having been obtained in the vicinity of Cape Flattery. Some bad weather was experienced, and on several occasions the water was so rough that other sealers (from San Francisco) cruising in the same vicinity did not venture to lower their boats. Not a day was lost, however, by the *Mollie Adams*, whose sailors were accustomed to the greater hardships of the North Atlantic. The next highest fare taken by other vessels during the same period amounted to two hundred and fifty seals.

Fresh-halibut trips.—After disposing of her cargo of seals, the *Mollie Adams* at once refitted for the fresh-halibut fishery, and made four trips in quick succession, landing 145,000 pounds of halibut, the stock of which amounted to $3,000, the crew sharing $75 each. The expenses of the trips were high, however, $15 per ton being paid for ice on the first one, although on a subsequent trip it was obtained at $8 per ton, which was considered very low by the dealers. The high price demanded for ice is one of the chief obstacles to the development of the fresh-halibut business on the Pacific coast. Could this necessary article be obtained at reasonable figures, the western fishermen would stand a better chance of competing successfully with the eastern markets in supplying the fresh trade.

The *Mollie Adams* landed her cargo at Seattle. A fare of 50,000 pounds of fresh halibut was recently taken to Tacoma, Wash., by the schooner *Oscar and Hattie*, this being the first cargo landed and shipped from that port. The fish were taken in the vicinity of Cape Flattery. Little or nothing was realized from the trip. The ice cost $22.50 per ton, and high rates across the continent were charged by the Northern Pacific Railroad Company, over whose road the shipment was made. After discharging her cargo, the *Oscar and Hattie* proceeded to Port Townsend, where preparations were made for a second trip. An agreement was entered into with a firm at Vancouver to furnish the ice at $10 per ton, but three weeks passed without receiving any, and the schooner was forced to go north in the hope of obtaining a supply from the glaciers in southeastern Alaska.

Capt. S. Jacobs and others interested in the fishery are seriously considering the expediency of building ice-houses at Seattle, and making the attempt to cut ice for their own use the coming winter. It is stated that ice 6 inches thick was cut in the vicinity of Seattle during the winter of 1887–'88. If this fact is true, however, it was an exceptional season, as many of the old residents in the region claim that the weather is never cold enough there to make ice over 3 inches thick. Should the effort to obtain the ice in Puget Sound prove unsuccessful, it is thought to be feasible to make use of large scows in bringing down supplies from the glacier region of Alaska. The expense of obtaining the ice by this method, including the cost of building and towing the scows and of cutting the ice, it is considered will be much less than by the present one.

A FLETCHED-HALIBUT TRIP.

July 24 the schooner *Mollie Adams* left Seattle, bound north on a fletched-halibut trip, the first one of its kind that had been undertaken on the Pacific coast. But few halibut were captured until the schooner arrived off the southern extremity of the Queen Charlotte Islands, where they were found in great abundance and of larger size than on the grounds off Cape Flattery. A few of those taken were estimated to weigh over 300 pounds each. About half of the number obtained were large enough for fletching, the remainder being used as bait or thrown away. The trawls were not left down over night, the fish biting so rapidly that all the available time was occupied in caring for the day's catch. Only one cod was caught during the trip. Dogfish were numerous, but did not seem to interfere with the halibut taking the bait, as is the case at this season farther south.

The fishing was carried on in depths of only 30 to 45 fathoms, so that the use of hurdy-gurdies was not resorted to. Halibut fishing in this region is very much easier than on the Grand Bank. Operations were continued without intermission until August 26, when a severe gale of wind sprang up from the southeast, lasting two days.

The heavy sea produced by the storm caused the *Adams* to drag her anchor several times, but she finally "brought up" and rode out the gale without sustaining any damage or loss. This was the first time that this vessel had been tested at her anchor in a heavy sea, and her sea-going qualities were thoroughly established. From the experience of the *Adams* it is probable that fishing vessels would have no difficulty in making two or more fletched trips for halibut each season to the neighborhood of the Queen Charlotte Islands. Such trips made to Greenland and Iceland consume an entire season, and to this extent the fishermen of the western coast have an advantage over those of the eastern coast.

On the morning of September 8, the *Adams* having "wet" all her salt, started for home with 150,000 pounds of fish. Light winds prevailed during the passage of eight days to Seattle. Previous to the return of the *Adams*, her owner, Captain Jacobs, had negotiated with the Northern Pacific Railroad Company to transport her cargo across the continent to Gloucester, Mass., at the rate of $1.25 per hundredweight. Immediately upon her arrival the rate was increased to $1.40 per hundredweight, which rendered it very doubtful if anything could be realized upon the trip; but the company was finally prevailed upon to return to its earlier figure, and the shipment was accordingly made. The cost of discharging, packing, and shipping the cargo amounted to $1,950. After deducting expenses the members of the crew received $175 each, or at the rate of $9 a day for nineteen days' fishing.

Captain Jacobs is considering the expediency of converting the *Mollie Adams* into a steamer. Shorter passages to and from the grounds could be made under steam, especially during the summer when calms and light variable winds prevail in this region. The amount of time that could be saved in that way would amply repay the cost of altering the vessel.

19. CAPE FLATTERY TO SHOALWATER BAY, WASHINGTON TERRITORY.

EXPLORATIONS.

Hydrographic work.—Sounding operations were commenced off Cape Flattery, September 19, and were continued down the coast as far as Shoalwater Bay until September 23. They were again taken up in the neighborhood of Shoalwater Bay, October 11, and continued to the region off the Columbia River until October 13. Dredgings and trials for fish were made at intervals during the same periods, as explained below.

On the morning of September 19, the *Albatross* began a line of soundings in 82 fathoms, 10 miles S. 68° W. from Cape Flattery Light. It was extended 65 miles S. 68° W., sounding at intervals of 5 miles to develop banks reported to exist 60 and 75 miles from the cape. The depths were irregular for 30 miles, then increased uniformly to 768 fathoms at the former, and 1,239 fathoms at the latter position. The reports of these banks were given by shipmasters, who said they had sounded upon them and knew that they were there. They no doubt found bottom in 60 or 70 fathoms, as reported, but they were 15 or 20 miles out in their reckoning. A severe storm which began in the morning prevented further work during that day after the line had been completed at 4 p. m. The next morning dredging stations Nos. 2866 and 2867 were made off Flattery Rocks as described in the preceding section, and in the afternoon a second line of soundings was begun at a point 19 miles S. 34° W. from

Flattery Light, and carried seaward 30 miles in a line parallel to that of the previous day, the outermost sounding being in 378 fathoms.

Subsequently four other regular lines were run farther south, in about the same direction, or practically at right angles to the coast line and at distances apart of about 16 miles, these lines being connected by intermediate soundings alternately at their outer and inner ends. They extended outward from depths of 28 to 31 fathoms near the coast into depths of 287 to 758 fathoms, the last line terminating in the latitude of Gray's Harbor, about 47° N. The bottom in this region was mainly gray sand, excepting in the deeper areas off shore where mud and ooze predominated. Rocky patches alternated with fine gray sand and mud on the last line, denoting a marked change from the uniform gray sand found thus far south of Cape Flattery. A report, of Indian origin, placed a bank 30 miles west (magnetic) from Shoalwater Bay. The change in the character of the bottom led to the belief that the report might be correct, and a careful examination of the region resulted in the development of a bank about 20 miles in length, southwest and northeast (magnetic), and 12 miles in extreme width. Its eastern extremity, on which there is 42 fathoms, rocky bottom, lies 15 miles southwest (magnetic) from Point Chehalis, on the southern side of the entrance to Gray's Harbor. The soundings are quite regular, but the bottom alternates in character between rocks, gray sand, and mud. The dredgings and trials for fish on this bank proved more successful than any previously made south of Cape Flattery, as explained below. There is little doubt that at the proper season good fishing would be found in this locality.

Dredgings and trials for fish.—The beam trawl was used at station 2868, off Cape Johnson, and station 2869, off Destruction Island, in depths of 31 and 32 fathoms, respectively, the bottom consisting of sand. At the former station tomcod, flounders, and one beshowe were taken in the beam trawl, but otherwise very little material was obtained. At the latter the bottom was composed of fine gray sand, perfectly clean, without adhering growths of any kind. A skate of halibut trawl, baited with salt salmon and clams, was set at station 2868. But few baits were disturbed and fish appeared to be scarce, only two red rockfish, three dogfish, and one skate being captured. Trial lines were also put over the side of the steamer at this place, but without result.

The beam trawl was next used at station 2870, on the southern edge of the bank off Gray's Harbor described above. The depth was 58 fathoms, the bottom rocky, and very rich in the lower forms of life serving as food for fishes. The halibut trawl, set for four hours at the same position, took ten red rockfish, two beshowe, and four sharks. Three red rockfish were also caught with hand lines from the ship at the same time. This species seemed to be fairly abundant, but it is not much in demand as a market fish. Hand lines were subsequently tried for fifteen minutes about 10½ miles off Shoalwater Light, but no fish were secured.

Station 2871, with the beam trawl, was about 45 miles off the entrance to Gray's Harbor, in a depth of 559 fathoms, brown ooze. Many deep-water forms were obtained at this place.

PROSPECTS OF A HALIBUT FISHERY SOUTH OF CAPE FLATTERY.

In a conference with Captain Tanner, Judge James G. Swan, of Port Townsend, stated that his knowledge of the Indian tribes and their habits has led him to believe that halibut will not be found in paying quantities south of Cape Flattery. It was, he said, a time-honored custom for the tribes living as far south as Flattery Rocks to go to Cape Flattery every spring for their winter's supply of halibut, which were taken on the well-known bank, from 9 to 12 miles west-northwest (magnetic) from Tatoosh Island.

Halibut have seldom been taken south of Cape Flattery, and never, to his knowledge, south of Flattery Rocks. They form no part of the winter's food of the tribes inhabiting that part of the coast, rock cod, surf smelt, tomcod, salmon, etc., constituting the staple supply. He thinks if halibut existed near the shore the Indians would have known it, and, like the tribes further north, have taken them for winter's use. He predicted that the *Albatross* would find a clean sand bottom, with very little life, between Cape Flattery and Gray's Harbor.

Judge Swan has lived for many years on different parts of the coast between Gray's Harbor and Neeah Bay, and having paid close attention to the subject his opinions are worthy of every consideration. While a few halibut were subsequently taken by the *Albatross* south of Cape Flattery, as mentioned elsewhere, there are no indications that they occur in quantities sufficient to pay for their exclusive capture.

20. SHOALWATER BAY, WASHINGTON TERRITORY, TO TILLAMOOK ROCK, OREGON.

EXPLORATIONS.

Hydrographic work.—The *Albatross* returned to the neighborhood of Shoalwater Bay October 11, and began sounding in 20 fathoms $10\frac{1}{2}$ miles S. 32° W. from the lighthouse at the entrance to that bay. From this point a line was run S. 78° W. 20 miles, sounding in 38, 51, 153, and 432 fathoms; S. 68° E., 15 miles, in 98, 55, and 40 fathoms; S. 78° W. 15 miles, in 60, 78, and 260 fathoms. The last line was only a short distance north of the latitude of the entrance to Columbia River.

Stormy weather interrupted operations during the 12th, but on the 13th three nearly parallel lines of soundings, at right angles to the coast, were made in the region off the mouth of the Columbia River between the latitudes of Cape Disappointment and Tillamook Rock. The northern line began $12\frac{3}{4}$ miles N. 78° W. of Cape Disappointment in 81 fathoms, and extended 20 miles S. 78° W., with soundings in 231, 421, 475, and 506 fathoms; the southern began at a point $16\frac{1}{2}$ miles N. 64° W. from Tillamook Light, and extended 15 miles S. 72° W., with soundings in 73, 82, 96, and 199 fathoms. By reference to the chart of this region it will be observed that the soundings on the former line show depths two or three times greater than those in similar positions on adjacent lines 7 or 8 miles distant, both to the north and south. The great submarine trough thus indicated is probably the ancient bed of the Columbia River.

Dredgings and trials for fish.—At station 2882, about 27 miles directly off the mouth of the Columbia River, a cast of the beam trawl was made and the trawl line was set in a depth of 68 fathoms, gray sandy bottom. On the latter only one beshowe or black cod, and four dogfish were taken. In most of the soundings made in this region the character of the bottom was found to be unsuitable for cod or halibut, or such, at least, as they usually inhabit.

Supposed fishing grounds off the Columbia River.—At Astoria there is a general belief in the existence of fishing banks 50 to 60 miles off the mouth of the Columbia River, but its origin could not be traced. Heceta Bank lies off the coast in latitude 44° N., longitude 124° 50′ W., and may possibly have had something to do with it. The explorations of the steamer *Albatross* developed over 600 fathoms in the locality where the banks were supposed to lie; but they may be found farther south, as the region between the Columbia River and Heceta Bank is still unexplored.

Tillamook Rock.—A cod and a halibut trawl were set off the northern side of the island, the former being placed near the can buoy off its northern end. The inner trawl buoy was dropped in about 18 fathoms, the outer in about 25 fathoms, the bottom being rocky. There was a southerly current running at the time, but it was not strong. After the trawls had been set, the men remaining by them, the ship proceeded off the southwestern side of the rock, where three casts were made with the dredge, at stations 2883, 2884, and 2885, depths 29 to 30 fathoms, bottom gray sand. Subsequently the trawl lines were hauled, with the result of obtaining seven dogfish and about a dozen star fish.

In the locality where this set was made it has been stated that the Indians obtain large quantities of halibut. At Astoria, however, it was said that the fish taken off Tillamook Rock were not the halibut, but the so-called turbot (*Atherestes stomias*). Judge Swan is of the opinion that a few halibut may have been taken there, but that the common flatfish of the region is the species of *Atherestes* above mentioned. It is customary for the fishermen of the Pacific coast to speak of all large edible species of flounders as halibut. Captain Richardson, of the light-house steamer *Manzanita*, reports having taken red rock cod (called red groupers in Astoria) in great numbers, and an occasional halibut, in this region. The indications are that good fishing may be found in this neighborhood at the proper season.

ASTORIA, OREGON.

Fresh markets.—The fish exposed for sale in the markets of Astoria during the brief visit made to that place, October 14 to 18, were chiefly salmon, flounders, and tomcod. The last-named species was very abundant about the wharves, where they were being taken in large quantities by many men and boys fishing with hook and line.

Bait.—Much difficulty was found in procuring bait at this place for the remainder of the cruise. Two days were spent in a search for clams and salmon, which were considered to form the best bait for cod and halibut. Clams are sometimes brought to Astoria from Shoalwater Bay by the Indians, but with no regularity, and none were obtained by the *Albatross*. A small lot of salt salmon was all that could be purchased. Tomcod were not regarded as of sufficient value for this purpose to lay in a supply.

Attempted sea fisheries.—Sea fisheries off the Columbia River were commenced a few years ago with a small schooner, which operated a 40-foot beam trawl, over the ground between Cape Disappointment and Shoalwater Bay. This vessel being found unsuited for the purpose, the steamer *Dolphin* was built, and made forty trips between April and October, 1887, but she also proved a failure. Her catch was fairly good, and had she been able to market her fish promptly the venture would have turned out profitably. The different fish taken by the *Dolphin* were classified as follows, namely: Sole, flounders, hake, cod, rock cod, and halibut; very few cod and halibut were obtained, but sole predominated, although, at times, rock cod were abundant. Crabs and a few large clams were also included in her capture.

Fishing vessels.—The fisheries of Astoria are chiefly confined to the capture of salmon. Several attempts have been made to establish other kinds of fisheries, but without success. The principal cause of these repeated failures has undoubtedly been the unseaworthiness of the boats and vessels fitted out to engage in fishing off the coasts of Oregon and Washington Territory, where gales of wind frequently occur during both summer and winter. This coast, south of the Straits of Fuca, also has very few harbors, which are indispensable to a fishing fleet in time of storms, especially when the fishing grounds are so near the land as to leave but little sea room to leeward, with the wind blowing on the shore. The class of vessels that resort to George's and the Grand Bank could easily work off shore in an ordinary gale of wind, but there are times when even such staunch crafts as these would find the task difficult, if not impossible. The introduction of a better class of sea-going boats would, however, greatly lessen the dangers which now exist.

Salmon canneries.—The salmon canneries were closed at the time of the visit of the *Albatross*, and no particulars of their operations during the previous season could be obtained.

Gill nets.—Salmon are caught in the Columbia River principally in gill nets, although a few are taken by means of drag seines and traps. The gill nets measure from 250 to 300 fathoms in length, from 36 to 45 feet in depth, and have a mesh of 8½ and 9 inches. Their cost is from $300 to $400. All of the nets were formerly knit by the fishermen during the winter months, but many of them are now obtained from eastern manufacturers.

Boats.—The boats from which the gill nets are set and hauled are 28 to 35 feet long, 7 to 10 feet wide, and 2½ feet deep. Two men generally go in each boat, but sometimes three, dependent upon the abundance of salmon. Most of the boats are carvel-built, but a few are clinker. Their cost, fully rigged for work, is about $200. They are all furnished with center-boards, and have but little dead-rise. The customary rig is that of a sloop, but a few are cat-rigged. A wash-rail runs fore and aft, about 1 foot inboard. This, together with the short deck forward, through which the mast is stepped, is all there is to prevent a sea from boarding them. Both fore and aft of the center-board casing there is a bulkhead running athwartships. The intervening space is covered with boards, and forms the hold, into which the fish are thrown as they are released from the net. In their general shape these boats resemble the so-called "carry-away boats" used in the early days of the menhaden fishery on the New England coast. The accommodations for living in these Columbia River boats are wretched; but the men sleep and eat upon them, taking their rest at night in the bottom of the boat, where there is barely room for one man to lie, even in a cramped position. The mode of living of these men is similar to that of the French boat fishermen in the Gulf of St. Lawrence; but it contrasts strangely with the condition of affairs existing on the typical New England fishing vessel.

About thirteen hundred fishing boats are employed upon the Columbia River during the salmon season, which continues from the first of April to the first of July. No fishing is permitted in the river after July. The majority of the boats and nets are owned by the canneries, but a few belong to the fishermen.

Prices paid for salmon.—The fishermen have a well-organized society, in which the price of salmon is agreed upon before beginning the season's work. To those who own their boats and nets a higher price is paid than to those who use the gear belonging to the canneries. In 1888 the price stipulated was $1 apiece for salmon caught by the cannery boats, and $1.25 each for those taken in the boats of the fishermen. The high prices demanded for salmon have caused many to withdraw from the business in this region, and some of them talk seriously of establishing canneries in Alaska.

21. HECETA BANK.

Hydrographic work.—October 19, lines of soundings were run across Heceta Bank to the westward, to the southward, and then to the southward and eastward, defining its extent. It was not fully developed, but from present knowledge it may be said to be about 20 miles in length and 10 miles in width, its center lying in latitude 44° 04′ N., longitude 124° 53′ W. It has a rocky bottom, alternating with patches of clay and pebbles, and presents every requisite for an excellent fishing bank, which it will undoubtedly prove to be at the proper season of the year.

Dredging and trials for fish.—At 7.30 a. m., the dinghy left the ship with a skate of halibut trawl and a tub of cod trawl, baited with salmon and herring. A set was made in a depth of 50 fathoms as soon as the boat was well clear of the ship, which immediately began dredging at station 2886, latitude 43° 59′ N., longitude 124° 56′ 30″ W. At the end of an hour and a half the trawls were taken up with the following catch: one halibut weighing 10½ pounds, one beshowe or black cod, one shark, and one dogfish. Four dredging stations (2886 to 2889) were made, all being within about a mile of the position given above, one with the dredge, the remainder with the beam trawls, which, on two occasions, were wrecked on the rocky bottom. The depths covered by the dredging ranged from 41 to 50 fathoms, the bottom consisting of rocks, pebbles, shells, etc. The bottom was rich in life and many interesting forms were taken, including several species of corals. This locality was by far the most promising of any that had been examined south of Cape Flattery. A specimen of halibut was captured, proving that the species occurs in this region, where it may be abundant in the proper season, but further investigations are necessary to prove this fact conclusively. The amount and character of the lower forms of life brought up in the dredge and beam trawl recalled the fauna of some of the eastern halibut grounds.

Just south of Heceta Bank, in latitude 43° 46′ N., longitude 124° 57′ W., the beam trawl was used in a depth of 277 fathoms, bottom gray sand, with the result of obtaining many deep-water forms, including *Macrurus*, *Sebastes*, *Nemichthys*, etc., among fishes; *Lithodes*, *Munida*, and shrimps among crustaceans, and large quantities of *Schizaster*, ophiurans, etc., among echinoderms.

D.—TABLES AND SPECIAL OBSERVATIONS.

22. *Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross from July 1 to December* 31, 1888.

Serial number.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Depth in fathoms.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Kind of reel.	Weight of sinker.
	1888.		° ′ ″	° ′ ″							*Lbs.*
1130	July 19	6.16 a.m.	52 15 00	156 37 00	2,550	br. Oz	51	51	34.9	Baird	60
1131	do	2.36 p.m.	52 12 00	158 20 00	2,581	wire carried away	51	49		do	60
1132	do	10.29 p.m.	52 15 00	160 00 00	2,558	gy. Oz. P	50	48	35.0	do	60
1133	July 20	6.33 a.m.	52 15 00	161 40 30	2,573	wire carried away	51	50		do	60
1134	do	11.57 a.m.	52 17 00	162 48 00	2,678	gy. Oz	55	51	35.2	do	60
1135	do	5.33 p.m.	52 18 00	163 54 00	2,848	gy. Oz	54	50	35.2	do	60
1136	do	11.46 p.m.	52 20 00	165 00 00	3,820	gy. Oz	52	50	35.7	do	60
1137	July 21	6.14 a.m.	52 20 00	166 05 00	2,654	gy. Oz	55	50	35.2	do	60
1138	do	10.03 a.m.	52 40 00	166 35 00	2,267	gy. Oz	52	51	35.2	do	60
1139	do	12.07 p.m.	52 53 00	166 44 00	1,961	gy. Oz	52	50	35.2	do	38
1140	do	2.19 p.m.	53 05 00	166 49 00	169	bk. S	53	50	41.2	do	38
1141	do	3.06 p.m.	53 11 00	166 51 00	84	bk. S. P	52	50	40.6	Tanner	25
1142	do	4.08 p.m.	53 17 00	166 54 00	57	S. bk. Sp	54	50		do	25
1143	do	5.08 p.m.	53 22 00	166 55 30	41	S. bk. Sp	54	50	42.7	do	25
1144	do	5.31 p.m.	53 23 00	166 56 00	28	S. bk. Sp	54	50	42.2	do	25
1145	do	6.40 p.m.	53 19 00	166 50 00	55	bk. S. P	51.5	48	41.7	do	25
1146	do	8.28 p.m.	53 17 00	166 42 00	58	gy. S	51	48	41.2	do	25
1147	do	9.11 p.m.	53 15 00	166 35 00	83	bk. S	51	48	41.2	do	25
1148	do	9.58 p.m.	53 13 00	166 27 00	174	bk. S	51	49	41.2	do	25
1149	do	11.27 p.m.	53 16 00	166 10 00	228	bk. S	51	49	39.5	Baird	38
1150	July 22	1.01 a.m.	53 25 00	166 02 30	94	crs. bk. S	51	49	41.2	Tanner	25
1151	do	2.25 a.m	53 27 00	165 46 00	113	crs. bk. S. P	51	49	41.2	do	25
1152	do	3.47 a.m.	53 30 00	165 30 00	261	gn. M	51	49	39.7	Baird	38
1153	do	5.16 a.m.	53 37 00	165 18 30	99	gy. S. P.	50	48	40.7	do	38
1154	do	6.39 a.m.	53 39 00	165 04 00	133	fne. gy. S	50	48	41.2	Tanner	25
1155	do	8.05 a.m.	53 42 00	164 46 00	163	bk. S	50	49	40.2	do	25
1156	do	9.34 a.m.	53 48 00	164 32 00	66	bk. S. G	59	49	40.2	do	25
1157	do	10.23 a.m.	53 43 00	164 38 00	111	bk. S. Sh	52	49	40.7	do	25
1158	do	11.20 a.m.	53 43 00	164 31 00	73	bk. S. fne. G	52	50	40.7	do	25
1159	do	12.14 p.m.	53 39 00	164 34 00	185	lt. S	52	50	40.2	do	25
1160	do	1.03 p.m.	53 39 00	164 26 00	211	gy. S. bk. Sp	52	50	40.1	do	25
1161	do	1.47 p.m.	53 41 30	164 20 00	89	bk. S	52	50	40.5	do	25
1162	do	2.32 p.m.	53 43 00	164 13 00	68	gy. S. bk. Sp. P	52	50	40.4	do	25
1163	do	3.16 p.m.	53 42 30	164 05 00	63	gy. S. bk. Sp	51	49	40.4	do	25
1164	do	4.01 p.m.	53 42 00	163 57 30	95	gn. M	51	49	40.2	do	25
1165	do	5.17 p.m.	53 51 00	163 51 00	43	bk. S	51	49	40.2	do	25
1166	do	6.39 p.m.	54 00 00	163 45 00	45	fne. gy. S	51	50	41.7	do	25
1167	do	9.24 p.m.	54 09 00	163 41 00	45	bk. S. brk. Sh	51	50	41.2	do	25
1168	do	11.31 p.m.	54 13 00	164 02 00	51	R. fne. G	51	49	39.2	do	25
1169	July 23	1.21 a.m.	54 16 00	164 23 00	56	gy. S. bk. Sp	52	49	41.2	do	25
1170	do	2.37 a.m.	54 18 00	164 38 00	45	gy. S. bk. Sp	52	50	42.2	do	25
1171	do	3.29 a.m.	54 20 00	164 49 00	30	G	51	48	43.9	do	25
1172	do	4.31 a.m.	54 22 00	165 00 00	42	crs. bk. S. G.	51	48	45.2	do	25
1173	do	5.12 a.m.	54 23 00	165 09 00	72	crs. bk. S	50	45	42.2	do	25
1174	do	5.54 a.m.	54 25 00	165 19 00	80	bk. S	50	45	40.7	do	25
1175	do	6.36 a.m.	54 24 00	165 25 00	85	bk. S. G	50	45	40.2	do	25
1176	do	7.18 a.m.	54 22 00	165 34 30	73	bk. S. G	48	44	40.7	do	25
1177	do	7.54 a.m.	54 21 00	165 41 00	51	bk. S. G	51	45	41.2	do	25
1178	do	8.38 a.m.	54 19 00	165 49 00	53	P	51	45	41.2	do	25
1179	July 28	11.39 a.m.	53 56 00	166 07 00	36	bk. S. brk. Sh	48	49	44.4	do	25
1180	do	2.18 p.m.	53 56 00	165 48 00	51	brk. Sh. G	52	46	43.2	do	25
1181	do	4.53 p m.	53 55 30	165 22 00	57	bk. S	51	48	41.2	do	25
1182	do	6.17 p.m.	53 55 00	165 05 30	53	bk. S. G	52	52	43.2	do	25
1183	do	7.40 p.m.	54 00 00	164 51 00	59	brk. Sh. P	51	51	44.2	do	25
1184	do	10.14 p.m.	53 58 00	164 39 00	61	gy. S. G	49	50	41.2	do	25
1185	do	11.33 p.m.	53 55 00	164 22 00	50	crs. bk. S	50	50	40.2	do	25
1186	July 29	12.59 a.m.	53 53 00	164 05 00	45	gy. S.	51	50	41.2	do	25
1187	do	3.23 a.m.	53 49 00	163 40 00	342	bk. S	51	50	39.2	Sigsbee	60

22. *Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, etc.*—Continued.

Serial number.	Date.	Time.	Position.		Depth in fathoms.	Character of bottom.	Temperature.			Kind of reel.	Weight of sinker.
			Lat. N.	Long. W.			Air.	Surface.	Bottom.		
	1888.		° ′ ″	° ′ ″							lbs.
1188	July 29	5.00 a. m.	54 00 00	163 37 00	62	bk. S	52	51	41.2	Tanner	25
1189	do	5.46 a. m.	54 01 00	163 45 00	49	bk. S	52	51	40.2	do	25
1190	do	6.30 a. m.	54 02 00	163 53 30	48	bk. S	52	51	41.7	do	25
1191	do	7.11 a. m.	54 04 00	164 01 00	46	bk. S	52	51	42.2	do	25
1192	do	9.31 a. m.	54 06 00	164 17 00	41	bk. S. G	53	51	43.2	do	25
1193	do	10.14 a. m.	54 08 00	164 25 00	52	bk. S	53	51	42.2	do	25
1194	do	11.03 a. m.	54 09 00	164 33 00	52	bk. S. G	52	50	41.2	do	25
1195	do	11.48 a. m.	54 10 00	164 42 00	49	brk. Sh	51	50	41.2	do	25
1196	do	12.21 p. m.	54 11 00	164 48 00	52	rky	51	50	43.2	do	25
1197	do	1.05 p. m.	54 15 00	164 41 00	71	crs. bk. S	50	51	40.7	do	25
1198	do	3.20 p. m.	54 25 00	164 21 00	63	R. bk. S.	52	51	40.6	do	25
1199	do	6.20 p. m.	54 22 00	164 01 00	55	bk. S	51	49	41.2	do	25
1200	do	8.30 p. m.	54 20 00	163 41 00	72	bk. S	51	49	40.2	do	25
1201	do	10.40 p. m.	54 18 00	163 21 00	44	bk. S. G	51	50	40.2	do	25
1202	do	11.19 p. m.	54 18 00	163 18 00	32	rky	51	50	42.2	do	25
1202a	do	...	54 16 00	163 19 30	28	No bottom specimens obtained.	51	50	...	...	...
1202b	do	...	54 15 00	163 21 00	25		51	50	...	...	...
1203	July 30	12.44 a. m.	54 14 00	163 21 30	39	gy. S. bk. Sp.	51	50	40.2	Tanner	25
1204	do	2.12 a. m.	54 10 00	163 24 00	42	gy. S. bk. Sp	51	51	42.3	do	25
1205	do	4.48 a. m.	54 09 00	163 14 00	44	bk. S. G	50	50	42.2	do	25
1206	do	5.33 a. m.	54 09 00	163 04 00	43	G	51	50	42.2	do	25
1207	do	5.58 a. m.	54 09 00	162 58 00	43	bk. S	51	50	...	do	25
1208	do	6.18 a. m.	54 08 00	162 54 00	41	gy. S. bk. Sp	51	50	42.2	do	25
1209	do	8.59 a. m.	54 03 00	162 43 00	51	G	51	50	41.2	do	25
1210	do	9.49 a. m.	53 58 00	162 42 00	464	rky	51	50	42.2	do	25
1211	do	10.55 a. m.	54 03 00	162 33 00	265	rky	51	50	39.2	do	25
1212	do	11.55 a. m.	54 08 00	162 22 00	60	crs. S. P	51	50	40.2	do	25
1213	do	12.40 p. m.	54 12 00	162 17 00	47	bk. S. fne. G	51	50	42.2	do	25
1214	do	2.06 p. m.	54 09 00	162 10 00	67	rky	51	51	40.2	do	25
1215	do	2.52 p. m.	54 12 00	162 02 00	51	rky. fne. G	51	50	41.2	do	25
1216	do	3.40 p. m.	54 16 00	161 53 00	37	rky	51	50	42.2	do	25
1217	do	4.28 p. m.	54 20 00	161 46 00	38	P	51	50	40.7	do	25
1218	do	5.14 p. m.	54 26 00	161 45 00	80	gn. M	52	50	39.8	do	25
1219	do	5.56 p. m.	54 31 00	161 44 00	82	gn. M	52	50	40.2	do	25
1220	do	6.49 p. m.	54 34 00	161 48 00	58	rky	52	50	41.2	do	25
1221	do	7.57 p. m.	54 27 00	161 53 00	81	gn. M	51	49	40.2	do	25
1222	do	9.32 p. m.	54 32 00	161 39 00	81	rky	51	49	40.2	do	25
1223	do	11.51 p. m.	54 37 00	161 27 00	59	bk. S	51	49	41.7	do	25
1224	July 31	12.13 a. m.	54 42 00	161 13 00	64	bk. S	51	49	42.2	do	25
1225	do	1.40 a. m.	54 47 00	161 00 00	47	bk. S. G	51	49	42.2	do	25
1226	do	4.55 a. m.	54 51 00	160 47 00	45	gy. S. P	51	49	...	do	25
1227	do	6.17 a. m.	54 56 00	160 33 00	52	gy. S	51	50	41.8	do	25
1228	do	7.25 a. m.	54 59 00	160 26 00	60	gy. S	51	51	41.7	do	25
1229	Aug. 2	9.14 a. m.	55 08 00	160 05 00	18	fne. gy. S	51	49	40.9	do	25
1230	Aug. 3	6.37 a. m.	55 04 00	160 26 00	34	brk. Sh	58	50	45.7	do	25
1231	do	7.46 a. m.	55 05 00	160 42 00	38	rky	54	51	44.2	do	25
1232	do	9.03 a. m.	55 00 00	160 56 00	71	dk. M	53	52	40.2	do	25
1233	do	10.18 a. m.	54 52 00	161 17 00	74	dk. M	54	51	41.7	do	25
1234	do	11.35 a. m.	54 47 00	161 26 00	41	rky	54	51	43.2	do	25
1235	do	11.57 a. m.	54 44 00	161 27 00	45	rky	52	51	...	do	25
1236	do	1.13 p. m.	54 38 00	161 39 00	49	bk. S. G	52	51	43.2	do	25
1237	do	2.32 p. m.	54 32 00	161 53 00	75	bk. S	52	51	41.2	do	25
1238	do	3.53 p. m.	54 25 00	162 05 00	63	bk. S	52	51	40.2	do	25
1239	do	4.45 p. m.	54 23 00	161 56 00	34	P	51	51	43.5	do	25
1240	do	5.55 p. m.	54 20 00	162 02 00	30	Sh	51	50	43.0	do	25
1241	do	6.39 p. m.	54 16 00	162 08 00	40	brk. Sh. G	52	50	42.2	do	25
1242	do	8.33 p. m.	54 07 00	162 07 00	435	dk. M	51	50	38.2	Sigsbee	38
1243	do	9.35 p. m.	54 10 00	161 54 00	52	rky	52	50	39.7	do	38
1244	do	10.21 p. m.	54 13 00	161 47 00	50	bk. S. P	52	51	40.2	Tanner	25
1245	do	11.04 p. m.	54 17 00	161 40 00	44	crs. S	52	51	41.7	do	25
1246	do	11.44 p. m.	54 18 00	161 34 00	42	S. R	52	51	42.2	do	25
1247	Aug. 4	1.05 a. m.	54 22 00	161 22 00	61	R. G	52	51	41.2	do	25
1248	do	2.17 a. m.	54 27 00	161 08 00	59	bk. S	52	50	41.2	do	25
1249	do	3.31 a. m.	54 31 00	160 54 00	71	bk. S	52	50	40.2	do	25
1250	do	4.48 a. m.	54 35 00	160 41 00	72	bu. M	52	51	40.2	do	25
1251	do	6.04 a. m.	54 39 00	160 28 00	62	gy. S. P	52	50	40.4	do	25
1252	do	7.24 a. m.	54 43 00	160 14 00	50	fne. gy. S	53	51	40.6	do	25
1253	do	8.34 a. m.	54 47 00	160 00 00	43	gy. S. bk. Sp	53	51	42.2	do	25
1254	do	9.21 a. m.	54 49 00	159 54 00	40	fne. gy. S	53	51	43.7	do	25
1255	do	12.08 p. m.	54 57 00	159 55 00	25	gy. S	51	50	48.3	do	25
1256	do	12.48 p. m.	55 00 00	159 54 00	27	rky	51	50	45.2	do	25
1257	do	1.24 p. m.	54 59 00	159 45 00	26	bk. S. P	51	50	45.2	do	25
1258	do	2.15 p. m.	55 02 00	159 41 00	37	gy. S. brk. Sh	53	50	44.7	do	25
1259	do	3.00 p. m.	55 06 00	159 39 00	57	S. brk. Sh	53	48	44.2	do	25
1260	do	3.30 p. m.	55 10 00	159 40 00	39	S. brk. Sh	53	48	44.2	do	25
1261	do	5.13 p. m.	55 15 00	159 28 00	23	R. Co	53	48	42.0	do	25
1262	Aug. 5	4.49 a. m.	55 03 00	159 15 00	27	brk. Sh	51	49	45.7	do	25
1263	do	5.29 a. m.	55 01 00	159 08 00	44	G	51	49	43.2	do	25

22. *Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, etc.*—Continued.

Serial number.	Date.	Time.	Position.		Depth in fathoms.	Character of bottom.	Temperature.			Kind of reel.	Weight of sinker.
			Lat. N.	Long. W.			Air.	Surface.	Bottom.		
	1888.		° ′ ″	° ′ ″							*Lbs.*
1264	Aug. 5	6.05 a. m.	54 59 00	159 00 00	48	gy. S	51	49	42.2	Tanner	25
1265	do	6.42 a. m.	54 57 00	158 52 00	43	gy. S. G	51	49	42.2	do	25
1266	do	7.13 a. m.	54 55 00	158 46 00	46	gy. S. brk. Sh	51	49	42.2	do	25
1267	do	8.13 a. m.	54 53 00	158 38 00	70	gy. S	52	51	40.2	do	25
1268	do	9.01 a. m.	54 49 00	158 42 00	56	gy. S. P	51	51	40.9	do	25
1269	do	9.46 a. m.	54 51 00	158 49 00	46	gy. S. brk. Sh	51	51	42.2	do	25
1270	do	10.07 a. m.	54 52 00	158 54 00	45	rky	51	51	......	Bassnet	25
1271	do	10.31 a. m.	54 53 00	158 57 00	41	S. R	51	51	42.7	Tanner	25
1272	do	10.55 a. m.	54 54 00	159 01 00	45	rky	51	52	......	Bassnet	25
1273	do	11.16 a. m.	54 55 00	159 05 00	35	rky	52	52	43.2	Tanner	25
1274	do	11.38 a. m.	54 52 00	159 07 00	38	gy. S. P. brk. Sh	52	52	......	Bassnet	25
1275	do	11.58 a. m.	54 50 00	159 08 30	35	rky	52	52	44.2	Tanner	25
1276	do	12.19 p. m.	54 49 00	159 05 00	57	rky	52	52	......	Bassnet	25
1277	do	12.38 p. m.	54 48 00	159 01 00	44	Sh. fne. G	52	52	43.2	do	25
1278	do	1.04 p. m.	54 47 00	158 55 00	47	R. Sh	54	51	42.2	Tanner	25
1279	do	1.22 p. m.	54 46 00	158 53 00	49	R	54	51	42.5	do	25
1280	do	2.01 p. m.	54 44 00	158 44 00	55	rky	54	51	41.7	do	25
1281	do	3.18 p. m.	54 35 00	158 51 00	99	bu. M. P	54	51	40.7	do	25
1282	do	4.04 p. m.	54 37 00	158 58 00	69	gy. S. P	54	51	40.2	do	25
1283	do	4.39 p. m.	54 38 00	159 02 00	56	gy. S. P	53	51	41.3	do	25
1284	do	5.27 p. m.	54 39 00	159 09 00	46	P	53	51	42.5	do	25
1285	do	6.07 p. m.	54 41 00	159 16 00	41	gy. S. Sh	53	51	43.2	do	25
1286	do	7.48 p. m.	54 42 00	159 24 00	35	rky	51	49	44.2	do	25
1287	do	7.55 p. m.	54 41 00	159 29 30	35	rky	51	49	44.2	do	25
1288	do	8.37 p. m.	54 37 00	159 25 00	43	rky	51	49	......	Bassnet	25
1289	do	9.52 p. m.	54 32 00	159 17 00	115	rky	51	51	......	Tanner	25
1290	do	11.53 p. m.	54 25 00	159 40 00	105	bk. S	50	50	41.2	do	25
1291	Aug. 6	1.16 a. m.	54 36 00	159 39 00	49	bk. S	50	51	42.4	do	25
1292	do	1.57 a. m.	54 41 00	159 39 00	42	P	50	51	43.0	do	25
1293	do	2.45 a. m.	54 42 00	159 47 00	44	R	50	51	43.2	do	25
1294	do	3.29 a. m.	54 37 00	159 52 00	49	R. gy. S	50	51	42.2	do	25
1295	do	4.51 a. m.	54 28 00	160 00 00	67	P	50	51	40.6	do	25
1296	do	5.25 a. m.	54 25 00	160 03 00	119	fne. gy. S	50	51	41.2	do	25
1297	do	12.48 p. m.	54 39 00	158 43 00	52	rky	58	51	41.2	do	25
1298	do	1.23 p. m.	54 40 00	158 35 00	57	rky	55	51	40.7	do	25
1299	do	2.04 p. m.	54 41 00	158 25 00	86	P	54	53	41.2	do	25
1300	do	2.45 p. m.	54 40 00	158 22 00	110	gy. S	54	53	41.2	do	25
1301	do	3.30 p. m.	54 50 00	158 30 00	87	gy. S	54	53	41.2	do	25
1302	do	4.12 p. m.	54 56 00	158 30 00	90	G	55	53	40.4	do	25
1303	do	4.54 p. m.	55 01 00	158 30 00	114	gn. M	53	53	40.6	do	25
1304	do	5.37 p. m.	55 03 00	158 38 00	87	G	53	52	39.9	do	25
1305	do	6.15 p. m.	55 04 00	158 48 00	79	gy. S	53	52	40.4	do	25
1306	do	6.55 p. m.	55 07 00	158 55 00	50	gy. S	51	50	41.5	do	25
1307	do	7.36 p. m.	55 09 00	159 03 00	47	gy. S. P	51	50	41.9	do	25
1308	do	8.17 p. m.	55 11 00	159 11 00	53	gy. S	52	51	43.2	do	25
1309	do	8.59 p. m.	55 13 00	159 18 00	58	gy. S	51	51	42.2	do	25
1310	do	9.43 p. m.	55 17 00	159 19 00	102	bu. M	51	51	40.4	do	25
1311	do	11.06 p. m.	55 18 00	159 02 00	103	bu. M	51	51	40.2	do	25
1312	Aug. 7	12.27 a. m.	55 20 00	158 45 00	97	gy. S	51	51	41.2	do	25
1313	do	1.47 a. m.	55 21 00	158 29 00	80	gy. S	50	52	40.2	do	25
1314	do	3.10 a. m.	55 22 00	158 12 00	68	M	50	52		do	25
1315	do	4.31 a. m.	55 23 00	157 55 00	56	G. brk. Sh	50	50	42.1	do	25
1316	do	5.48 a. m.	55 25 00	157 37 00	46	yl. S	51	50	42.0	do	25
1317	do	6.25 a. m.	55 26 00	157 28 00	47	gn. M	51	50	42.1	do	25
1318	do	8.21 a. m.	55 30 00	157 44 00	53	gy. S. G	50	50	41.9	do	25
1319	do	9.38 a. m.	55 34 00	158 00 00	73	fne. gy. S	51	51	40.1	do	25
1320	do	10.53 a. m.	55 39 00	158 14 00	73	M. fne. gy. S	51	51	42.1	do	25
1321	do	12.07 p. m.	55 47 00	158 27 00	64	fne. gy. S	51	51	41.9	do	25
1322	do	1.23 p. m.	55 54 00	158 40 00	68	bu. M	53	51	43.1	do	25
1323	do	2.03 p. m.	55 57 00	158 47 00	82	bu. M	53	52	42.1	do	25
1324	Aug. 8	6.56 a. m.	55 52 00	158 29 00	67	fne. Gy. S	52	50	42.1	do	25
1325	do	8,00 a. m.	55 49 00	158 12 00	44	Sh. G	53	51	43.3	do	25
1326	do	9.15 a. m.	55 47 00	157 55 00	57	gy. S	53	51	44.3	do	25
1327	do	10.28 a. m.	55 45 00	157 39 00	67	fne. bk. S	54	53	41.3	do	25
1328	do	11.08 a. m.	55 44 00	157 30 00	59	bk. S	54	53	41.5	do	25
1329	do	12.24 p. m.	55 42 00	157 24 00	54	rky	54	53	......	do	25
1330	do	12.29 p. m.	55 41 00	157 24 00	49	bu. S, G	54	53	......	do	25
1331	do	4.48 p. m.	55 40 00	157 16 00	48	bk. S. G	56	52	43.9	do	25
1332	do	5.27 p. m.	55 39 00	157 07 00	47	crs. gy. S	56	52	45.1	do	25
1333	do	6.02 p. m.	55 37 00	156 57 00	50	gy. S	54	51	42.9	do	25
1334	do	6.36 p. m.	55 36 00	156 47 00	55	fne. gy. S	53	52	41.7	do	25
1335	do	7.52 p. m.	55 34 00	156 30 00	135	gn. M	53	52	41.1	do	25
1336	do	9.12 p. m.	55 44 00	156 19 00	137	bu. M	54	52	41.1	do	25
1337	do	11.02 p. m.	55 53 00	156 06 00	119	bu. M	54	52	41.3	do	25
1338	Aug. 9	12.20 a. m.	55 46 00	155 55 00	89	P	53	50	41.1	do	25
1339	do	1.37 a. m.	55 39 00	155 44 00	60	rky	52	50	42.6	do	25
1340	do	2.51 a. m.	55 32 00	155 32 00	96	gy. S. P	52	50	42.1	do	25

22. *Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, etc.*—Continued.

Serial number.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Depth in fathoms.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Kind of reel.	Weight of sinker.
	1888.		° ′ ″	° ′ ″							*Lbs.*
1341	Aug. 9	4.11 a. m.	55 39 00	155 27 00	57	gy. S	52	50	46.1	Tanner	25
1342	....do	4.53 a. m.	55 47 00	155 22 00	26	gy. S	52	50	48.2	....do	25
1343	....do	5.09 a. m.	55 49 00	155 20 00	27	gy. S. bk. Sp	52	50	48.0	....do	25
1344	....do	6.14 a. m.	55 44 00	155 14 00	76	gy. S	50	48	41.9	do	25
1345	....do	6.59 a. m.	55 39 00	155 09 00	287	gy. S	50	48	38.9	do	25
1346	....do	8.17 a. m.	55 47 00	155 00 00	89	gy. S	52	52	41.6	.. do	25
1347	....do	9.25 a. m.	55 55 00	154 51 00	81	fne. bk. S	55	54	41.3	.. do	25
1348	... do	10.08 a. m.	55 59 00	154 47 00	76	fne. gy. S	58	54	42.5	.. do	25
1349	....do	10.43 a. m.	56 04 00	154 44 00	60	fne. gy. S	58	54	41.5	.. do	25
1350	....do	11.21 a. m.	56 07 00	154 38 00	37	gy. S	58	54	42.5	.. do	25
1351	....do	12.43 p. m.	56 05 00	154 33 00	61	fne. gy. S	55	55	41.6	...do	25
1352	....do	1.25 p. m.	56 03 00	154 25 00	66	gy. S. P. Co	55	55	41.6	....do	25
1353	....do	4.03 p. m.	56 09 00	154 15 00	75	bk. S	55	53	41.9	....do	25
1354	....do	5.18 p. m.	56 18 00	154 10 00	54	gy. S. bk. Sp	54	53	43.1	....do	25
1355	... do	6.29 p. m.	56 28 00	154 05 00	28	gy. S	53	50	48.2	....do	25
1356	....do	7.09 p. m.	56 27 00	153 55 00	23	brk. Sh	53	52	48.0	....do	25
1357	....do	7.47 p. m.	56 24 00	153 47 00	52	bk. S	53	52	43.1	....do	25
1358	....do	9.01 p. m.	56 18 00	153 33 00	46	G	53	52	43.2	....do	25
1359	....do	9.40 p. m.	56 15 00	153 25 00	52	gy. S. P	54	53	41.4	... do	22
1360	....do	10.19 p. m.	56 12 00	153 18 00	88	fne. gy. S	54	53	41.5	... do	25
1361	....do	11.42 p. m.	56 23 00	153 24 00	36	Sh.	54	52	44.5	.. do	25
1362	Aug. 10	12.27 a. m.	56 28 00	153 26 00	45	gy. S. Sh	53	51	44.1	... do	25
1363	....do	1.09 a. m.	56 34 00	153 29 00	73	bu. M	52	51	41.1	....do	25
1364	....do	1.50 a. m.	56 35 00	153 19 00	53	gy. S. C	54	53	42.1	....do	25
1365	....do	2.33 a. m.	56 36 00	153 10 00	58	bu. M	54	51	42.6	....do	25
1366	....do	3.10 a. m.	56 37 00	153 00 00	49	bu. M	53	51	42.1	....do	25
1367	....do	3.49 a. m.	56 39 00	152 50 00	44	rky	52	51	42.1	....do	25
1368	... do	4.30 a. m.	56 40 00	152 40 00	51	gy. S	53	51	42.6	....do	25
1369	... do	5.08 a. m.	56 41 00	152 30 00	49	rky	53	51	42.1	... do	25
1370	....do	5.46 a. m.	56 42 00	152 21 00	37	S. P	54	52	43.3	... do	25
1371	.. do	8.26 a. m.	56 46 00	152 35 00	61	S. P	66	54	41.9	....do	25
1372	... do	8.37 a. m.	56 51 00	152 50 00	37	gy. S., brk. Sh	66	54	44.7	....do	25
1373	....do	11.05 a. m.	56 58 00	153 10 00	18	brk. Sh	57	55	47.3	....do	25
1374	... do	1.09 p. m.	57 04 00	153 18 00	68	bk. M	57	55	43.2	....do	25
1375	....do	1.47 p. m.	57 07 00	153 18 00	57	bk. M	57	55	44.1	...do	25
1376	Aug. 12	4.17 p. m.	56 55 00	153 19 00	71	fne. gy. S	54	53	43.8	...do	25
1377	....do	4.55 p. m.	56 51 00	153 13 00	111	gn. M	54	55	39.9	....do	25
1378	....do	6.03 p. m.	56 43 00	153 00 00	60	rky	53	54	40.9	.. do	25
1379	....do	7.10 p. m.	56 35 00	152 48 00	46	S. P	53	54	41.9	... do	25
1380	... do	8.14 p. m.	56 28 00	152 36 00	38	P	52	53	42.6	... do	25
1381	... do	9.23 p. m.	56 20 00	152 23 00	347	gn. M	52	54	39.1	... do	25
1382	....do	10.53 p. m.	56 29 00	152 11 00	173	gy. S	52	54	40.1	....do	25
1383	Aug. 13	12.14 a. m.	56 38 00	151 59 00	28	rky	53	54	44.6	....do	25
1384	....do	12.52 a. m.	56 35 00	151 50 00	60	gy. S. R	53	54	42.1	.. do	25
1385	... do	1.29 a. m.	56 33 00	151 42 00	298	gy. S	53	54	39.6	....do	25
1386	....do	2.40 a. m.	56 42 00	151 29 00	485	rky	53	54	39.1	....do	25
1387	... do	3.59 a. m.	56 49 00	151 42 00	58	gy. S	53	54	42.9	....do	25
1388	....do	5.12 a. m.	56 56 00	151 56 00	49	gy. S	53	53	44.8	....do	25
1389	. do	6.20 a. m.	57 03 00	152 10 00	44	rky	53	52	43.9	....do	25
1390	.. do	7.27 a. m.	57 10 00	152 23 00	86	fne. gy. S	54	52	41.4	... do	25
1391	. do	8.08 a. m.	57 12 00	152 27 00	53	fne. gy. S	55	53	44.4	... do	25
1392	...do	9.07 a. m.	57 16 00	152 22 00	39	bk. S. G	55	50	45.3	....do	25
1393	....do	10.34 a. m.	57 20 00	152 15 00	25	rky	57	52	47.5	....do	25
1394	....do	1.36 p. m.	57 17 00	152 07 00	45	brk. Sh	52	49	44.6	....do	25
1395	....do	2.37 p. m.	57 11 00	151 52 00	43	gy. S., brk. Sh	52	49	45.1	....do	25
1396	....do	3.44 p. m.	57 05 00	151 37 00	46	Co	52	53	45.1	....do	25
1397	... do	4.51 p. m.	57 00 00	151 23 00	90	gy. S	56	53	41.4	....do	25
1398	... do	6.30 p. m.	57 11 00	151 05 00	75	gy. S	55	53	41.8	...do	25
1399	... do	7.39 p. m.	57 18 00	151 19 00	71	G	53	53	43.4	....do	25
1400	....do	8.46 p. m.	57 24 00	151 33 00	39	rky	52	50	45.5	....do	25
1401	... do	9.53 p. m.	57 30 00	151 46 00	57	rky	52	50	44.9	.. do	25
1402	....do	10.31 p. m.	57 35 00	151 52 00	81	rky	52	50	42.9	... do	25
1403	Aug. 21	3.26 p. m.	57 43 00	152 14 00	69	bu. M	60	54	46.5	....do	25
1404	....do	3.52 p. m.	57 42 00	152 09 00	17	rky	60	54		...do	25
1405	....do	4.33 p. m.	57 46 00	152 01 00	28	Sh	57	53	48.5	....do	25
1406	....do	5.14 p. m.	57 49 00	151 53 00	56	gy. S., brk. Sh	57	53	44.6	....do	25
1407	....do	5.54 p. m.	57 52 00	151 47 00	47	gy. S	56	55	45.1	....do	25
1408	... do	6.34 p. m.	57 49 00	151 39 00	30	G. Sh	56	55	47.3	...do	25
1409	....do	7.14 p. m.	57 46 00	151 32 00	33	G. Sh	62	55	48.8	....do	25
1410	....do	7.46 p. m.	57 43 00	151 25 00	35	crs. gy. S., brk. Sh	56	52	48.1	....do	25
1411	...do	8.25 p. m.	57 39 00	151 18 00	38	Sh. Co	56	52	47.3	....do	25
1412	.. do	7.08 p. m.	57 36 00	151 11 00	42	Sh	55	52	46.0	....do	25
1413	....do	10.22 p. m.	57 29 00	150 56 00	48	gy. S., Sh	54	53	44.3	....do	25
1414	....do	11.36 p. m.	57 23 00	150 41 00	57	gy. S	55	55	42.7	....do	25
1415	Aug. 22	12.18 a. m.	57 19 00	150 35 00	72	gy. S. P	55	56	41.6	....do	25
1416	... do	2.35 a. m.	57 26 00	150 06 00	200	gy. S., bk. Sp	56	57	39.6	....do	25
1417	....do	4.00 a. m.	57 32 00	150 18 00	59	gy. S. G	56	56	42.6	....do	25
1418	....do	5.17 a. m.	57 39 00	150 33 00	51	S. brk. Sh	54	52	45.1	....do	25

22. *Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, etc*—Continued.

Serial number.	Date.	Time.	Position.		Depth in fathoms.	Character of bottom.	Temperature.			Kind of reel.	Weight of sinker.
			Lat. N.	Long. W.			Air.	Surface.	Bottom.		
	1888.		° ′ ″	° ′ ″							Lbs.
1419	Aug. 22	6.43 a.m.	57 44 00	150 46 00	43	S. brk. Sh	55	53	46.8	Tanner	25
1420	do	8.00 a.m.	57 51 00	151 00 00	40	S. G	58	53	46.5	do	25
1421	do	9.18 a.m.	57 57 00	151 08 00	36	brk. Sh. G	55	54	46.5	do	25
1422	do	10.54 a.m.	58 03 00	151 26 00	78	fne. gy. S	55	54	44.1	do	25
1423	do	1.27 p.m.	58 14 00	151 23 00	41	G	59	56	44.1	do	25
1424	do	2.40 p.m.	58 20 00	151 11 00	60	gy. S. G	59	53	43.6	do	25
1425	do	4.00 p.m.	58 12 00	151 01 00	56	gy. S., brk. Sh	63	53	44.1	do	25
1426	do	8.31 p.m.	57 58 00	150 32 00	102	gy. S	59	56	41.3	do	25
1427	do	9.46 p.m.	57 52 00	150 16 00	114	gy. S., bk. Sp	56	55	41.1	do	25
1428	do	11.03 p.m.	57 47 00	150 00 00	113	gy. S., bk. Sp	54	55	41.3	do	25
1429	Aug. 23	12.22 a.m.	57 41 00	149 44 00	140	gy. S., bk. Sp	55	56	41.1	do	25
1430	do	1.45 a.m.	57 47 00	149 31 00	119	gy. S., bk. Sp	55	56	41.6	do	25
1431	do	3.04 a.m.	57 53 00	149 19 00	166	gy. S., bk. Sp	55	56	41.1	do	25
1432	do	4.24 a.m.	57 59 00	149 33 00	112	gy. S	54	56	41.5	do	25
1433	do	5.43 a.m.	58 05 00	149 48 00	128	gy. S	59	55	41.3	do	25
1434	do	7.01 a.m.	58 11 00	150 03 00	69	gy. S. P	63	56	44.1	do	25
1435	do	8.28 a.m.	58 17 00	150 17 00	37	brk. Sh. G	64	56	49.1	do	25
1436	do	9.43 a.m.	58 23 00	150 32 00	37	brk. Sh	58	53	48.5	do	25
1437	do	11.17 a.m.	58 29 00	150 48 00	50	S. P. brk. Sh	58	54	44.1	do	25
1438	do	12.39 p.m.	58 35 00	151 03 00	99	gy. S	57	54	41.1	do	25
1439	do	1.53 p.m.	58 40 00	151 16 00	99	rky	56	54	41.1	do	25
1440	do	3.06 p.m.	58 50 00	151 07 00	76	gy. S	56	54	41.6	do	25
1441	do	4.18 p.m.	58 57 00	151 00 00	97	gy. M	56	54	41.2	do	25
1442	do	5.35 p.m.	58 51 00	150 47 00	84	gy. S	55	56	41.2	do	25
1443	do	6.54 p.m.	58 46 00	150 33 00	105	bk. S. P	55	55	41.3	do	25
1444	do	8.13 p.m.	58 40 00	150 17 00	69	gy. S., brk. Sh	55	54	41.1	do	25
1445	do	9.32 p.m.	58 33 00	150 03 00	67	gy. S. P	55	54	41.1	do	25
1446	do	10.56 p.m.	58 27 00	149 47 00	84	bk. S	55	54	40.9	do	25
1447	Aug. 24	12.21 a.m.	58 21 00	149 33 00	90	gy. S	56	56	41.3	do	25
1448	do	1.41 a.m.	58 14 00	149 17 00	85	gy. S	56	56	41.2	do	25
1449	do	3.02 a.m.	58 08 00	149 04 00	77	gy. S. P	56	56	41.7	do	25
1450	do	4.28 a.m.	58 01 00	148 49 00	98	gy. S	56	56	41.6	do	25
1451	do	6.21 a.m.	57 54 00	148 34 00	507	bu. M	57	56	38.1	Sigsbee	38
1452	do	8.25 a.m.	58 00 00	148 20 00	594	bk. S. G	60	59	37.6	do	38
1453	do	10.03 a.m.	58 10 00	148 20 00	761	bu. M	62	59	37.0	do	38
1454	do	1.38 p.m.	58 24 00	148 46 00	71	gy. S	60	59	41.7	Tanner	25
1455	do	2.56 p.m.	58 31 00	148 57 00	66	gy. S., G. Sh	58	57	41.8	do	25
1456	do	4.15 p.m.	58 39 00	149 08 00	72	gy. S	58	57	42.1	do	25
1457	do	5.33 p.m.	58 46 00	149 17 00	103	bu. M	57	56	41.6	do	25
1458	do	6.55 p.m.	58 53 00	149 30 00	122	gy. M	57	57	41.6	do	25
1459	do	9.03 p.m.	58 44 00	149 02 00	118	gy. S	57	56	.....	do	25
1460	do	10.23 p.m.	58 37 00	148 45 00	99	gy. S	57	56	41.8	do	25
1461	do	11.42 p.m.	58 30 00	148 29 00	106	G. S	57	57	41.5	do	25
1462	Aug. 25	1.31 a.m.	58 23 00	148 07 00	902	bu. M	57	57	36.0	Sigsbee	38
1463	do	3.10 a.m.	58 32 00	148 07 00	358	bu. M	57	58	39.1	Tanner	25
1464	do	4.30 a.m.	58 41 00	148 07 00	151	gy. S	57	58	40.9	do	25
1465	do	5.46 a.m.	58 37 00	147 50 00	301	S. G	57	58	.....	do	25
1466	do	7.30 a.m.	58 45 00	147 50 00	537	bu. M	62	59	38.0	Sigsbee	38
1467	do	9.06 a.m.	58 54 00	147 50 00	87	Sh.	63	57	41.8	do	38
1468	do	10.21 a.m.	59 02 00	147 50 00	101	M. G	64	56	41.7	do	38
1469	do	11.37 a.m.	59 05 00	147 33 00	308	S. R	62	56	39.2	Tanner	25
1470	do	12.54 p.m.	59 10 00	147 17 00	252	rky	61	57	40.1	do	25
1471	do	2.09 p.m.	59 15 00	147 00 00	109	bu. M	59	53	41.1	do	25
1472	do	3.23 p.m.	59 20 00	146 42 00	92	bu. M	57	53	42.6	do	25
1473	do	4.34 p.m.	59 21 00	146 26 00	45	rky	59	53	44.8	do	25
1474	do	5.11 p.m.	59 24 00	146 19 00	11	rky	58	53	51.8	do	25
1475	Aug. 26	8.39 a.m.	59 20 00	146 23 00	15	G. P	61	53	49.8	do	25
1476	do	3.40 p.m.	59 12 00	146 20 00	22	No specimen obt	58	53	......	Hand lead.	......
1477	do	4.26 p.m.	59 09 00	146 13 00	141	P	58	53	41.2	Tanner	25
1478	do	5.39 p.m.	59 03 00	145 56 00	620	bu. M	61	57	37.0	Sigsbee	38
1479	do	8.30 p.m.	58 51 00	145 25 00	2,425	M	59	58	35.0	do	38
1480	Aug. 27	2.54 a.m.	59 01 00	144 22 00	2,220	gy. Oz	59	59	35.0	do	60
1481	do	7.31 a.m.	59 08 00	143 30 00	2,138	gy. Oz	60	59	35.0	do	60
1482	do	10.39 a.m.	59 12 00	143 00 00	1,528	gy. Oz	63	59	35.1	do	60
1483	do	1.32 p.m.	59 00 00	142 37 00	1,764	gy. Oz	65	60	35.0	do	60
1484	do	3.38 p.m.	58 54 00	142 33 00	1,745	br. and gy. Oz	64	60	35.0	do	60
1485	do	5.33 p.m.	58 56 00	142 18 00	1,675	br. and gy. Oz	62	60	35.0	do	60
1486	do	7.24 p.m.	58 58 00	141 59 00	1,500	gy. Oz	60	59	35.0	do	60
1487	do	9.19 p.m.	58 51 00	141 46 00	1,548	gy. Oz	60	60	35.1	do	60
1488	Aug. 28	3.51 a.m.	58 17 00	140 35 00	1,815	gy. Oz	60	60	35.0	do	60
1489	do	11.26 a.m.	57 45 00	139 25 00	1,778	br. and gy. Oz	56	58	......	do	60
1490	Aug. 29	12.48 a.m.	56 35 00	137 55 00	1,433	No specimen	57	57	.	do	60
1491	Aug. 30	5.50 a.m.	54 02 00	134 34 00	1,571	br. and gy. Oz	57	57	35.3	do	38
1492	do	6.29 p.m.	52 32 00	133 05 00	1,601	gy. Oz	67	60	35.1	do	38
1493	Aug. 31	4.38 a.m.	51 34 00	131 25 00	1,099	gn. M	59	59	35.9	do	38
1494	do	6.44 p.m.	51 09 00	129 07 00	83	bu. M	69	60	44.2	Tanner	25
1495	do	10.02 p.m.	51 01 00	128 25 00	52	gy. S	61	55	46.5	do	25
1496	Sept. 1	9.23 a.m.	50 56 00	128 09 00	22	No specimen obtained	56	56	.....	Hand lead	....

22. *Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, etc.*—Continued.

Serial number.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Depth in fathoms.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Kind of reel.	Weight of sinker.
	1888.		° ′ ″	° ′ ″							Lbs.
1497	Sept. 1	9.53 a. m.	50 55 00	128 04 30	16	No specimen obtained	56	56	.....	Hand lead	....
1498	Sept. 19	3.53 a. m.	48 20 00	124 58 00	82	rky	54	52	44.2	Tanner	25
1499	do	4.34 a. m.	48 18 00	125 05 30	106	bk. S	54	52	44.2	do	25
1500	do	5.17 a. m.	48 16 00	125 12 30	108	R	57	52	43.7	do	25
1501	do	6.02 a. m.	48 14 00	125 19 30	55	yl. S	57	57	......	do	25
1502	do	6.33 a. m.	48 12 00	125 26 30	70	bk. S	57	57	45.7	do	25
1503	do	7.14 a. m.	48 10 00	125 33 30	86	bk. S	59	60	45.2	do	25
1504	do	7.56 a. m.	48 08 00	125 40 30	105	bk. S	59	61	44.8	do	25
1505	do	9.12 a. m.	48 06 00	125 47 30	586	gn. M	59	61	38.2	Sigsbee	38
1506	do	10.18 a. m.	48 04 00	125 54 30	505	gn. M	59	59	38.6	do	38
1507	do	11.18 a. m.	48 03 00	126 01 30	692	gn. M	60	59	38.0	do	38
1508	do	12.25 p. m.	48 01 00	126 09 00	768	br. M	62	60	37.2	do	38
1509	do	1.41 p. m.	47 59 00	126 15 00	856	br. M	62	60	36.7	do	38
1510	do	3.04 p. m.	47 57 00	126 22 30	816	br. M	62	60	36.7	do	38
1511	do	4.24 p. m.	47 55 00	126 29 00	1,239	br. M	61	59	......	do	38
1512	Sept. 20	12.47 p. m.	48 07 00	125 03 00	80	gn. M	57	58	44.7	Tanner	25
1513	do	7.34 p. m.	48 07 00	125 00 30	178	fne. gy. S	58	58	......	do	25
1514	do	8.40 p. m.	48 05 00	125 08 00	77	gy. S and P	58	58	44.7	do	25
1515	do	9.42 p. m.	48 03 00	125 15 00	82	P	59	57	44.7	do	25
1516	do	10.47 p. m.	48 01 00	125 22 00	218	bu. M. and G	59	59	42.7	do	25
1517	Sept. 21	12.04 a. m.	47 59 00	125 29 00	90	S. and G	59	59	44.7	do	25
1518	do	1.20 a. m.	47 58 00	125 35 00	141	S. and G	58	57	43.2	do	25
1519	do	2.24 a. m.	47 56 00	125 42 30	378	gn. M	59	59	39.7	Sigsbee	38
1520	do	3.39 a. m.	47 52 00	125 35 00	274	G	59	58	40.2	Tanner	25
1521	do	4.57 a. m.	47 49 00	125 28 00	462	yl. Oz	58	58	39.7	Sigsbee	38
1522	do	5.57 a. m.	47 46 00	125 20 30	522	yl. Oz	58	58	39.1	do	38
1523	do	6.55 a. m.	47 47 00	125 14 00	378	yl. Oz	60	58	40.1	do	38
1524	do	7.44 a. m.	47 48 00	125 07 00	206	gy. Oz	60	58	42.9	Tanner	38
1525	do	8.33 a. m.	47 49 00	124 59 00	67	No specimen obt	60	58	45.1	do	38
1526	do	9.13 a. m.	47 51 00	124 52 00	52	gy, S. and P	63	58	46.5	do	38
1527	do	2.41 p. m.	47 48 00	124 43 00	30	gy. S	61	58	48.1	do	38
1528	do	3.22 p. m.	47 43 00	124 41 00	33	fne. gy. S	61	59	48.1	do	38
1529	do	5.25 p. m.	47 36 00	124 46 00	53	bk. S	63	58	49.1	do	38
1530	do	6.10 p. m.	47 35 00	124 53 00	75	fne. gy. S	63	58	45.7	do	38
1531	do	6.55 p. m.	47 33 00	125 01 00	111	fne. bk. S	63	58	44.9	do	38
1532	do	7.44 p. m.	47 32 00	125 08 00	287	bu. M	63	58	41.1	Sigsbee	38
1533	do	8.38 p. m.	47 27 00	125 06 00	535	bu. M	60	59	39.2	do	38
1534	do	9.36 p. m.	47 22 00	125 03 30	758	gy. Oz	60	59	37.1	do	38
1535	do	10.34 p. m.	47 17 00	125 01 30	578	gy. Oz	59	59	38.3	do	38
1536	do	11.32 p. m.	47 18 00	124 54 00	386	No specimen obt	58	58	40.1	do	38
1537	Sept. 22	12.23 a. m.	47 19 00	124 47 00	82	bu. M	58	58	44.9	Tanner	25
1538	do	1.04 a. m.	47 21 00	124 39 30	51	fne. bk. S	57	57	45.9	do	25
1539	do	1.45 a. m.	47 22 00	124 32 00	28	G. and P	57	57	46.9	do	25
1540	do	2.26 a. m.	47 17 00	124 30 00	28	gy. S	57	57	47.6	do	25
1541	do	3.04 a. m.	47 12 00	124 28 00	28	P	57	57	46.9	do	25
1542	do	3.43 a. m.	47 07 00	124 26 00	28	gy. S	56	57	48.1	do	25
1543	do	4.26 a. m.	47 05 00	124 32 30	41	bk. S	56	57	46.6	do	25
1544	do	5.07 a. m.	47 04 00	124 39 30	56	bk. S	56	57	46.0	do	25
1545	do	5.45 a. m.	47 02 00	124 47 00	74	bk. S. P	56	57	45.9	do	25
1546	do	6.25 a. m.	47 00 00	124 53 30	93	gn. M	54	56	44.9	do	25
1547	do	7.07 a. m.	46 58 00	125 00 30	438	gn. M	54	56	39.7	do	25
1548	do	8.03 a. m.	46 53 00	124 57 00	450	gn. M	56	58	39.4	do	25
1549	do	8.48 a. m.	46 54 00	124 50 00	91	No specimen obt	56	58	......	do	25
1550	do	9.41 a. m.	46 56 00	124 43 00	78	G. S	57	59	......	do	25
1551	do	10.21 a. m.	46 51 00	124 41 00	76	G. M	57	59	46.0	do	25
1552	do	11.01 a. m.	46 50 00	124 48 00	87	rky	57	60	46.0	do	25
1553	do	11.41 a. m.	46 48 00	124 55 00	250	rky	57	59	......	do	25
1554	do	12.38 p. m.	46 43 00	124 52 00	181	rky	58	60	44.9	do	25
1555	do	1.23 p. m.	46 45 00	124 44 00	80	gy. S	58	60	46.0	do	25
1556	do	2.00 p. m.	46 47 00	124 37 00	64	rky	60	60	46.1	do	25
1557	do	2.41 p. m.	46 49 00	124 30 00	42	rky	60	59	47.0	do	25
1558	do	3.18 p. m.	46 51 00	124 22 30	33	gy. and bk. S	60	59	48.1	do	25
1559	do	3.56 p. m.	46 54 00	124 15 00	18	gy. S	60	59	57.8	do	25
1560	do	4.47 p. m.	46 54 00	124 22 30	35	fne. gy. S	57	59	48.3	do	25
1561	do	5.32 p. m.	46 54 00	124 30 00	48	fne. gy. S	58	59	47.0	do	25
1562	do	6.10 p. m.	46 51 00	124 35 00	58	fne. gy. S	57	59	46.4	do	25
1563	do	6.52 p. m.	46 55 00	124 39 00	64	fne. gy. S	57	59	55.8	do	25
1564	do	7.25 p. m.	46 52 00	124 45 00	78	fne. bk. S	57	53	46.0	do	25
1565	do	8.18 p. m.	46 47 00	124 43 00	81	gy. S	58	60	45.5	do	25
1566	do	9.33 p. m.	46 36 00	124 39 00	132	rky	58	60	45.0	do	25
1567	do	10.28 p. m.	46 53 00	124 32 00	72	gy. M	58	60	45.4	do	25
1568	do	11.24 p. m.	46 40 00	124 25 00	50	gy. S	58	59	46.0	do	25
1569	Sept. 23	12.15 a. m.	46 41 00	124 18 00	37	gy. S	57	58	46.7	do	25
1570	do	1.11 a. m.	46 37 00	124 17 30	37	hrd. S	57	58	46.1	do	25
1571	do	1.58 a. m.	46 35 00	124 24 30	51	hrd. S	58	58	..	do	25
1572	do	2.37 a. m.	46 33 00	124 31 00	82	hrd. S	58	58	45.1	do	25
1573	do	3.36 a. m.	46 31 00	124 38 00	433	No bottom specimen.	58	58	39.2	do	25
1574	Sept. 25	9.43 a. m.	48 34 00	124 53 00	65	gn. M	55	51	45.8	do	25

22. *Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, etc.*—Continued.

Serial number.	Date.	Time.	Position.		Depth in fathoms.	Character of bottom.	Temperature.			Kind of reel.	Weight of sinker.
			Lat. N.	Long. W.			Air.	Surface.	Bottom.		
	1888.		° ′ ″	° ′ ″							*Lbs.*
1575	Sept. 29	10.22 a. m.	48 27 00	125 09 00	60	S. R	54	53	45.2	Tanner	25
1576	Oct. 10	3.51 p. m.	48 16 00	123 40 00	101	S. G	52	49	45.2	....do	25
1577	Oct. 11	3.36 p. m.	46 34 00	124 12 30	20	gy. S	60	57	52.9	... do	25
1578	....do	4.36 p. m.	46 33 00	124 19 00	38	fne. gy. S	61	58	47.0	....do	25
1579	.. do	5.17 p. m.	46 32 00	124 26 00	51	fne. gy. S	61	58	47.0	....do	25
1580	... do	5.58 p. m.	46 31 00	124 33 00	153	gr. M	61	58	45.0	. do	25
1581	.. do	6.42 p. m.	46 30 00	124 39 30	432	br. Oz	61	58	39.6	Sigsbee	38
1582	....do	7.38 p. m.	46 28 00	124 33 00	98	fne. gy. S	61	58	44.8	Tanner	25
1583	. do	8.22 p. m.	46 27 00	124 26 00	55	bk. S	61	58	47.0	....do	25
1584	do	9.10 p. m.	46 25 00	124 20 00	40	bu. M	60	58	47.9	....do	25
1585	.. do	9.59 p. m.	46 23 00	124 27 00	59	fne. bk. S	60	58	47.0	.. do	25
1586	....do	10.52 p. m.	46 22 00	124 34 00	78	fne. gy. S	58	59	46.5	....do	25
1587	....do	11.49 p. m.	46 21 00	124 41 00	260	bu. M	58	59	42.5	....do	25
1588	Oct. 13	6.58 a. m.	46 03 00	124 22 00	73	fne. gy. S	57	57	45.1	....do	25
1589	.. do	7.48 a. m.	46 02 00	124 29 00	82	fne. gy. S	57	57	45.8	....do	25
1590	.. do	8.38 a. m.	46 00 00	124 36 00	96	br. S	58	56	46.0	....do	25
1591	....do	9.26 a. m.	45 50 00	124 42 30	199	gy. Oz	58	56	43.8	....do	25
1592	.. do	10.18 a. m.	46 03 00	124 45 00	174	gy. Oz	60	61	44.2	...do	25
1593	do	11.35 a. m.	46 07 00	124 48 00	601	br. Oz	62	62	38.8	....do	25
1594	...do	12.30 p. m.	46 08 00	124 39 00	102	bk. S	64	60	55.9	... do	25
1595	....do	1.15 p. m.	46 08 00	124 31 00	78	fne. gy. S	64	60	46.1	....do	25
1596	....do	4.46 p. m.	46 17 00	124 21 30	81	bu. M	62	60	46.6	....do	25
1597	.. do	5.35 p. m.	46 16 00	124 28 30	231	bu. M	58	57	43.1	....do	25
1598	.. do	6.36 p. m.	46 15 00	124 36 00	421	br. Oz	57	57	39.8	Sigsbee	38
1599	....do	7.46 p. m.	46 14 00	124 42 30	475	gy. Oz	57	56	39.6	.. do	38
1600	.. do	9.01 p. m.	46 13 00	124 50 00	506	br. Oz	56	56	39.3	....do	38
1601	Oct. 19	6.40 a. m.	44 04 00	124 53 00	56	M	57	57	47.1	Tanner	25
1602	....do	7.06 a. m	44 02 00	124 55 00	51	crs. bk. S	57	57	47.6	... do	25
1603	.. do	11.52 a. m.	43 59 00	125 02 00	91	bk. S. G	60	58	46.2	....do	25
1604	... do	12.20 p. m.	43 59 00	125 05 00	563	gy. M	60	58	38.7	Sigsbee	38
1605	....do	1.14 p. m.	43 54 00	125 05 00	355	bk. S	60	59	40.3	.. do	38
1606	....do	2.04 p. m.	43 50 00	125 01 30	299	gy. C	60	59	42.1	....do	38

23. *Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July* 1 *to December* 31, 1888.

Serial number.	Date.	Time.	Position.		Temperature.			Depth in fathoms.	Character of bottom.	Wind.		Drift.		Instrument used.
			Latitude N.	Longitude W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Dist.	
	1888.		° ′ ″	° ′ ″										
2841	July 23	9.05 a. m.	54 18 00	165 55 00	53	46	41	56	P	SSE.	4	WNW.	0.2	S. B. T.
2842	...do	10.27 a. m	54 15 00	166 03 00	50	46	41	72	P	SSE.	4	SW.	0.3	S. B. T.
2843	July 28	12.37 p. m.	53 56 00	165 56 00	52	50	43.5	45	brk. Sh. and P.	NW.	3	ENE.	1.5	S. B. T.
2844	...do	2.47 p. m.	53 56 00	165 40 00	51	48	42	54	gy. S	NW.	4	E. ¼ S.	1.5	L. B. T.
2845	July 29	8.30 a. m.	54 05 00	164 09 00	53	51	42	42	crs. bk. S	SSE.	2	SW.	0.8	L. B. T.
2846	July 30	7.45 a. m.	54 08 00	162 44 00	51	50	42	44	G	South.	3	S. by E.	0.5	L. B. T.
2847	July 31	8.00 a. m.	55 01 00	160 12 00	51	51	42	48	fne. gy. S	South.	3	SSW.	0.8	L. B. T.
2848	...do	9.40 a. m.	55 10 00	160 18 00	51	49	41	110	gn. M	SSE.	3	South.	0.3	L. B. T.
2849	Aug. 2	7.30 a. m.	55 16 00	160 28 00	54	51	43	69	gn. M	SSE.	3	South.	0.7	L. B. T.
2850	Aug. 4	10.00 a. m.	54 52 00	159 46 00	53	51	48.2	21	brk. Sh	SW.	4	W. by N.	0.5	L. B. T.
2851	...do	11.15 a. m.	54 55 00	159 52 00	53	51	44.8	35	gy. S., brk. Sh.	SW.	3	W. by N.	1.0	L. B. T.
2852	...do	4.08 p. m.	55 15 00	159 37 00	53	48	41.8	58	bk. S	West.	3	NNW.	0.7	L. B. T.
2853	Aug. 9	2.04 p. m.	56 00 00	154 20 00	55	55	41	159	gy. S	West.	2	N. ¾ E.	1.0	L. B. T.
2854	Aug. 10	9.55 a. m.	56 55 00	153 04 00	57	55	42.8	60	bk. S	SW.	2	SW.	1.0	L. B. T.
2855	...do	11.44 a. m.	57 00 00	153 18 00	58	56	44	69	gn. M	SW.	1	NNW.	1.0	L. B. T.
2856	Aug. 22	11.35 a. m.	58 07 00	151 36 00	55	54	44	68	gy. S., bk. Sh.	WNW.	2	NW.	0.5	L. B. T.
2857	...do	6.30 p. m.	58 05 00	150 46 00	68	57	44.6	51	brk. Sh., gy. S	Calm.	0	SE. ¼ E.	0.5	L. B. T.
2858	Aug. 24	11.40 a. m.	58 17 00	148 36 00	61	59	39.8	230	bu. M. G	NE.	2	WSW.	0.2	L. B. T.
2859	Aug. 29	2.00 p. m.	55 20 00	136 20 00	61	60	34.9	1,569	gy. Oz	Calm.	0	SE.	2.5	L. B. T.
2860	Aug. 31	9.30 a. m.	51 23 00	130 34 00	61	58	36.5	876	gn. M	West.	2	E. ½ N.	1.5	L. B. T.
2861	.. do	2.50 p. m.	51 14 00	129 50 00	69	60	42.6	204	No spec. in cup	NW.	2	East.	1.0	L. B. T.
2862	Sept. 1	12.32 p. m.	50 49 00	127 36 30	61	58	44.7	238	gy. S. and P.	West.	3	ESE.	0.5	L. B. T
2863	Sept. 5	10.58 a. m.	48 58 00	123 10 00	60	62	48.5	67	fne. S., brk. Sh.	SE.	2	SSE.	0.8	L. B. T.
2864	Sept. 6	7.16 a. m.	48 22 00	122 51 00	59	52	47.7	48	M. brk. Sh. S	South.	0.1	SSW.	0.5	L. B. T.
2865	...do	8.56 a. m.	48 12 00	122 49 00	58	52	51.7	40	P	Calm.	0	S. by E.	0.6	L. B. T.
2866	Sept. 20	11.10 a. m.	48 09 00	125 03 00	59	59	43.2	171	gy. S	SSE.	2	SE. by E.	0.8	L. B. T.

23. *Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, etc.*—Cont'd.

Serial number.	Date.	Time.	Position.		Temperature.			Depth in fathoms.	Character of bottom.	Wind.		Drift.		Instrument used.
			Latitude N.	Longitude W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Dist.	
	1888.		° ′ ″	° ′ ″										
2867	Sept. 20	1.47 p. m.	48 07 00	124 55 00	58	58	....	37	fne. gy. S.	SSE.	3	SE.	0.8	L. B. T.
2868	Sept. 21	1.27 p. m.	47 52 00	124 44 00	63	58	46.9	31	gy. S..........	SSE.	2	SE.	0.5	L. B. T.
2869	...do	4.09 p. m.	47 38 00	124 39 00	64	60	48.4	32	bk. S..........	South.	2	West.	1.0	L. B. T.
2870	Sept. 23	9.04 a. m.	46 44 00	124 32 00	58	58	46.5	58	rky..........	NE.	2	E. by S.	1.5	L. B. T.
2871	..do	1.32 p. m.	46 55 00	125 11 00	60	62	38.4	559	br. Oz.........	WNW.	2	NW.	1.3	L. B. T.
2872	Sept. 24	10.09 a. m.	48 17 00	124 52 00	62	59	45.5	38	gy. S..........	North.	3	ENE.	0.4	L. B. T.
2873	.. do	12.45 p. m.	48 30 00	124 57 00	61	54	47.8	40	R.............	NNE.	3	West.	0.3	L. B. T.
2874	...do	1.25 p. m.	48 30 00	124 57 00	55	52	50.3	27	R. and Sh.....	NNE.	3	SE.	0.2	Tangles.
2875	...do ..	1.58 p. m.	48 30 00	124 57 00	55	52	47.8	40	R. and Sh. ...	NE.	3	WSW.	0.4	Tangles.
2876	Sept. 25	10.34 a. m.	48 33 00	124 53 00	58	49	45.5	59	bk. S. and M..	ENE.	2	WSW.	0.4	L. B. T.
2877	...do ...	10.59 a. m.	48 33 00	124 53 00	58	49	45.5	59	bk. S. and M..	ENE.	3	SE. by S.	0.2	Tangles.
2878	..do ...	3.02 p. m.	48 37 00	125 32 00	60	57	45.5	66	P	WNW.	1	South.	0.3	Dredge.
2879	Sept. 26	8.35 a. m.	48 53 00	125 53 00	56	54	50.3	34	R.............	NE.	1	WNW.	0.2	Do.
2880	...do ..	8.49 a. m.	48 53 00	125 53 00	56	54	50.3	34	R.............	ESE.	1	E. by S.	0.2	Do.
2881	.. do	11.44 a. m.	49 00 00	125 48 00	63	57	52.3	24	gy. S..........	ESE.	1	SE. ¼ E.	0.2	Do.
2882	Oct. 13	2.12 p. m.	46 09 00	124 22 30	64	60	45.8	68	gy. S..........	SE.	1	North.	1.0	L. B. T.
2883	Oct. 18	3.01 p. m.	45 56 00	124 01 30	62	60	50.1	29	fne. gy. S.	NE.	2	SSE.	0.2	Dredge.
2884	...do	3.16 p. m,	45 55 00	124 02 00	62	60	50.2	29	fne. gy. S. ...	NE.	2	WNW. by N.	0.3	Do.
2885	...do	3.44 p. m.	45 56 00	124 02 00	62	60	49	30	fne. gy. S.	Calm.	0	NW.	0.5	Do.
2886	Oct. 19	9.05 a. m.	43 59 00	124 56 30	57	57	48.1	50	rky...........	SE.	1	SSW.	0.2	Do.
2887	...do	9.28 a. m.	43 58 00	124 57 00	60	59	47.1	42	C. and P	SE.	1	SW.	0.4	L. B. T.
2888	.. do ...	10.01 a. m.	43 58 00	124 57 30	60	59	47.6	41	C. and P	SE.	1	West.	0.1	L. B. T.
2889	...do	10.42 a. m.	43 59 00	124 56 00	59	57	47.7	46	C. Sh..........	SE.	1	SSW.	0.4	L. B. T.
2890	...do	2.58 p. m.	43 46 00	124 57 00	62	59	42.2	277	gy. S..........	Calm.	0	SSE.	2.3	L. B. T.

24. *Tabular statement of trials made for fish.*

Station No.	Date.	Hour.	Locality.		Depth of water.	Character of bottom.	Bait used.
			Latitude N.	Longitude W.			
Hyd.	1888.		° ′ ″	° ′ ″	*Fath.*		
1141	July 21	3.00 p.m.	53 11 00	166 51 00	84	bk. S. Peb	Salt clams
1142	...do ...	4.07 p.m.	53 17 00	166 54 00	57½	S. bk. Sp	do
1143	...do ...	5.07 p.m.	53 22 00	166 55 30	41	S. bk. Sp	do
1145	...do ...	6.40 p.m.	53 19 00	166 50 00	55½	bk. S. Peb	do
1166	July 22	6.39 p.m.	54 00 00	163 45 00	45	fne. gy. S	do
Dredging.							
2843	July 28	12.38 p.m.	53 56 00	165 56 00	45	bk. S. Peb	Clams; salmon
2844	...do ...	2.49 p.m.	53 56 00	165 40 00	54	gy. S	do
2845	July 29	7.55 a.m.	54 05 00	164 09 00	42	crs. bk. S	do
2846	July 30	7.00 a.m.	54 08 00	162 44 00	44	Gravel	do
Hyd.							
1213	...do	12.42 p.m.	54 12 00	162 17 00	47	bk. S. fne. G	do
1227	July 31	6.20 a.m.	54 56 00	160 33 00	52	gray S	Clams; salmon; sculpins
....	Aug. 2	....	Eagle Harbor.		....	soft Mud	Clams; salmon
1239	Aug. 3	4.45 p.m.	54 23 00	161 56 00	34	Pebbles	do
1258	Aug. 4	2.05 p.m.	55 02 00	159 41 00	37	gy. S. and brk. Sh	do
1266	Aug. 5	7.15 a.m.	54 55 00	158 46 00	46	gy. S. and brk. Sh	Pollock; salmon
1286	...do ..	6.50 p.m.	54 42 00	159 24 00	36	Rocky	Salmon; pollock
1317	Aug. 7	6.25 a.m.	55 26 00	157 28 00	47	green M	do
1343	Aug. 9	5.10 a.m.	55 49 00	155 20 00	27	gy. S. brk. Sh	Pollock; cod
1350	.. do ...	11.21 a.m.	56 07 00	154 38 00	37	gy. S	Walrus; cod
1392	Aug. 13	9.07 a.m.	57 16 00	152 22 00	39	bk. S. G	Salmon
....	Aug. 18	....	St. Paul.		13	Mussels and kelp	Cod; salmon
1421	Aug. 22	9.18 a.m.	57 57 00	151 08 00	36	brk. Sh. and G	Salmon
Dredging.							
2857	...do ...	6.31 p.m.	58 05 00	150 46 00	51	gray S	do
Hyd.							
1436	Aug. 23	9.43 a.m.	58 23 00	150 32 00	37	brk. Sh	do
....	Aug. 26	1.00 p.m.	Middleton Island.		....	Rocks and kelp	do
Dredging.							
2867	Sept. 20	3.00 p.m.	48 07 00	124 55 00	37	fne. gy. S	do
2868	Sept. 21	10.00 a.m.	47 52 00	124 44 00	31	gy. S	Salmon; clams
2870	Sept. 23	6.30 a.m.	46 44 00	124 32 00	58	Rocky	do
2872	Sept. 24	7.30 a.m.	48 17 00	124 52 00	38	gy. S	Salmon; clams; red rockfish
2873	...do ...	12.30 p.m.	48 30 00	124 57 00	40	Rocky	Salmon; red rockfish
....	...do ...	Over night	Neeah Bay.		20	Rocky	Salmon; halibut
2876	Sept. 25	10.15 a.m.	48 33 00	124 55 00	59	blk. S. and M	do
2878	...do	3.00 p.m.	48 37 00	125 32 00	66	Peb	Salmon; halibut; red rockfish
2879	Sept. 26	5.30 a.m.	48 53 00	125 53 00	34	Rocky	do
2881	...do ...	11.15 a.m.	49 00 00	125 48 00	24	gy. S	do
....	Sept. 28	Over night. 7.00 p.m.	Barclay Sound.		....	Rocks and slime	Salmon; halibut
Hyd.							
1577	Oct. 11	3.45 p.m.	46 34 00	124 12 00	20	gy. S	Salmon
Dredging.							
2882	Oct. 13	3.30 p.m.	46 09 00	124 22 00	68	gy. S	do
2883	Oct. 18	3.00 p.m.	Tillamook Rock.		25 to 18	Rocky	Salmon; herring
[illegible]	Oct. 19	7.39 a.m.	43 59 00	124 56 30	50	Rocky	do

24. Tabular statement of trials made for fish.

No. lines used.	Length of trial.	Fish taken.	Cod.				Halibut.		
			Sexes.		Average weight.	Average length.	Sexes.		Average weight.
	Minutes.		♂	♀	*Pounds.*	*Inches.*	♂	♀	*Pounds.*
1	29	2 cod	1	1	11¾	21			
2	23	3 cod	2	1	8	27			
5	18	4 cod	1	3	10	28¾			
8	15	13 cod; 1 halibut; 2 flounders	7	6		26½	1		15½
8	62	21 cod; 1 halibut	8	13	11¾	29½	1		6½
1	20	None							
6	17	2 cod; 1 flounder; 3 halibut	2		6½	24	1	2	20
6	20	25 cod	11	14	11¾	28			
7	15	10 cod; 2 halibut	4	6	11	23½	1	1	14½
9	29	6 cod; 1 halibut	1	5	8½	25	1		30
9	25	9 cod; 3 flounders	3	6	11	30			
(*)		6 cod; 3 halibut	2	4	8½	26¾		3	14⅝
9	15	2 cod; 5 halibut	1	1	8½	23¾	3	2	9¾
9	15	1 halibut							4
8	20	1 halibut; 3 sculpins						1	5
9	35	8 cod; 3 halibut; 3 sculpins	4	4	8	26½	2	1	18⅜
9	40	None							
7	25	15 cod	10	5	9¼	23⅘			
9	38	47 cod	20	27	10	28½			
9	50	69 cod	25	44	12	30¾			
(†)		2 cod; 1 halibut; 2 salmon	1	1	10	29½		1	22
9	18	30 cod; 1 halibut	18	12	8½	27		1	10
9	15	2 cod; 4 flounders	1	1	8½				
8	18	3 cod	3		5⅓				
6		2 halibut					1	1	53
(‡)	120	1 halibut; 8 sharks; 3 dogfish						1	140
(‡)	180	1 skate; 3 dogfish; 2 red rockfish							
(‡)	180	10 red rockfish; 2 black cod; 4 sharks							
(‡)	120	2 sharks; 1 star fish							
(‡)	120	4 halibut; 4 red rockfish; 1 shark					1	3	47¾
(‡)		21 dogfish; 2 skates							
(‡)	120	2 halibut; 1 red rockfish; 9 dogfish					1	1	55
(‡)	120	3 black cod; 2 ground sharks; 2 common sharks; 15 dogfish.							
(‡)	180	1 halibut; 2 sharks; 3 dogfish						1	25
(‡)	120	1 halibut; 5 dogfish; 1 shark; 1 skate						1	15
(§)		1 red rockfish; 28 dogfish							
9	12	None							
(§)	60	1 black cod; 4 dogfish							
(‖)	90	7 dogfish							
(‖)	150	1 halibut; 1 shark; 1 black cod; 1 dogfish					1		10½

* 1 trawl (500) hooks.
† 1 trawl (400) hooks.
‡ 1 trawl line.
§ Cod trawl.
‖ Cod and halibut trawl.

25. *Record of temperatures and water densities by the steamer Albatross, July 1 to December 31, 1888.*

Date.	Time of day.	Latitude north.	Longitude west.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° F.
1888.		° ′ ″	° ′ ″		°	°	°		
July 4	12 m	Off Ballenas Point.		Surface	59	63	70	1.0240	1.025450
4	6 p. m	38 26 00	123 00 00	......do	53	55	68	1.0244	1.025536
4	12 p. m	39 04 00	123 31 00	......do	50	52	68	1.0246	1.025736
5	6 a. m	39 42 00	124 01 00	......do	50	52	68	1.0246	1.025736
5	12 m	40 21 00	124 29 00	......do	48	52	68	1.0250	1.026136
5	6 p. m	40 58 00	124 32 30	......do	52	55	69	1.0244	1.025687
5	12 p. m	41 35 00	124 36 00	......do	53	52	69	1.0244	1.025687
6	6 a. m	42 12 00	124 39 30	......do	50	51	69	1.0244	1.025687
6	12 m	42 50 00	124 43 00	......do	48	53	69	1.0246	1.025887
6	6 p. m	43 23 00	124 34 00	......do	49	53	69	1.0244	1.025687
6	12 p. m	43 56 00	124 23 00	......do	48	54	69	1.0232	1.024487
7	6 a. m	44 29 00	124 15 00	......do	51	56	69	1.0232	1.024487
7	12 m	45 04 00	124 04 00	......do	50	55	69	1.0232	1.024487
7	6 p. m	45 50 00	124 16 00	......do	59	62	69	1.0226	1.023887
7	12 p. m ...	46 36 00	124 28 00	......do	58	59	69	1.0226	1.023887
8	6 a. m	47 22 00	124 40 00	......do	58	58	69	1.0212	1.022487
8	12 m	48 09 00	124 51 00	......do	56	61	69	1.0218	1.023087
8	6 p. m	Victoria, British Columbia.		......do	52	58	69	1.0222	1.023487
9	6 p. m	Gulf Georgia.		......do	59	60	69	1.0146	1.015887
11	4 p. m	Departure Bay.		......do	64	68	69	1.0146	1.015887
11	6 p. m	Off Departure Bay.		......do	64	65	69	1.0146	1.015887
11	12 p. m	Tribune Bay.		......do	59	57	68	1.0160	1.017136
12	12 m	Johnston's Strait.		......do	56	56	62	1.0224	1.022670
12	6 p. m	Off Beaver Harbor.		......do	50	55	69	1.0226	1.023887
13	12 m	Beaver Harbor.		......do	55	56	68	1.0224	1.023536
13	6 p. m	Off Cape Scott.		......do	56	56	68	1.0232	1.024336
13	12 p. m	50 56 00	129 40 00	......do	55	55	68	1.0236	1.024736
14	6 a. m	51 05 00	131 02 00	......do	56	55	68	1.0236	1.024736
14	12 m	51 14 00	132 30 00	......do	54	54	68	1.0236	1.024736
14	6 p. m	51 29 00	133 40 00	......do	54	55	68	1.0236	1.024736
14	12 p. m	51 44 00	134 50 00	......do	54	54	68	1.0234	1.024536
15	6 a. m	51 59 00	136 00 00	......do	53	53	68	1.0236	1.024736
15	12 m	52 15 00	137 13 30	......do	52	54	68	1.0236	1.024736
15	6 p. m	52 18 00	138 33 00	......do	53	53	68	1.0236	1.024736
15	12 p. m	52 23 00	139 43 00	......do	52	53	68	1.0236	1.024736
16	6 a. m	52 29 00	141 03 00	......do	51	51	68	1.0236	1.024736
16	12 m	52 35 00	142 34 00	......do	52	52	68	1.0236	1.024736
16	6 p. m	52 37 00	143 44 00	......do	52	52	68	1.0236	1.024736
16	12 p. m	52 34 00	144 54 00	......do	51	50	68	1.0236	1.024736
17	6 a. m	52 36 00	146 04 00	......do	50	50	68	1.0236	1.024736
17	12 m	52 35 00	147 35 00	......do	50	49	68	1.0236	1.024736
17	6 p. m	52 26 00	148 29 00	......do	50	50	68	1.0236	1.024736
17	12 p. m	52 17 00	149 43 00	......do	50	49	68	1.0236	1.024736
18	6 a. m	52 08 00	150 57 00	......do	50	49	68	1.0240	1.025136
18	12 m	51 58 00	152 12 00	......do	51	51	68	1.0240	1.025136
18	6 p. m	52 04 00	153 35 00	......do	51	52	68	1.0240	1.025136
18	12 p. m	52 10 00	154 58 00	......do	50	51	68	1.0240	1.025136
19	6 a. m	52 15 00	156 37 00	......do	51	51	68	1.0240	1.025136
19	12 m	52 11 00	157 44 00	......do	49	50	68	1.0240	1.025136
19	6 p. m	52 13 00	158 58 00	......do	48	50	68	1.0238	1.024936
19	12 p. m	52 11 00	160 12 00	......do	49	50	68	1.0240	1.025136
20	6 a. m	52 15 00	161 40 30	......do	50	50	68	1.0240	1.025136
20	12 m	52 25 00	162 40 00	......do	50	55	68	1.0240	1.025136
20	6 p. m	52 18 00	163 54 00	......do	50	54	68	1.0240	1.025136
20	12 p. m	52 20 00	165 00 00	......do	50	52	68	1.0238	1.024936
21	12 m	52 50 00	166 42 00	......do	50	52	68	1.0238	1.024936
21	6 p. m	53 19 00	166 50 00	......do	50	53	68	1.0236	1.024736
21	12 p. m	53 16 00	166 10 00	......do	49	51	68	1.0234	1.024536
22	6 a. m	53 39 00	165 04 00	......do	48	50	69	1.0232	1.024487
22	12 m	53 40 00	164 28 30	......do	50	52	69	1.0234	1.024687
22	6 p. m	54 00 00	163 45 00	......do	50	51	69	1.0234	1.024687
22	12 p. m	54 13 00	164 02 00	......do	49	51	69	1.0236	1.024887
23	6 a. m	54 22 00	165 34 30	......do	45	50	69	1.0236	1.024887
23	12 m	54 10 00	166 13 00	......do	45	52	69	1.0232	1.024487
23	6 p. m	Unalashka Harbor.		......do	52	59	69	1.0202	1.021487
28	12 m	53 56 00	166 07 00	......do	50	52	68	1.0240	1.025136
28	6 p. m	53 55 00	165 05 30	......do	52	52	68	1.0236	1.024736
28	12 p. m	53 55 00	164 22 00	......do	50	50	68	1.0234	1.024536
29	6 a. m	54 02 30	163 53 30	......do	51	52	68	1.0234	1.024536
29	12 m	54 11 00	164 46 00	......do	50	51	68	1.0234	1.024536
29	6 p. m	54 22 00	164 01 00	......do	49	51	68	1.0234	1.024536
29	12 p. m	54 18 00	163 18 00	......do	50	51	68	1.0234	1.024536
30	6 a. m	54 09 00	162 58 00	......do	50	51	68	1.0234	1.024536

25. *Record of temperatures and water densities by the steamer Albatross, etc.*—Continued.

Date.	Time of day.	Latitude north.	Longitude west.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° F.
1888.		° ′ ″	° ′ ″		°	°	°		
July 30	12 m	54 08 00	162 43 30	Surface	50	51	68	1.0234	1.024536
30	6 p. m	54 31 00	161 44 00	do	50	52	68	1.0234	1.024536
30	12 p. m	54 42 00	161 13 00	do	49	51	68	1.0230	1.024136
31	6 a. m	54 56 00	160 33 00	do	50	51	68	1.0230	1.024136
31	1 p. m	Humboldt Harbor.		do	49	53	68	1.0226	1.023736
Aug. 2	12 m	Eagle Harbor.		do	51	55	68	1.0230	1.024136
3	12 m	54 44 00	161 27 30	do	51	52	68	1.0230	1.024136
3	6 p. m	54 20 00	162 02 00	do	50	51	68	1.0230	1.024136
3	12 p. m	54 18 00	161 34 00	do	51	52	68	1.0230	1.024136
4	6 a. m	54 39 00	160 28 00	do	50	52	68	1.0230	1.024136
4	12 m	54 56 00	159 54 00	do	50	51	71	1.0230	1.024606
4	7 p. m	Yukon Harbor.		do	50	52	71	1.0230	1.024606
5	12 m	54 50 00	159 08 00	do	52	52	71	1.0230	1.024606
5	6 p. m	54 41 00	159 16 00	do	51	52	71	1.0230	1.024606
5	12 p. m	54 34 00	159 40 00	do	50	50	71	1.0230	1.024606
6	6 a. m	54 25 00	160 03 00	do	51	50	71	1.0230	1.024606
6	12 m	54 34 00	158 43 00	do	51	58	71	1.0230	1.024606
6	6 p. m	55 04 00	158 48 00	do	52	53	71	1.0230	1.024606
6	12 p. m	55 20 00	158 48 00	do	51	51	71	1.0230	1.024606
7	6 a. m	55 25 00	157 37 00	do	50	51	71	1.0230	1.024606
7	12 m	55 45 00	158 25 00	do	51	52	71	1.0226	1.024206
7	6 p. m	Ivanoff Bay.		do	51	55	71	1.0224	1.024006
8	6 a. m	Off Mitrofania Island.		do	50	53	71	1.0163	1.017906
8	12 m	55 43 00	157 24 00	do	53	54	71	1.0226	1.024206
8	6 p. m	55 37 00	156 57 00	do	51	54	71	1.0228	1.024406
8	12 p. m	55 46 00	155 55 00	do	50	51	71	1.0230	1.024606
9	6 a. m	55 44 00	155 14 00	do	48	50	71	1.0230	1.024606
9	12 m	56 07 00	154 39 00	do	54	58	71	1.0230	1.024606
9	6.30 p. m	56 28 00	154 05 00	do	50	53	71	1.0230	1.024606
9	12 p. m	56 23 00	153 24 00	do	51	53	71	1.0230	1.024606
10	6 a. m	56 42 00	152 21 00	do	52	54	71	1.0230	1.024606
10	12 m	57 00 00	153 20 30	do	56	58	71	1.0228	1.024406
11	6 p. m	Old Harbor, Kadiak Island.		do	58	73	71	1.0220	1.023606
12	12 p. m	56 38 00	151 59 00	do	54	53	71	1.0234	1.025006
13	6 a. m	57 03 00	152 10 00	do	52	53	70	1.0234	1.024850
13	12 m	57 20 00	152 13 00	do	54	53	70	1.0234	1.024850
13	6 p. m	57 11 00	151 05 00	do	53	55	70	1.0234	1.024850
20	12 m	St. Paul, Kadiak.		do	54	60	70	1.0230	1.024450
21	6 p. m	57 52 00	151 47 00	do	55	56	70	1.0230	1.024450
21	12 p. m	57 19 00	150 35 00	do	56	55	70	1.0230	1.024450
22	6 a. m	57 44 00	150 46 00	do	52	54	70	1.0232	1.024650
22	12 m	58 07 00	151 33 00	do	54	55	70	1.0230	1.024450
22	6.30 p. m	58 05 00	150 46 00	do	56	62	70	1.0230	1.024450
22	12 p. m	57 41 00	149 44 00	do	56	55	70	1.0230	1.024450
23	6 a. m	58 05 00	149 48 00	do	55	59	70	1.0230	1.024450
23	12 m	58 31 00	150 56 00	do	54	57	70	1.0228	1.024250
23	6 p. m	58 51 00	150 47 00	do	56	55	70	1.0222	1.023650
23	12 p. m	58 21 00	149 33 00	do	56	56	70	1.0226	1.024050
24	6 a. m	57 54 00	148 34 00	do	56	57	70	1.0230	1.024450
24	12 m	58 17 00	148 36 00	do	59	61	70	1.0226	1.024050
24	6 p. m	58 46 00	149 17 00	do	56	57	69	1.0226	1.023887
24	12 p. m	58 30 00	148 29 00	do	57	57	69	1.0226	1.023887
25	6 a. m	58 37 00	147 50 00	do	58	59	69	1.0234	1.024687
25	12 m	59 06 00	147 30 00	do	58	62	69	1.0234	1.024687
25	6 p. m	Middleton Island.		do	53	57	69	1.0226	1.023887
26	2 p. m	59 01 00	144 22 00	do	53	59	69	1.0236	1.024887
27	6 a. m	59 08 00	143 30 00	do	59	59	69	1.0236	1.024887
27	12 m	59 09 00	142 51 00	do	60	64	69	1.0236	1.024887
27	6 p. m	58 56 00	142 18 00	do	60	62	69	1.0234	1.024687
27	12 p. m	58 27 00	141 11 00	do	59	60	69	1.0234	1.024687
28	6 a. m	58 08 00	140 21 00	do	58	56	69	1.0232	1.024487
28	12 m	57 44 00	139 30 00	do	58	56	69	1.0230	1.024287
28	6 p. m	57 10 00	138 44 00	do	58	58	69	1.0232	1.024487
28	12 p. m	56 36 00	137 58 00	do	58	58	69	1.0234	1.024687
29	6 a. m	56 02 00	137 11 00	do	57	57	69	1.0230	1.024287
29	12 m	55 28 00	136 25 00	do	59	60	69	1.0230	1.024287
29	6 p. m	54 56 00	135 47 00	do	60	65	69	1.0232	1.024487
29	12 p. m	54 23 00	135 09 00	do	57	57	69	1.0234	1.024687
30	6 a. m	53 52 00	134 31 00	do	57	57	69	1.0234	1.024687
30	12 m	53 18 00	133 55 00	do	57	59	69	1.0234	1.024687
30	6.30 p. m	52 48 00	133 04 00	do	60	79	69	1.0234	1.024687
30	12 p. m	52 22 00	132 11 00	do	58	59	69	1.0234	1.024687
31	6 a. m	51 54 00	131 21 00	do	59	59	69	1.0232	1.024487
31	12 m	51 24 00	130 29 00	do	59	65	69	1.0234	1.024687

25. *Record of temperatures and water densities by the steamer Albatross, etc.*—Continued.

Date.	Time of day.	Latitude north.	Longitude west.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° F.
1888.		° ′ ″	° ′ ″		°	°	°		
Sept. 5	6 p. m....	Burrows' Bay.		Surface	57	59	69	1.0214	1.022687
6	12 m	47 36 00	122 20 00	do	56	61	69	1.0216	1.022887
7	High water	Seattle, Wash.		do	60	68	60	1.0192	1.019200
7	Low water	Do.		do	60	59	60	1.0152	1.015200
17	4 p. m.	Port Townsend.		do	54	59	69	1.0224	1.023687
18	12 p. m.	Off Cape Flattery.		do	51	52	69	1.0230	1.024287
19	12 m	48 00 00	126 02 00	do	59	61	69	1.0230	1.024287
19	5 p. m.	47 55 00	126 29 00	do	59	61	69	1.0230	1.024287
20	12 m	48 08 00	125 02 00	do	59	59	69	1.0232	1.024487
20	6 p. m.	Off Flattery Rocks.		do	56	59	69	1.0232	1.024487
20	12 p. m.	47 59 00	125 29 00	do	59	59	69	1.0234	1.024687
21	6 a. m.	47 46 00	125 20 00	do	58	58	69	1.0230	1.024287
21	12 m	47 52 00	124 45 00	do	56	60	69	1.0226	1.023887
21	6 p. m.	47 35 00	124 53 00	do	58	63	69	1.0228	1.024087
21	12 p. m.	47 18 00	124 54 00	do	58	58	69	1.0230	1.024287
22	6 a. m.	47 00 00	124 53 00	do	56	56	69	1.0230	1.024287
22	12 m	46 48 00	124 55 00	do	59	57	69	1.0230	1.024287
22	12 p. m.	46 41 00	124 18 00	do	59	58	69	1.0220	1.023287
23	6 a. m.	46 44 00	124 32 00	do	58	58	69	1.0230	1.024287
23	12 m	46 48 00	124 54 00	do	60	58	69	1.0230	1.024287
24	6 p. m.	Neeah Bay, Wash.		do	50	59	65	1.0244	1.025090
27	12 m	Barclay Sound, B. C.		do	58	68	65	1.0192	1.019890
Oct. 13	12 m	46 08 00	124 45 00	do	62	62	65	1.0240	1.024690
14	7 a. m.	Mouth Columbia River.		do	56	56	65	1.0194	1.020090
17	12 m	Astoria, Oregon, high water.		do	59	56	65	1.0054	1.006090
17	8 p. m.	Astoria, Oregon, low water.		do	59	56	64	1.0000	1.000548
18	3 p. m.	Tillamook Rock.		do	60	62	65	1.0226	1.023290
19	12 m	43 59 00	125 03 00	do	58	60	65	1.0244	1.025090
20	2 p. m.	Cape Mendocino.		do	50	58	65	1.0250	1.025690

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26. *Record of meteorological observations by the steamer Albatross, July 1 to December 31, 1888.*

Date.	Latitude north.	Longitude west.	Barometer. Highest.	Barometer. Lowest.	Barometer. Mean.	Dry bulb. Highest.	Dry bulb. Lowest.	Dry bulb. Mean.	Wet bulb. Highest.	Wet bulb. Lowest.	Wet bulb. Mean.	Sur. water. Highest.	Sur. water. Lowest.	Sur. water. Mean.	Winds. Direction.	Winds. Force.	Weather.	Clear sky, in tenths.	Rain.
1888.	° ′ ″	° ′ ″																	
July 1	San Francisco.		30.14	29.98	30.06	71	54	62.5	65	53	59	63	58	60.5	SW	0–3½	Clear	6–9	0
2	...do		29.98	29.84	29.91	73	57	65	67	57	62	66	59	62.5	SW. and WSW	1–2	....do	7–9	0
3	....do		30.02	29.90	29.96	70	57	63.5	65	57	61	62	58	60	SW	0–4	....do	8–9	0
4	37 54 00	122 40 30	30.04	29.96	30.00	71	52	61.5	65	52	58.5	63	49	56	SW., NNW., WNW.	1–4	Fair	2–9	0
5	40 18 00	124 28 00	30.06	29.98	30.02	55	51	53	54	52	53	53	48	50.5	WNW., NW., NW. by N.	2–7	....do	7–9	0
6	42 29 00	129 34 00	30.10	30.00	30.05	55	55	55	55	50	51.5	52	48	50	NNW., NW., N	4–7	....do	8–9	0
7	45 04 00	124 04 00	30.08	29.98	30.03	62	53	57.5	60	54	57	59	47	53	N., NW., W	1–6	...do	5–9	0
8	48 09 00	124 57 00	30.08	29.92	30.00	63	58	60.5	60	57	58.5	60	52	55.5	W., NW., NNW., SW.	1–4	Overcast to fair	0–9	0
9	Esquimalt.		30.16	29.98	30.07	61	54	57.5	60	54	57	64	51	55.5	SW., SE., SSE	0–6	Fair	0–8	Light.
10	Departure Bay.		30.16	30.08	30.12	69	50	59.5	68	50	59	66	53	58.5	ESE., E	0–2	....do	5–9	0
11	.. do		30.18	29.94	30.06	69	52	60.5	67	50	58.5	66	58	62	E., NE	0–2	Clear	6–9	0
12	....		30.16	29.94	30.05	58	56	57	57	55	56	60	50	55	SSW. to NW	1–5	Overcast to fair	0–8	Light.
13	Beaver Harbor.		30.30	30.14	30.22	56	53	54.5	55	53	54	56	52	54	SW. to ENE	0–3	Overcast to cloudy.	0–4	Light.

26. *Record of meteorological observations by the steamer Albatross, etc.*—Continued.

Date.	Latitude north.	Longitude west.	Barometer.			Thermometer, Fahrenheit.									Winds.		Weather.	Clear sky, in tenths.	Rain.
			Highest.	Lowest.	Mean.	Dry bulb.			Wet bulb.			Sur. water.			Direction.	Force.			
						Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.					
1888.	° ′ ″	° ′ ″																	
July 14	51 19 00	132 26 00	30. 34	30. 26	30. 30	55	54	54. 5	55	53	54	56	54	55	SW. by S. to SE. by S.	2– 4	Overcast, fog..	0– 3	Moderate.
15	52 15 00	137 13 30	30. 40	30. 28	30. 34	54	53	53. 5	54	53	53. 5	54	52	53	SSW. to SE	2– 4	Overcast	0– 3	Light.
16	52 35 00	142 34 00	30. 30	30. 20	30. 25	53	49	51	53	50	51. 5	52	51	51. 5	SW. to SE......	2– 5	Fog to fair....	0– 8	Light.
17	52 35 00	147 14 00	30. 40	30. 30	30. 35	51	48	49. 5	50	49	49. 5	51	50	50. 5	SW .	2– 3	Overcast	0– 7	Light.
18	51 58 00	152 12 00	30. 40	30. 26	30. 33	52	49	50. 5	52	48	50	51	50	50. 5	S. by W. to ESE.	1– 3	Overcast to fair	0– 5	Light.
19	52 11 00	157 44 00	30. 24	30. 16	30. 20	51	50	50. 5	51	49	50	51	48	49. 5	SE. to NW	0– 4	Fog.	0	Light.
20	52 25 00	162 40 00	30. 22	30. 14	30. 18	55	50	52. 5	55	50	52. 5	51	49	50	NW. to ESE...	0– 2	Fog to cloudy.	0– 2	Light.
21	52 50 00	166 42 00	30. 26	30. 22	30. 24	54	51	52. 5	53	51	52	51	48	49. 5	E. to SSW. ...	2– 3	Fog...........	0	Light.
22	53 40 00	164 28 50	30. 30	30. 20	30. 25	52	50	51	52	50	51	50	48	49	SSE., SE., ESE., E.	2– 3	....do	0	Light.
23	54 10 00	166 13 00	30. 20	29. 90	30. 05	58	48	53	57	48	52. 5	52	45	48. 5	ESE., ENE., SE.	2– 5	Foggy to fair..	0– 4	Light.
24	Iliuliuk.		29. 90	29. 80	29. 85	58	54	56	56	53	54. 5	53	52	52. 5	SE., ENE., ESE	2– 6	Fog, cloudy, and misty.	0– 4	Light.
																		0– 4	Light.
25	....do..........		30. 00	29. 86	29. 93	59	50	54. 5	56	49	52. 5	56	51	53. 5	SE	1– 5	Foggy	0– 3	Light.
26	....do.........		30. 00	29. 88	29. 94	57	50	53. 5	55	49	52	51	49	50	SE., NNW	0– 2	Overcast fair..	0– 7	0
27	....do..........		30. 00	29. 80	29. 90	55	50	52. 5	54	50	52	51	49	50	NE.............	0– 2	Fog...........	0–	Light.
28	53 56 00	166 07 00	29. 86	29. 72	29. 79	52	48	50	52	47	49. 5	52	47	49. 5	NE.............	0– 2	... do	0	Light.
29	54 11 00	164 46 00	29. 90	29. 86	29. 88	53	50	51. 5	52	50	51	52	49	50. 5	NE. to SW	1– 4	. do	0	Mod.
30	54 08 00	162 43 30	29. 86	29. 79	29. 82	52	50	51	51	50	50. 5	50	49	49. 5	SE	3– 4	....do	0	Light.
31	55 17 00	160 31 00	29. 86	29. 72	29. 79	53	51	52	53	51	52	51	49	50	S. to SE	2– 4	... do	0	Mod.
Aug. 1	55 20 00	160 32 00	29. 90	29. 78	29. 84	55	52	53. 5	55	52	52. 5	51	50	50. 5	SE. and SSE.....	2	.. do	0– 4	Light.
2	55 07 00	160 04 30	30. 18	29. 76	29. 92	59	51	55	58	51	54. 5	51	49	50	SE. to NW	0– 4	Fog, fair	0– 7	Light.
3	54 44 00	161 27 30	30. 24	30. 10	30. 17	56	50	53	55	49	52	51	49	50	SE., ESE	0– 3	Fair, foggy....	7– 0	Light.
4	54 56 00	159 54 00	30. 30	30. 10	30. 20	53	51	52	53	49	51	51	47	49	SW	3– 5	Fog, fair	0– 5	Light.
5	54 50 00	159 08 00	30. 50	30. 30	30. 40	54	50	52	53	49	51	52	48	50	SE. to SW.......	1– 4	Fair...........	9– 1	Light.
6	54 34 00	158 43 00	30. 54	30. 50	30. 52	58	50	54	56	50	53	53	50	51. 5	SSW	2– 3	Overcast, fair .	0– 7	0
7	55 45 00	158 25 00	30. 50	30. 38	30. 44	55	50	52. 5	54	49	51. 5	52	50	51	SSW	1– 3	Fair...........	0– 6	0
8	55 43 00	157 24 00	30. 38	30. 30	30. 34	57	53	55	56	52	54	53	50	51. 5	SSW	0– 3	Fog...........	0	Light.
9	56 07 00	154 39 00	30. 30	30. 26	30. 28	58	50	54	57	50	53. 5	54	48	51	WSW...........	1– 3	Fog, fair	0– 9	Light.
10	57 00 00	153 20 30	30. 32	30. 24	30. 28	73	52	61. 5	73	51	61	58	51	54. 5	SW., WSW	0– 3	Clear.........	7– 9	0
11	57 01 00	155 12 00	30. 42	30. 32	30. 37	67	51	59	66	51	58	60	51	55. 5	SSW	0– 2	....do	6–10	0
12	Old Harbor, Kadiak.		30. 58	30. 44	30. 51	60	52	56	59	52	55. 5	56	53	54. 5	SW	0– 4	Fog, fair	0– 9	Light.
13	57 20 00	152 13 00	30. 56	30. 48	30. 52	57	51	54	56	50	53	54	49	51. 5	SW	3– 4	.. do	0– 9	Light.
14	St. Paul, Kadiak.		30. 48	30. 32	30. 40	63	51	57	60	53	56. 5	55	49	52	SW	0– 3	Fog, clear	0–10	0
15	....do..........		30. 32	30. 10	30. 21	69	51	60	66	51	58. 5	55	49	52	SW	0– 2	Fair...... ...	4– 9	0
16	....do..........		30. 10	29. 84	29. 97	57	53	55	57	52	54. 5	53	51	52	NE. to SE......	0– 2	Fair, fog	8– 0	Light.
17	....do..........		29. 80	29. 58	29. 69	63	52	57. 5	59	50	54. 5	54	50	52	ESE. to ENE ..	1– 2	Foggy to fair..	0– 6	Light.
18	....do..........		29. 64	29. 5[illegible]	29. 61	57	54	55. 5	56	54	55	52	51	51. 5	N	2– 4	Fog...........	0	Light.
19	....do..........		29. 90	29. 64	29. 77	60	53	56. 5	57	52	54. 5	54	51	52. 5	N	1– 2	Fog to fair....	0– 6	Light.
20	....do..........		20. 00	29. 90	29. 95	61	53	57	60	52	56	54	51	52 5	N. to NE.......	0– 2	Fair...........	2– 8	0
21	...do..........		30. 06	30. 00	30. 03	61	51	56	60	51	55. 5	54	50	52	N. to NE. by E ..	0– 3	Fair to overcast	9– 0	0
22	58 07 00	151 33 00	30. 14	30. 04	30. 09	68	54	61	63	53	58	57	52	54. 5	N. to WSW......	0– 3	Fair	2– 9	0
23	58 31 00	150 56 00	30. 18	30. 12	30. 15	64	55	59. 5	60	54	57	56	53	54. 5	Variable	0– 2	Fair to overcast	9– 0	0
24	58 17 00	148 36 00	30. 20	30. 16	30. 18	62	56	59	59	56	57. 5	59	56	57. 5	N. to E	0– 3	Fair	3– 9	0
25	59 06 00	147 30 00	30. 16	29. 70	29. 93	64	54	59	61	54	57. 5	59	53	56	ENE., N. to WNW	0– 4	Overcast to fair	0– 9	Light.
26	Middleton Island		29. 72	29. 56	29. 64	61	54	57. 5	59	54	56. 5	58	52	55	Variable	2– 4	Fair	5– 9	0
27	59 09 00	142 51 00	29. 72	29. 60	29. 66	66	59	62. 5	66	58	62	60	58	59	... do....... ...	2– 3	Fair to overcast	7– 0	Light.
28	57 44 00	139 30 00	30. 16	29. 66	29. 91	60	56	58	60	55	57. 5	60	58	59	W., S. to ESE..	0– 3	Overcast to fair	0– 9	Mod.
29	55 28 00	136 25 00	30. 30	30. 18	30. 24	65	57	61	65	56	60. 5	60	56	58	Variable	0– 2	Fair	4– 9	0
30	53 18 00	133 55 00	30. 22	30. 10	30. 16	79	56	67. 5	70	56	64	60	57	58. 5	NNW., SW	1– 4	Overcast to fair	0– 9	0
31	51 24 00	130 29 00	30. 26	30. 12	30. 19	79	59	69	72	59	65. 5	60	55	57. 5	N. to WSW	0– 2	Clear, foggy...	9– 0	0
Sept. 1	50 50 00	127 43 00	30. 28	30. 12	30. 20	67	54	60. 5	65	53	57	60	52	56	NE. to WSW ...	0– 3	Fog, fair	0-7 to 9	Light.
2	50 15 00	125 25 00	30. 14	29. 96	30. 05	79	52	65. 5	73	52	62. 5	69	50	59. 5	W. to E	0– 2	Fog, clear	0–10	0
3	Departure Bay.		30. 00	29. 86	29. 93	70	62	66	66	61	63. 5	67	60	63. 5	SW., E., NE ...	0– 3	Clear to fair...	10– 2	0
4	......do.........		30. 08	29. 98	30. 03	64	59	61. 5	63	59	61	64	59	61. 5	NE., E	0– 2	Overcast to fair	0– 8	Mod.
5	48 57 00	... ...	30. 24	30. 08	30. 16	60	55	57. 5	59	55	57	62	53	57. 5	E. to SSE	0– 3	Fair, overcast .	8– 0	Light.
6	Seattle, Wash.		30. 34	30. 24	30. 29	70	58	64	68	57	62. 5	64	52	58	Variable	0– 2	Overcast, fair	0– 8	0
7	...do..........		30. 32	30. 12	30. 22	68	58	63	65	57	61	61	54	57. 5	N., W	0– 3	Clear...... ..	8–10	0
8	...do..........		30. 20	30. 04	30. 12	68	55	61. 5	66	55	60. 5	62	56	59	W	0– 1	Clear, foggy, fair.	10–0–8	0
9	.. do		30. 18	30. 12	30. 15	64	57	60. 5	64	56	60	61	56	58. 5	S., SW	0– 1	Foggy, clear...	0–10	0
10	...do		30. 16	29. 92	30. 04	73	51	62	65	52	58. 5	60	55	57. 5	N., W.	0– 4	Clear..........	9–10	0
11	. do..........		29. 96	29. 82	29. 89	72	51	61. 5	67	51	59	62	56	59	SE., W..........	0– 2	Fair, fog	9– 0	0
12	....do..........		30. 04	29. 88	29. 96	70	54	62	67	54	60. 5	60	57	58. 5	SE. to WSW....	0– 2	....do	9– 0	Light.
13	...do..........		30. 26	30. 06	30. 16	67	58	62. 5	65	57	61	64	56	60	Variable	0– 4	Misty to clear.	0– 9	Light.
14	. do		30. 16	29. 86	30. 01	76	55	65. 5	70	55	62. 5	61	55	58	NW., WSW., W .	0– 3	Clear..........	10	0
15	....do..........		30. 00	29. 84	29. 92	65	59	62	63	59	61	61	55	58	W., WSW	0– 2	Foggy	0	0
16	.. do..........		29. 96	29. 90	29. 93	66	59	62. 5	65	58	61. 5	59	56	57. 5	E. to S	0– 2	Foggy and misty.	0– 4	Light.
17	47 44 00	122 26 00	30. 16	29. 96	30. 06	64	54	59	61	54	57. 5	58	50	54	S. to NNW	0– 4	Squally to clear	0– 9	Light.
18	Port Townsend.		30. 30	30. 08	30. 19	60	51	55. 5	58	51	54. 5	54	50	52	SSE., NE., N., SSW., SW.	0– 1	Clear, fair, misty.	10–7–0	0

26. *Record of meteorological observations by the steamer Albatross, etc.*—Continued.

Date.	Latitude north.	Longitude west.	Barometer.			Thermometer, Fahrenheit.									Winds.		Weather.	Clear sky, in tenths.	Rain.
						Dry bulb.			Wet bulb.			Sur. water.							
			Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Direction.	Force.			
1888.	° ′ ″	° ′ ″																	
Sept. 19	48 00 00	126 02 00	30.06	29.82	29.94	62	53	57.5	62	53	57.5	61	52	56.5	ENE., ESE., SSE., S.	2–6	Squally and misty.	0–2	Light.
20	48 08 00	125 02 00	30.02	29.84	29.93	60	56	58	61	55	58	59	52	55.5	SE. by E. to S....	2–5	Squally	0–7	Light.
21	47 52 00	124 45 00	30.34	30.02	30.18	63	58	60.5	62	58	60	59	56	57.5	Variable	1–3	Fair to clear ..	5–9	Light.
22	46 48 00	124 55 00	30.40	30.32	30.36	60	56	58	59	55	57	60	56	58	NNW. to NNE..	2–4	Clear to fair ..	10–7	0
23	46 48 00	124 54 00	30.50	30.42	30.46	63	57	60	62	57	59.5	62	58	60	WNW. to NE ...	2–4	Clear..........	8–10	0
24	48 27 00	124 56 00	30.50	30.36	30.43	63	55	59	59	55	57	58	50	54	NW. by N. to ENE	1–4	....do	8–10	0
25	48 33 00	125 14 00	30.34	30.14	30.24	67	55	61	63	54	58.5	59	49	54	WNW. to E	0–3	.. do	10	0
26	49 00 00	125 48 00	30.14	30.02	30.08	74	56	65	68	56	62	62	54	58	N to ESE	0–1	....do	10	0
27	Barclay Sound, British Columbia.		30.04	29.94	29.99	84	59	71.5	71	59	65	60	57	58.5	Variable	0–1	....do	10	0
28	....do		30.18	30.04	30.11	60	55	57.5	60	55	57.5	59	57	58	....do	0–1	Foggy to clear.	0–9	0
29	48 27 00	125 09 00	30.16	30.08	30.12	58	53	55.5	57	52	54.5	58	52	55	NE., SE., S., SSW.	0–3	Foggy	0–4	Light.
30	48 13 00	123 32 00	30.20	30.14	30.17	58	54	56	57	54	55.5	54	51	52.5	NNE., SSE	0–2	.. do	0	0
Oct. 1	47 44 00	122 26 00	30.20	30.14	30.17	62	57	59.5	61	56	58.5	60	53	56.5	SE., WSW	0–1	....do	0	0
2	Seattle, Wash.		30.14	30.08	30.11	63	59	61	62	58	60	60	57	58.5	SW., WSW	0–2	Overcast	0	0
3	....do		30.08	30.00	30.04	63	57	60	62	56	59	61	56	58.5	SW	0–1	Foggy, fair, clear.	0–7–10	0
4	47 43 00	122 27 00	30.08	29.94	30.01	63	53	58	61	52	56.5	58	52	55	NW., to NE	0–2	Fair......	8–9	0
5	Port Townsend, Wash.		29.98	29.80	29.89	65	52	58.5	61	51	56	55	50	52.5	NE., WNW	0–2	Fair to clear ..	7–10	0
6	Victoria Harbor, British Columbia.		30.02	29.88	29.95	58	53	55.5	59	52	55.5	53	50	51.5	SSE. NNE., NW., NE.	0–2	Clear to overcast.	10–0	Light.
7	48 59 00	123 24 00	30 04	29.94	29.99	58	52	55	57	51	54	57	50	53.5	NW., NNE. to SSE.	0–2	Overcast	0–5	Moderate.
8	Departure Bay, British Columbia.		30.22	29.94	30.08	60	51	55.5	59	50	54.5	57	52	54.5	Variable	0–3	Overcast to fair	0–8	Light.
9	...do		30.26	30.20	30.23	63	51	57	61	49	55	56	51	53.5	...do	0–3	Fair to overcast	8–0	Light.
10	48 39 00	123 15 00	30.28	30.22	30.25	55	51	53	64	50	57	55	49	52	... do	0–3	Overcast to fair	0–8	Light.
11	47 03 00	124 20 00	30.22	29.80	30.01	61	54	57.5	61	53	57	60	55	57.5	E. by N. to S.....	1–7	Fair to overcast	8–0	Light.
12	46 07 00	125 14 00	30.34	29.84	30.09	61	58	59.5	60	56	58	63	59	61	SE. to WNW....	3–8	Squally, fair...	2–6	Light.
13	46 08 00	124 45 00	30.46	30.38	30.42	64	57	60.5	60	54	57	62	56	59	WNW. to SE....	0–4	Overcast to fair	0–8	Light.
14	Astoria, Oregon.		30.40	30.22	30.31	63	56	59.5	60	55	57.5	61	56	58.5	Variable	0–3	.. do	0–8	Light.
15	...do		30.20	29.96	30.08	63	54	58.5	60	53	56.5	62	57	59.5	....do	0–2	do	0–7	Light.
16	....do		30.02	29.94	29.98	71	55	63	64	53	58.5	60	57	58.5	do	0–3	Overcast......	0–2	Light.
17	...do		30.38	30.04	30.21	71	50	60.5	63	49	56	61	57	59	NW. to W., E ..	1–4	Overcast to c ear.	0–9	0
18	46 14 00	124 03 00	30.38	30.04	30.21	62	49	55.5	61	49	55	61	55	58	N. to SSE	0–4	Fair.	2–7	0
19	43 59 00	125 03 00	30.36	30.08	30.22	68	56	62	64	54	59	60	57	58.5	Variable	0–3	Overcast to clear.	0–10	Light.
20	40 42 00	124 52 00	30.36	30.16	30.26	63	55	59	61	54	57.5	59	50	54.5	N. to NW	3–6	Fair to clear..	7–10	0
21	37 49 00	122 28 30	30.16	30.02	30.09	75	54	64.5	70	53	61.5	63	52	57.5	W. to NNE......	1–4	Clear	9–10	0

27. OBSERVATIONS OF WIND, WEATHER, AND BAROMETER.

From the 1st to the 4th of July daily sea breezes prevailed in San Francisco from the southwest with clear weather, the barometer ranging from 29.84 to 30.06.

Leaving port on the latter date, we carried a light southwest wind nearly to Point Reyes, where it hauled to the northward and westward, increasing to a moderate gale the following day, with a heavy head sea.

It moderated after we passed 45° 00′ 00″ north latitude, and in the Straits of Fuca we had a fresh breeze from southwest to southeast. It was fair to clear weather, except in the region of Cape Flattery and the Straits of Fuca, where it was partially overcast.

Light to moderate southeast to southwest winds with generally fair weather prevailed in the inland waters of British Columbia from the 10th to the 13th of July, although some portion of each day was foggy. The barometer ranged from 29.94 to 30.30.

From Vancouver Island to Unalashka, light to moderate southwest and southeast winds were encountered until the 20th, and easterly winds thence to port, where we arrived on the 23rd. The weather was misty at all times, and frequently overcast or foggy, the sun appearing at intervals, however, until the 20th, after which a dense fog prevailed. Light rain fell during some portion of each day. The barometer was high during the prevalence of southwest winds, ranging from 30.16 to 30.40, but fell gradually to 29.80, with winds from the eastward.

Easterly winds and foggy, rainy weather prevailed in Iliuliuk until the 28th, although the sun came out brightly on one or two occasions. The barometer ranged from 29.72 to 30.00.

It partially cleared for a few hours on the afternoon of the latter date, then the fog shut down until our arrival in Humboldt Harbor on the 31st. The winds were from northeast to southeast, light to moderate, the barometer ranging from 29.90 to 29.72. A breeze came out from northwest on the following day, and from 6 a. m. to meridian it was clear, but a change to southeast brough. the fog in again for the remainder of the day.

It cleared for an hour on the morning of the 2nd, shut in again until noon, then cleared for several hours during the afternoon.

August 3 was clear most of the time until 2 p. m., when the fog shut in for the remainder of the day. The winds continued from the eastward until the 4th, then hauled to southwest with rising barometer and clearing weather.

They held in the same quarter from light to moderate in force until August 15, the day following our arrival in St. Paul, Kadiak. Four days were fair or clear, six days foggy, with clear weather at intervals, and one day of dense fog. Rain fell on five days, very light, however, little more than a heavy mist. The barometer ranged from 30.10 to 30.58.

We remained in St. Paul until the 21st, north to east winds prevailing. The weather was generally fair with intervals of fog and rain. A dense fog prevailed during the 18th, wind north, light to moderate, the barometer falling to 29.58. Light rain fell during four days.

Light northerly winds prevailed until our arrival at Middleton Island on the 25th. The weather was generally fair, although there were intervals of fog on two days; barometer from 30.20 to 29.70, falling to 29.56 the following day, yet the weather continued clear and pleasant, except two or three hours of fog in the evening. Light rain fell on the 25th.

Leaving the island on the evening of the 26th, we had light variable winds and frequent calms until our arrival in Departure Bay on the morning of September 3. The weather was generally fair, with intervals of fog, except on two days, which were from fair to clear. Light rains are recorded on two days and moderate rain one day. The barometer ranged from 29.60 to 30.30.

Leaving port on the morning of September 5, we had rainy, misty weather during the day, and overcast, partially foggy weather the following morning, clearing after we entered Puget Sound. We arrived in Seattle during the afternoon, where we remained until the 17th. Light variable winds and frequent calms prevailed, with generally fair weather, although the mornings were foggy as a rule, and light rains occurred on five days, usually at night or early morning. Barometer 29.82 to 30.34.

We left Port Townsend on the 18th of September and cruised off the coast of Washington Territory until the 23rd, and Vancouver Island until the 29th, finally returning to Seattle October 2. Light variable winds prevailed on the day of our departure, followed by a moderate gale from southeast the following day, variable winds on the 21st, light to moderate breeze from northwest to northeast until the 26th, and light variable airs with frequent calms until our return to port. The first three days were misty or rainy, followed by six fair or clear days, then five days of continuous fog, light rain falling during four days. The barometer ranged from 29.82 to 30.50.

Light variable winds with fair weather prevailed in Seattle from October 2 to 4, light northeast to west-northwest winds in Port Townsend on the 5th, with clear weather. Variable winds and light rain were encountered in Victoria, British Columbia, on the 6th. Fair weather prevailed at Departure Bay from the 7th to the 10th, with intervals of fog and rain. The same conditions prevailed on the 11th in the Straits of Fuca and off Cape Flattery, and on the 12th a fresh gale from southeast to west-northwest occurred off the Columbia River, followed by moderate winds from west-northwest on the 13th, light rain having fallen every day since the 6th. Light variable winds and frequent calms with partially clear weather prevailed in Astoria, Oregon, from the 14th to the 18th. Light rains fell on three days. The same conditions prevailed on the 19th on Heceta Bank, followed on the 20th by a moderate gale from northwest to north, moderating the following day as we approached the harbor of San Francisco.

The barometer was very unsteady from the 1st of October, oscillating between 29.80 and 30.46, the average being 30.12.

Attention is called to the meteorological table on pages 82 to 84 of this report where the extreme and mean climatic conditions are recorded for each day.

28. OBSERVATIONS, RELATIVE TO OCEAN CURRENTS.

From San Francisco to the Straits of Fuca the currents were to the southward and eastward, in the general direction of the coast line, and averaged 15 miles per day.

Tidal influences only were felt through the inland passages of British Columbia; and from the north end of Vancouver Island to 143° 00′ 00″ west longitude the set was northerly, about 13 miles per day. It then changed to the southward and eastward (about S. 22° E.), averaging 8 miles per day until we reached the island of Unalashka, near its western end. Thence to Unimak Pass it was about N. 75° W. one-half mile per hour.

From the pass to Unalashka we were near the land and affected by tidal influence.

The same may be said when on leaving port we steamed through Unalga Pass and to the eastward parallel with the islands until we took a departure for Ugomok.

A current of about one-half mile per hour N. 70° W. was encountered in running a line of soundings 45 miles off shore and returning. It may have been the result of tides, as the vessel was within their influence several hours.

Steaming across Unimak Pass to Promontory Cape the tide only was noticed. Thence to the east side of the Sannakhs a current of three-fourths mile per hour was encountered setting to the northward and eastward, and between the latter group and the Shumagins the set was in the same direction, about one-half mile per hour.

Strong tides were found among the islands of the above group.

A subsequent run from the Sannakhs to Bird Island on August 4, developed a current of 1 knot per hour S. 68° W., so it will be seen that the currents are not uniform, and it is more than probable that they are affected by the tides.

While engaged in sounding off the east and south shores of the Shumagins, from Atkin Island to Chernabour, a current of seven-tenths mile per hour was found setting S. 53° E.; and from Castle Rock N. 84° E. 65 miles, thence to Mitrofania Island we found it was setting N. 18° W., about one-half mile per hour.

From Mitrofania Island to Light-house Rocks, and thence to Trinity Islands, the current was about N. 78° E., three-fourths mile per hour.

We were within the influence of the tidal streams much of the time while off the east coast of Kadiak, which affected us more or less according to our distance from land, and made it difficult to determine the amount of drift. The resultant of tides and currents indicated a set of about one-fourth mile per hour to the northward and eastward.

On Portlock Bank north and east from Kadiak we found a current of four-tenths mile per hour S. 24° W. to longitude 151° 00′ 00″ W., S. 65° W. three-tenths mile per hour to 148° 30′ 00″ W., and S. 10° E. four-tenths mile per hour to 147° 30′ 00″ W., increasing in force and taking a more easterly direction as we approached Middleton Island.

From the island to the reported position of Pamplona Rocks, and thence to latitude 55° 30′ 00″ north, the current was to the northward and westward, averaging six-tenths mile per hour, and S. 60° W. one-half mile per hour to the south end of the Queen Charlotte Islands when we again came within the influence of the tides.

From September 19 to October 21, between Cape Flattery and San Francisco, the current was to the southward and eastward, averaging about three-tenths mile per hour, except during one day off Gray's Harbor and Shoalwater Bay, where it set north four-tenths mile per hour.

29. PARTIAL LIST OF HARBORS AND ANCHORAGES BETWEEN KADIAK ISLAND AND UNALASHKA ISLAND.

The following list of harbors and anchorages is inserted in this report chiefly for the purpose of calling the attention of strangers to localities where vessels have found shelter. The information respecting them was obtained principally from local authorities, very few having been visited by the *Albatross*. In dealing with this information it should be borne in mind that the vessels navigating the regions in question are for the most part light, handy schooners, and the availability of a harbor is very apt to be considered with reference to the craft in which the informant has been in the habit of sailing. Some of the harbors are designated as good for all classes of vessels, and here again a word of caution may be necessary, as the largest vessel ever seen among the islands was probably a sloop-of-war.

The positions given are approximate, and are only intended as a guide to enable the navigator to recognize localities in case of confusion or absence of names on his chart. The list is arranged with reference to longitude, from east to west. Too much dependence should not be placed on any of the charts of this region, as very few accurate surveys have been made, and most of the data are from the reconnaissances of early Russian navigators. The eye and the lead will continue to be the most reliable guides until the region has been properly surveyed.

List of harbors and anchorages.

Latitude N.	Longitude W.	Harbors and anchorages.
° ′ ″	° ′ ″	
57 37 00	152 00 00	Cape Greville to Low Cape, Kadiak Island. Anchorage may be found near the shore protected from northerly winds.
57 26 00	152 09 00	
57 37 00	152 05 00	Chiniak Bay, Kadiak Island. Anchorage protected from winds from west to southeast.
57 47 57	152 21 21	Harbor of St. Paul, Kadiak Island. Outer and inner harbor, the former good for all classes. See Coast Survey chart No. 776.
57 24 00	152 08 00	Ugak Island. Anchorages on northwest and northeast extremities of the island, on either side of the sand point.
58 12 00	152 18 00	Ujut Bay, Afognak Island. Good harbor for all classes of vessels on the west side of the bay.
57 55 00	152 25 00	Narrow Strait. Anchorage for all classes, off the settlement near the west end of Spruce Island, between it and Kadiak.
57 28 00	152 36 00	Ugak Bay, Kadiak Island. Good harbor for all classes. There are rocks in the entrance which are easily avoided in moderately clear weather.
57 58 00	152 48 00	Between Kadiak, Afognak, Raspberry, and Whale Islands, at the eastern end of Northern Strait. Good anchorage for all classes.
57 10 00	152 57 00	Port Hobron. Sitkalidak Island. The second bay inside Cape Barnabas. Good harbor for all classes. There are other harbors on the northeast and southwest sides of the island.
57 18 00	153 00 00	Kiliuda Bay, Kadiak Island. Good harbor for all classes. Several good harbors in the bay.
57 11 00	153 13 00	Old Harbor, Kadiak Island. A good harbor for all classes. Surrounded by land of moderate elevation, and not liable to violent squalls. It lies in the strait north of Lisiansky Bay off an Indian village formerly called Old Village, now called Three Saints by the natives.
57 09 00	153 17 00	Lisiansky Bay, north of Bay of Three Saints. Good harbor for all classes. It lies between the Bay of Three Saints and Old Harbor.
57 10 00	153 20 00	Bay of Three Saints, Kadiak Island. Good harbor for all classes, but it is surrounded by high land and subjected to furious "woollies" (squalls) in bad weather.
57 00 00	153 20 00	Kiyavak Bay, Kadiak Island. There are several anchorages in this bay.
56 51 00	153 40 00	Alsentia Bay, Kadiak Island. Anchorage for all classes, but open to northeast winds when a heavy swell rolls in.
56 43 00	153 58 00	Russian Harbor, Kadiak Island. Good harbor for all classes.
56 29 00	154 00 00	Trinity Islands, south of Kadiak. Anchorage may be found off the islands in good weather, but they have no harbors. Tugidak is very low with shoal water extending some distance from the shore.
55 53 00	155 24 00	Chirikoff Island. See Coast Survey chart No. 786. Anchorage near northeast extremity.
55 48 00	155 33 00	Chirikoff Island. See Coast Survey chart No. 796. Anchorage off southwest extremity.
57 08 00	156 18 00	Agripin Bay, mainland. Good harbor for small vessels.
57 05 00	156 28 00	Port Wrangel, mainland. Good harbor for all classes.
56 02 00	156 41 00	Chowee-et Island, Semidi Islands. Anchorage for all classes under northeast end of island. See Coast Survey chart No. 786.
56 01 00	156 44 00	Chowee-et Island. See Coast Survey chart No. 786. Anchorage under northwest side of the island for all classes.
56 18 00	156 51 00	Aghik Island, Semidi Islands. Anchorage for all classes on the east side of the island. See Coast Survey chart No. 786.
56 18 00	156 55 00	Aghik Island. See Coast Survey chart No. 786. Anchorage for all classes on the west side of the island.
56 24 00	158 07 00	Chignik Bay, mainland. There are several anchorages in the bay, the best one being under Southwest Point. The outer one between Chankliut Island and the Point. See Coast Survey chart No. 797.
55 57 00	158 39 00	Mitrofania Bay, mainland. Mitrofania Harbor, first bay on the east side of the entrance to Mitrofania Bay. Good harbor for all classes. Fish Ranch Bay, second bay on east side of entrance to Mitrofania Bay. Anchorage for all classes. Open to southerly winds.
55 58 00	158 47 00	Long Beach. West side of Mitrofania Bay. Anchorage for all classes. Open to southerly winds.
55 52 00	159 05 00	Chiachi Island. Anchorage for all classes on the northeast and north sides of the islands. See Coast Survey chart No. 798.
55 52 00	159 08 00	Chiachi Island. See Coast Survey chart No. 798. Anchorage for all classes on northwest side of the island.
54 55 30	159 15 03	Simeonoff Island, Shumagin Group. Simeonoffsky Harbor. Good for small vessels, but difficult of entrance. See Coast Survey chart No. 808.
55 46 00	159 18 00	Jacob Island. Harbor at north end of Jacob Island, between it and Paul Island. Good for all classes.
54 56 00	159 19 00	Twelve Fathom Straits, Shumagin Islands. Anchorage for all classes with protection from easterly winds. See Coast Survey chart No. 806.
55 02 00	159 21 00	Little Koniushi, Shumagin Group. Sandy Cove. Good anchorage for all classes. Open to easterly winds. See Coast Survey chart No. 806.
55 49 00	159 21 00	Alexander Point, mainland. Anchorage on the east side of the Point for 10 miles. Small islands break the swell.
54 58 25	159 22 18	Northeast Harbor, Little Koniushi, Shumagins. Good harbor for all classes. See Coast Survey chart No. 808.
55 03 18	159 23 25	Northwest Harbor, Little Koniushi. Good harbor for all classes. See Coast Survey chart No. 756.
55 33 00	159 27 00	Ivanoff Bay, mainland. Good harbor for all classes.
55 04 00	159 30 00	Big Koniushi Island. Yukon Harbor. Good for all classes. Anchorage may be had in many places on both sides of Big Koniushi Island. See Coast Survey chart No. 756.
54 46 00	159 31 00	Chernabour Island, Shumagin Group. Anchorage on east side of island. Open to all except westerly winds.
55 44 00	159 42 00	Fox Bay, mainland. Harbor for all classes. Partially exposed to westerly winds.
55 37 00	159 46 00	Boulder Bay, mainland. Anchorage for small vessels. Protected from easterly winds.
55 08 00	159 48 00	Mist Harbor, Nagai Island, Shumagin Group. Good harbor for small vessels.
55 06 00	159 55 00	East Bight, Nagai Island. Good harbor for small vessels. Anchorages may be found in many places on either side of Nagai, near the island.
55 07 36	159 56 06	Sanborn Harbor, Nagai Island. Excellent harbor for all classes. It is a deep bay surrounded by high land, and sailing vessels avoid it on account of frequent and long-continued calms. See Coast Survey chart No. 813.

List of harbors and anchorages.—Continued.

Latitude N.	Longitude W.	Harbors and anchorages.
° ′ ″	° ′ ″	
55 08 00	160 03 00	Eagle Harbor, Nagai Island. Excellent harbor for all classes. See Coast Survey chart No. 808.
55 03 30	160 06 00	Falmouth Harbor, Nagai Island. Excellent harbor for all classes. See Coast Survey chart No. 808.
55 28 00	160 10 00	Korovin Island. Anchorage under northeast end of the island. Open to the northward and eastward.
55 22 00	160 19 00	Popoff Island. Pirate Cove. Good harbor for small vessels.
55 17 00	160 24 00	Popoff Island. Red Cove. Anchorage for all classes. Open to south and southwest. See Coast Survey chart No. 814.
55 11 00	160 30 00	Delaroff Harbor, Unga Island, Shumagin Group. For all classes. Open to southeast winds which send in a heavy swell.
55 13 00	160 30 00	Barloff Harbor, Unga Island. Good harbor for all classes.
55 19 17	160 30 58	Humboldt Harbor, or Sandy Point, Popoff Island. Good harbor for all classes. Position given is for Sandy Point. See Coast Survey chart No. 814.
55 36 00	160 35 00	Portage Bay, mainland. Good harbor for all classes.
55 20 45	160 38 39	Coal Harbor, Unga Island. Good harbor for all classes. Position given—east extremity of Round Island. See Coast Survey chart No. 815.
55 21 00	161 10 00	Coal Bay, mainland. Good harbor for all classes.
55 13 00	161 23 00	Wosnesensky Island. Anchorage under the southeast end.
55 14 00	161 24 00	Wosnesensky Island. Anchorage under the northeast end.
55 07 00	161 48 00	Dolgoi Bay, Dolgoi Island. Harbor for small vessels.
55 18 00	161 56 00	Volcano Harbor, Bear Bay, mainland. Good harbor for all classes.
55 09 00	161 58 00	Nicoloffsky Anchorage, mainland. First bay north of Moss Cape. Anchorage for all classes. Open to westerly winds.
55 04 00	162 00 00	Belkovsky Anchorage, Belkovsky Bay. Good anchorage for all classes. Open to easterly winds.
55 09 00	162 07 00	Bailey's Harbor, Belkovsky Bay. Good harbor for all classes.
55 07 00	162 09 00	Kitchen Anchorage, Belkovsky Bay. Good anchorage for all classes. Open to westerly winds.
54 58 00	162 16 00	Deer Island, Fox Island. Anchorage between Deer and Fox Islands. Good for all classes.
55 05 00	162 19 00	King's Cove, mainland. Harbor for all classes.
54 25 00	162 28 00	Caton Island, Sannakh Group. Anchorage between Caton and Sannakh Islands. For small vessels. It is a dangerous locality.
54 25 00	162 40 00	Pavloff Harbor, Sannakh Island. For small vessels.
54 26 00	162 48 00	Acherk Harbor, Sannakh Island. For all classes. Open from north to northwest. See Coast Survey chart No. 756.
54 55 00	162 50 00	Amagat Island. Anchorage for all classes under the north side of the island.
54 43 00	163 09 00	East Anchor Cove, Unimak Island. Anchorage for all classes.
54 42 00	163 12 00	West Anchor Cove, Unimak Island. Anchorage for all classes.
54 44 00	163 18 00	Loras Harbor, Unimak Island. For small vessels.
54 10 00	164 57 00	Ugamok Island—Ashmiahk Island. Anchorage between the islands for all classes.
54 05 00	165 04 00	The Nook, Tigalda Island. For small vessels.
54 14 00	165 34 00	Akun Cove, Akun Island. Anchorage for all classes. Open to easterly winds.
54 04 00	165 51 00	Vulcan Cove, Akutan Island. Anchorage for all classes. Open to southerly winds.
54 07 00	165 57 00	Akutan Harbor, Akutan Island. Good for all classes. Best anchorage near the north shore.
53 50 00	166 13 00	Gull Bay, Spirkin Island. For all classes.
53 56 00	166 17 00	English Bay, Unalashka Island. Good harbor for all classes.
53 53 00	166 32 00	Unalashka Bay. Iliuliuk Harbor and several good anchorages. See Coast Survey chart No. 821.
53 43 00	166 41 00	Makushin Bay, Unalashka Island. Good harbor for all classes.
53 29 00	167 03 00	Kashuga Harbor, Unalashka Island. Good for all classes.
53 25 00	167 22 00	Chernoffsky Harbor, Unalashka Island. Good for all classes.

30. *Record of whales seen during the season of* 1888.

Date.	Time.	Position.		Species.	Date.	Time.	Position.		Species.
		Latitude north.	Longitude west.				Latitude north.	Longitude west.	
1888.		° ′ ″	° ′ ″		1888.		° ′ ″	° ′ ″	
July 17..	10 a. m	52 36 00	146 51 00	Unknown.	Aug. 23	Meridian	58 31 00	150 56 00	Finback.
Do....	3 p. m	52 33 00	147 49 00	Do.	Do....	....do	58 31 00	150 56 00	Killer.
Do....	4 to 6 p. m	52 23 00	148 09 00	Do.	Aug. 24.	....do	58 17 00	148 36 00	Finback.
July 20..	Meridian	52 25 00	162 40 00	Do.	Do....	....do	58 17 00	148 36 00	Killer.
July 21..	4 to 6 p. m ..	53 02 00	166 56 00	Do.	Sept. 2..	4 to 8 a. m	50 31 00	126 38 00	Blackfish.
July 28..	8 a. m. to mer.	53 56 00	166 07 00	Killer.	Sept. 3..	Meridian	49 13 00	123 58 00	Do.
July 30..	Mer. to 4 p. m.	54 11 00	162 30 00	Unknown.	Sept. 21.	4 to 6 p. m	47 36 00	124 46 00	Unknown.
Aug. 5..	8 a. m. to mer.	54 53 00	158 50 00	Do.	Sept. 22.	5 a. m.........	47 04 00	124 39 00	Do.
Aug. 6..	Meridian	54 34 00	158 43 00	Do.	Sept. 23.	10 a. m. to mer.	46 41 00	124 40 00	Do.
Do....	....do	54 34 00	158 43 00	Killer.	Oct. 7...	8 a. m. to mer.	48 51 00	123 22 00	Killer.
Aug. 12.	4 to 6 p. m	56 52 00	153 08 00	Unknown.	Oct. 10..	.. do	48 54 00	123 18 00	Unknown.
Do....	6 to 8 p. m	56 35 00	152 54 00	Do.	Oct. 13..	4 to 6 p. m	46 16 00	124 28 00	Do.
Aug. 13.	Meridian	57 20 00	152 13 00	Finback.	Oct. 19..	Meridian	43 59 00	125 03 00	Do.
Aug. 21.	6 to 8 p. m	57 46 00	151 32 00	Unknown.					

31. REPORT OF THE ENGINEER'S DEPARTMENT.

BY C. R. ROELKER,

Passed Assistant Engineer, U S. Navy, in charge.

The following statement shows the work done in the engineer's department of this vessel from July 1 to October 21, 1888:

Total time covered by present report	days	113
Total time the fires were lighted in main boilers	hours	2,486$\frac{50}{60}$
Total time the fires were lighted in donkey boiler	do	240$\frac{15}{60}$
Total time the engines were in operation, including time spent in sounding, dredging, getting under way, etc	hours	1,311$\frac{23}{60}$
Total time the engines were in operation, with vessel on her course	do	1,078$\frac{32}{60}$
Total revolutions made by engines with vessel on her course:		
Starboard engine	number	4,249,444
Port engine	do	4,243,530
Mean revolutions made per minute	do	65.5
Total knots run	do	8,771.1
Mean knots run per hour	do	8.13
Mean slip of screws	per cent	15.33
Weight of fuel consumed in main and donkey boilers	tons	636$\frac{1700}{2240}$
Weight of fuel consumed in steam cutters	do	2$\frac{1780}{2240}$
Weight of fuel consumed in galley	do	12$\frac{2160}{2240}$
Total weight of fuel consumed	do	652$\frac{460}{2240}$
Amount of refuse in fuel consumed	per cent	15.3
Total weight of fuel consumed while engines were in operation	tons	521$\frac{200}{2240}$
Mean number of pounds of fuel consumed per hour	pounds	890
Total time the dynamo has been in operation	hours	566$\frac{22}{60}$

The main engines have worked quite satisfactorily, notwithstanding they were frequently subjected to severe strains. A single main boiler has been used at a time; up to July 13 the full grate surface of each boiler (58½ square feet) was used; after that date the grate surface was reduced to 45 square feet by bricking off 18 inches at the back of the grate in each furnace. Leaks have developed again in the bottom of the boilers, and some blisters have been formed in furnaces and back connections.

The fuel used during this cruise has been mainly Wellington and Nanaimo coal. The rapidity with which these coals ignite and produce steam is of special advantage when this vessel is engaged in sounding and dredging, and the demand for steam is intermittent and irregular. The large volumes of black smoke and soot produced are not only a source of annoyance and necessitate frequent sweeping of tubes and connections, but cause serious trouble, as the soot in the smoke-pipe ignites easily. The Wellington coal, which was mostly procured fresh from the mines at Departure Bay, Vancouver Island, gave results in steaming efficiency only slightly inferior to Welsh coal. Great precautions are necessary to prevent the spontaneous combustion of this coal in the bunkers. At Astoria, Oregon, smoke was observed to issue from the after port bunker. It was found that the rope covering on the auxiliary steam pipe was completely charred, and that a great heat had been developed in the surrounding coal. No actual ignition of the coal had taken place. The rope covering has been removed from all the pipes in the bunkers, and asbestus and hair-felt covering is being substituted and the pipes will be encased in wood.

The Nanaimo coal obtained at Unalashka had been stored in a closed warehouse; in steaming efficiency it was 13 per cent. inferior to Wellington coal. The Nanaimo coal taken on board at Kadiak had been left exposed to the weather, without any covering, and it appeared to have lost 18 per cent. in steaming efficiency on that account.

Thirty tons of Seattle coal, taken on board at Unalashka, were more or less mixed with the Nanaimo coal in the bunkers, so that no accurate test of its steaming efficiency could be made, but a marked falling off in the steam supply and an increase in the quantity of refuse were observed as soon as this lot of coal was used.

Twenty tons of patent fuel (Anchor brand), manufactured from Welsh coal slack, were taken on board at Esquimalt, Vancouver Island. Its steaming efficiency was about 12 per cent. less than that of good Welsh coal.

The selection of the most economical fuel depends on the cost of the fuel per ton and its steaming efficiency. In a vessel engaged in making regular passages between certain ports, the steaming efficiency is easily measured by the weight of fuel consumed per mile steamed. But when this vessel is engaged in its regular duties of sounding, dredging, and fishing, the value of the fuel must be determined by the amount of work which can be done, starting out with a full supply of fuel on board, before it is necessary to return to a base in order to replenish the supply. As the space available for the storage of fuel in the bunkers and on deck is limited, the bulk of a given weight of fuel is of importance; and as the demand for steam supply is intermittent and very irregular while the vessel is engaged in sounding, dredging, and fishing, a coal which ignites easily and produces steam rapidly, possesses considerable economic advantages.

I find that in our boilers Wellington coal, fresh from the mines, has produced about 2 per cent. less steam than an equal weight of good Welsh coal; but that about 10 per cent. more space is required to store a ton of Wellington coal than of Welsh coal. This vessel is therefore capable of carrying about twenty tons more of Welsh coal than of Wellington coal, and at our usual moderate rate of speed she would steam about 450 miles farther with the former coal. The superiority of Wellington coal, on account of the greater rapidity with which it ignites and generates steam, can not be expressed in exact figures, and varies according to the character of the work in which the vessel is engaged.

The Nanaimo and Seattle coals have about the same bulk as Wellington coal, and ignite with equal ease. The better quality of Nanaimo coal used by us was 13 per cent. inferior to Wellington coal in steaming efficiency. The relative value of the two coals, as measured by the actual useful work to be obtained from a full supply, would depend greatly on the distance of the base of supply from the field of work; the greater this distance the smaller the value of the inferior coal.

It would be wrong to draw general conclusions from the unsatisfactory results obtained by us from the small amount of Seattle coal taken on board at Unalashka. An examination of the coal shipped from the coal wharves at Seattle, Wash., disclosed great differences in character and in the amount of incombustible matter mixed with it.

Our experience with the Nanaimo coal procured at Kadiak proved how rapidly these coals deteriorate when exposed to the influence of the weather, especially in the damp climate of western Alaska. The coal should always be procured freshly mined, if possible, and when stored for future use it should be kept in a closed house.

The only serious accident to the machinery was the breaking of the connecting-rod strap of the dynamo engine, caused by an original flaw. Fortunately no further damage was done. As the accident occurred at sea we were deprived of the use of the electric plant for nearly two weeks, until a new steel strap was obtained at Seattle, Wash. The new gypsy-head fitted to the dredging engine for the purpose of reeling in the steel hawser works satisfactorily.

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2.—REPORT OF EXPLORATIONS MADE DURING THE SUMMER AND AUTUMN OF 1888, IN THE ALLEGHANY REGION OF VIRGINIA, NORTH CAROLINA AND TENNESSEE, AND IN WESTERN INDIANA, WITH AN ACCOUNT OF THE FISHES FOUND IN EACH OF THE RIVER BASINS OF THOSE REGIONS.

BY DAVID STARR JORDAN.

INTRODUCTION.

Under the instructions of the U. S. Commissioner of Fish and Fisheries, Hon. Marshall McDonald, the writer undertook to make a series of examinations of the different streams of the Alleghany region of Virginia, North Carolina, and Tennessee, and the streams of western Indiana. This examination had two general purposes: first, to ascertain the general character of the streams in question, their present stock of food-fishes and their suitability for the introduction of species not now found there; second, to catalogue the fishes native to each stream, whether food-fishes or not, in order to complete our knowledge of the geographical distribution of each species, and to throw light on the laws which govern geographical distribution.

In the present paper is given an account of each stream, a list of the fishes found in it, and such notes, zoölogical or economic, on each species as add to our knowledge of it.

In the work of the summer the writer had the very efficient help of his former students, Prof. Oliver P. Jenkins, of De Pauw University, Greencastle, Ind.; Prof. Barton W. Evermann, of the State Normal School, Terre Haute, Ind.; Prof. Seth E. Meek, of Coe College, Cedar Rapids, Iowa; and Mr. Charles H. Bollman, museum assistant in the Indiana University. The prosecution of the work was also materially aided by the help given by Mr. Richard Rathbun, assistant in charge of the work of scientific inquiry in the U. S. Fish Commission.

The discovery of new species of fishes, which amounted to fourteen in number, was a secondary feature of the work of the summer. These, with the permission of the Commissioner, I have described in a preliminary paper[1] in the Proceedings of the U. S. National Museum. The new species are as follows:

1. **Noturus gilberti** Jordan & Evermann. Roanoke River at Salem and Roanoke.
2. **Noturus furiosus** Jordan & Meek. Neuse River at Millburnie; Tar River at Rocky Mount.
3. **Moxostoma rupiscartes** Jordan & Jenkins. Catawba River at Marion and Morganton; Buck's Creek at Pleasant Garden; Pacollet River near Spartanburgh, S. C., etc.

[1] Description of fourteen species of fresh-water fishes collected by the U. S. Fish Commission in the summer of 1888. Proceedings U. S. Nat. Mus., 1888, p. 351.

4. **Notropis macdonaldi** Jordan & Jenkins. Shenandoah River at Waynesborough; North River at Loch Laird; Buffalo Creek near Lexington.

5. **Notropis kanawha** Jordan & Jenkins. Reed Creek near Wytheville.

6. **Hybopsis watauga** Jordan & Evermann. North Fork of Holston at Saltville; Watauga River at Elizabethtown, Tenn.

7. **Chologaster avitus** Jordan & Jenkins. Dismal Swamp outlet near Suffolk, Va.

8. **Fundulus rathbuni** Jordan & Meek. Allemance Creek; Reedy Fork of Haw River; Buffalo Creek near Greensborough, N. C.; South River near Salisbury, N. C.

9. **Etheostoma rex** Jordan & Evermann. Roanoke River at Roanoke, Va.

10. **Etheostoma roanoka** Jordan & Jenkins. Roanoke River at Salem, Roanoke, and Alleghany Springs; Neuse River at Millburnie; Tar River at Rocky Mount.

11. **Etheostoma podostemone** Jordan & Jenkins. Roanoke River at Salem and Roanoke; Mason's Creek at Salem; Bottom Creek at Alleghany Springs.

12. **Etheostoma swannanoa** Jordan & Evermann. South Fork of Swannanoa River at Black Mountain, N. C.; Middle Fork of Holston at Marion; South Fork of Holston at Holstein Mills.

13. **Etheostoma verecundum** Jordan & Evermann. Middle Fork of Holston at Glade Spring.

14. **Etheostoma.** *Species nova.* Tippecanoe River at Marshland, Ind.

The streams examined may be grouped as follows:

A.—Potomac River:
1. East Fork of Shenandoah River, Luray, Va.
2. Hawksbill Creek, Luray, Va.
3. East Fork of Shenandoah River, Waynesborough, Va.

B.—James River:
1. James River at Lick Run, Va.
2. Elk Creek near Natural Bridge, Va.
3. Cedar Creek at Natural Bridge, Va.
4. Buffalo Creek near Lexington, Va.
5. North River at Loch Laird, Va.
6. Swift Creek near Petersburgh, Va.

C.—Dismal Swamp (Elizabeth River):
1. Jericho Canal (outlet to Lake Drummond), Suffolk, Va.
2. Shingle Creek near Suffolk, Va.
3. Spring Creek, Suffolk, Va.
4. Canal feeder, Wallaceton, Va.
5. Dover farm (ditch), Wallaceton, Va.

D.—Chowan River:
1. Blackwater River, Zuni, Va.

E.—Roanoke River:
1. Bottom Creek near Alleghany Spring, Va.
2. Roanoke (Staunton) River at Roanoke and at Salem, Va.
3. Mason's Creek near Salem, Va.
4. Back Creek at Poage's Mill, Va.

F.—Pamlico River:
1. Tar River at Rocky Mount, N. C.

G.—Neuse River:
1. Neuse River at Millburnie, near Raleigh, N. C.
2. Little River at Goldsborough, N. C.
3. Moccasin Swamp near Goldsborough, N. C.

H.—Cape Fear River:
1. Reedy Fork of Haw River at Fulk's Mill.
2. Spring Branch.
3. South Buffalo Creek near Greensborough, N. C.
4. Little Allemance Creek near Greensborough, N. C.

I.—Great Pedee River:
1. Little Yadkin River, or South River, at South River Post-office, near Salisbury, N. C.
2. Second Creek near Salisbury, N. C.
3. Jumping Run near Salisbury, N. C.

J.—Santee River:
1. Catawba River at Marion, N. C.
2. Buck's Creek at Pleasant Garden, N. C.
3. John's River near Morganton, N. C.
4. Catawba River at Morganton, N. C.
5. Pacollet River at Clifton, near Spartanburgh, S. C.
6. Tiger River near Spartanburgh, S. C.
7. Forest Creek near Spartanburgh, S. C.

K.—Kanawha River:
1. Peak Creek, Pulaski, Va.
2. Little Peak Creek, Pulaski, Va.
3. Reed Creek, Wytheville, Va.
4. Hatchery Stream, Wytheville, Va.

L.—Holston River:
1. South Fork, Holstein Mills, Va.
2. Middle Fork, Marion, Va.
3. Middle Fork, Glade Spring, Va.
4. North Fork, Saltville, Va.
5. Beaver Creek, Bristol, Tenn.
6. Watauga River, Elizabethtown, Tenn.
7. Doe River, Elizabethtown, Tenn.

M.—French Broad River:
1. French Broad River near Asheville, N. C.
2. French Broad River at Hot Springs, N. C.
3. Spring Creek at Hot Springs, N. C.
4. North Fork Swannanoa River near Black Mountain, N. C.
5. South Fork Swannanoa River, Black Mountain, N. C.
6. Swannanoa River near Asheville, N. C.

N.—St. Joseph's River:
1. At Mishawaka, Ind.

O.—Illinois Basin (Kankakee River), Yellow River:
1. At Plymouth, Ind.

P.—Upper Wabash River:
1. Blue River, Columbia City, Ind.
2. Eel River at Logansport, Ind.
3. Lake Maxinkuckee, Indiana.
4. Tippecanoe River, Marshland, Ind.
5. Deer Creek, Camden, Ind.

Q.—Lower Wabash River:
1. Wabash River at Vincennes, Ind.
2. Wabash River at New Harmony, Ind.
3. Black River at New Harmony, Ind.
4. Gresham's Creek at New Harmony, Ind.
5. Patoka River, Patoka, Ind.

Q.—Lower Wabash River—Continued.

6. Big Creek, Lynn Township, Posey County, Ind.
7. Wabash River at Mackey's Ferry, Ind.

R.—Lower Ohio River:

1. Big Pigeon Creek, Evansville, Ind.
2. Cypress Swamp, Mount Vernon, Ind.

S.—White River:

1. White River (West Fork), Spencer, Ind.
2. Eel River, Cataract, Ind.

The following is, in brief, the itinerary of the summer's work:

July 24.—Left Washington, in company with Prof. O. P. Jenkins, for Luray, Va.
July 25, 26.—At work about Luray.
July 27.—At Waynesborough and Loch Laird; joined at Lexington by Prof. B. W. Evermann.
July 28.—At Lexington; drove to Buffalo Creek.
July 29, 30.—At Natural Bridge; drove to Elk Creek.
July 31.—Roanoke.
August 1.—At Salem; drove to Poage's Mill.
August 2.—At Salem.
August 3.—At Alleghany Springs; drove to Bottom Creek.
August 4, 5.—At Pulaski.
August 6.—At Wytheville.
August 7.—At Marion; drove to Holstein Mills.
August 8.—At Glade Spring, Va.
August 9.—Drove to Saltville, Va.
August 10.—At Bristol; drove to Beaver Creek, N. C.
August 11, 12.—At Johnson City; drove to Elizabethtown, N. C.
August 13, 14.—At Hot Springs, N. C. Prof. Seth E. Meek takes the place of Professor Evermann, who is compelled to return home.
August 15, 16.—At Asheville, N. C.; drove to Long Shoals and Swannanoa River.
August 17, 18.—At Spartanburgh, S. C.; drove to Clifton and to Tiger River.
August 19, 20, 21.—At Black Mountain; drove to North Fork.
August 22.—At Marion, N. C.; drove to Pleasant Garden.
August 23.—At Morganton; drove to John's River.
August 24.—At Salisbury; drove to South River.
August 25, 26.—At Greensborough; drove to Reedy Fork and Allemance Creek.
August 27.—Was compelled to return home, leaving Professors Jenkins and Meek to complete the work. Jenkins and Meek go to Raleigh and drive to Millburnie.
August 28.—At Goldsborough, N. C.
August 29.—At Rocky Mount, N. C.
August 31, *September* 1.—At Suffolk, Va.
September 2, 3.—At Wallaceton, Va.
September 4, 5.—At Norfolk, Va. (Marine collections.)
September 6.—At Zuni, Va.
September 7.—At Petersburgh, Va.
September 8.—At Clifton Forge, Va. At this time, floods on the James and Kanawha Rivers made the completion of the work impossible, and Professors Jenkins and Meek returned home.
September 7.—Professor Evermann and Mr. Bollman began work in Indiana, at Spencer and Cataract, Ind.
September 10.—At Evansville and Mount Vernon, Ind.
September 11.—At Mackey's Ferry, Ind.
September 12, 13.—At New Harmony, Ind.
September 14.—At Patoka, Ind,
September 15.—At Vincennes, Ind.
September 16.—Mr. Bollman returned home, giving place to Mr. Albert J. Woolman, a student of Professor Evermann.

September 17.—At Mishawaka, Ind.
September 18.—At Plymouth, Ind.
September 19.—Lake Maxinkuckee.
September 20.—At Marshland, Ind.
September 21.—At Logansport, Ind.
September 22.—At Camden, Ind.

Here cold weather caused the relinquishment of the work for the present season. On November 5 a small collection was made by Mr. W. E. Clapham in Blue River, Columbia City, Ind., and by him turned over to the U. S. Fish Commission.

A.—THE POTOMAC RIVER.

The Shenandoah River is one of the chief tributaries of the Potomac, into which it flows from the southwest at Harper's Ferry. The Shenandoah is a comparatively clear, swift stream, having its rise in cold springs. It flows between two parallel ranges of mountains, chiefly over limestone rocks. In dry weather the waters of the Shenandoah are decidedly bluish in hue, like those of most limestone streams, but after rains they are stained with the red color of the soil.

Collections were made at three points in the Shenandoah Valley, as follows:

1. *Shenandoah River* (*East Fork*) at the ford and ferry, 5 miles west-northwest of Luray Village.—At this point, below the mill-dam, the stream is rather broad and shallow, with considerable current. The bottom is covered with loose rocks and pebbles, with occasional outcrops of rocks in place. In some quiet spots the bottom is rather muddy, and there are numerous water weeds. This is a good locality for seining, but fishes are somewhat scarce, and not many kinds were found. The temperature July 26 was 78° Fahr.[1]

2. *Hawksbill Creek* from Luray to a point about one-half mile below the town.—A rather swift, shallow stream, 8 or 10 feet in width, the bottom very stony, and slimy in the quiet places. The water is warm and far from clear, being stained yellow by clay. Temperature July 25 was 80° Fahr.

3. *Shenandoah River* (*East Fork*) at Waynesborough, Va.—At this point, near its source, the river is clear, flowing over a rocky or gravelly bottom. The water is cold, most of it coming from a few large springs, some of them near Waynesborough, all within 4 or 5 miles of the town. The temperature July 27 was 69° Fahr.

In the following list of species those found in the Shenandoah River near Luray are marked S, those in Hawksbill Creek H, and those at Waynesborough W.

1. **Ameiurus nebulosus** (Le Sueur). S., H.

Small specimens common in mud and weeds. A. 21.

2. **Noturus insignis** (Richardson). "*Mad-Tom.*" S., H.

Rather common among weeds. Well known to the negroes here, as elsewhere in Virginia, by the appropriate name of Mad-Tom. Color, light yellowish brown; the dorsal, anal, caudal, and pectorals edged with black in the adult.

3. **Anguilla anguilla** (L.). "*Eel.*" H.

Frequently taken.

4. **Catostomus teres** (Mitchill). S., H., W.

Very common in sluggish waters.

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[1] All of the temperatures mentioned in this report relate to the water in the streams.

5. Catostomus nigricans (Le Sueur). S., H, W.

Equally common, but in swift waters.

6. Hybognathus nuchalis Agassiz. W.

Three rather small specimens. Compared with examples from Parke County, Indiana, these are a little less elongate and darker in color, with a plumbeous lateral band, and back and sides thickly punctate.

7. Notropis megalops (Rafinesque). H., W.

Common only at Waynesborough.

8. Notropis macdonaldi, Jordan & Jenkins. W. (Jordan & Jenkins, Proc. U. S. Nat. Mus., 1888, p. 354).

Five specimens. The types of this interesting new species were obtained in the cold waters at Waynesborough.

9. Notropis analostanus (Girard). S., H., W.

Common. Compared with specimens of the western species or variety, *N. whipplei* from White River, Indiana, the Virginia examples are less elongate (depth of adult male $3\frac{1}{2}$ in length instead of 4) and the scales are larger (lat. l. 34 or 35 instead of 38 to 40). These characters, already noticed by Professor Cope, seem to be reasonably constant. For the present, therefore, I retain *N. analostanus* as a species distinct from *N. whipplei*.

10. Notropis amœnus (Abbott). S., W.

Common, especially at Luray. This species is closely related to *N. rubrifrons*, but deeper in body, more compressed, and with notably smaller scales before the dorsal. These specimens vary a good deal among themselves, those from the river at Luray being larger, much paler in color, and with decidedly larger eye as compared with those from Waynesborough. The latter resemble *N. rubrifrons* more closely than the former, but all probably belong to the same species.

The largest specimens approach in form the rather poor figure given by Abbott of his *Alburnellus amœnus*,[1] and they are probably specifically identical with the latter, as Abbott's description agrees in all essential respects. Head, 4; depth, $5\frac{1}{3}$ ($4\frac{3}{4}$ to $5\frac{1}{2}$). D. 8, A. 10. Scales, 6–39–3. Length (Luray), $3\frac{3}{8}$-inches. Body elongate, compressed, the form varying somewhat. Head sub-conic, more or less compressed; eye large, rather longer than snout, about $3\frac{1}{3}$ in head, its size largest in Luray specimens. Mouth large, oblique, the maxillary reaching to just past front of eye, the jaws about equal when the mouth is closed. Scales of back smaller than in related species, there being 22 to 25 (rarely 18 to 20) rows between the occiput and the dorsal fin. Lateral line much decurved. Dorsal fin inserted behind ventrals, rather high, and rather large, its free edge concave; pectorals moderate, scarcely reaching ventrals, which extend to vent. Color translucent green; sides silvery, in some specimens a faint plumbeous band ending in an obscure plumbeous spot. Some specimens with dark points along lateral line. Fins plain.

This species is abundant in the river channels, both at Luray and at Waynesborough. Numerous specimens were taken. Specimens from the Potomac similar to these have been formerly identified by me as *Notropis photogenis* (Cope). It may be

[1] Abbott's Amer. Nat. VIII, p. 334. Delaware and Raritan Rivers.

that this identification is correct, but as yet I have not found a genuine *photogenis* in Atlantic waters.

11. Notropis procne (Cope). S.

Rather common in the river. These specimens agree very well with Professor Cope's description of *Hybopsis longiceps*, except in the form of the preorbital bone, which is but little longer than deep. Compared with *N. microstomus* (Rafinesque)=(*N. deliciosus stramineus*) from White River, Indiana, *N. longiceps* differs chiefly in the higher fins, more elevated back, slenderer tail, and more rapidly ascending profile. The scales are a little larger in *N. longiceps* (lat. l. 34), and the dark punctulations along side and at base of caudal are more conspicuous. There is a striking difference in the height of the dorsal fin, its longest ray being about as long as head in *N. longiceps* adult, and about three-fourths head in *N. microstomus* of the same size. The lateral line is also less decurved in *N. longiceps* than in the other.

I have no specimens of *Notropis procne* for comparison. My specimens agree with Cope's description of the latter and with my own notes on it. I therefore regard *longiceps* as a synonym of *procne*.

I may here note that *Hemitremia vittata* Cope, from the Holston, seems to be the same as *Phoxinus flammeus* Jordan and Gilbert. The teeth are described by Cope as 4–5 instead of 2, 4–5, 2, but in other respects Cope's description agrees with our specimens. The species may stand as *Phoxinus vittatus*.

12. Phoxinus margaritus (Cope). S.

A single specimen. Head, 4 in length; depth, $4\frac{1}{4}$; A. I 9 (not I 8); dorsal low; scales, 58; lateral line incomplete, the pores mostly ceasing not far behind middle of body; body dusted with black specks; a narrow lateral streak of plumbeous on caudal peduncles.

13. Hybopsis kentuckiensis (Rafinesque). S.

Common in the river.

14. Semotilus bullaris (Rafinesque). S.

One small specimen.

15. Semotilus atromaculatus (Mitchill). H., W.

Scarce. Lat. l. 53 to 60.

16. Rhinichthys atronasus (Mitchill). S., H., W.

Very common in brooks and springs, scarce in the river. Lat. l. 63. A black lateral band, with yellow or orange below it. Scales of back more or less mottled.

17. Rhinichthys cataractæ (Cuv. & Val.). S., H., W.

Very common. Lat. l. 62; snout much projecting; insertion of dorsal midway between anterior nostril and base of caudal.

18. Exoglossum maxillingua (Le Sueur). "*Nigger-Dick.*" S., H., W.

Very common in the river. Lat. l. 52.

19. Fundulus diaphanus (Le Sueur). S.

Two large specimens from the river. Lat. l. 44. Body in one specimen with about 15 silvery cross-bands, most of them narrower than the dark interspaces; back and fins unspotted. The second specimen has about 11 very narrow dark cross-bars, not one-third the width of the interspaces, which are of the color of the body; back with some dark spots.

20. Micropterus dolomieu (Lacépède). S., W. Seen also at Harper's Ferry.

Common. The black bass is not a native of this river, but was introduced from the Ohio into the Potomac some thirty[1] years ago.

It is evident that the species finds congenial surroundings in the Shenandoah.

21. Lepomis auritus (L.). S., H., W.

Common, especially in deep eddies and below logs. Scales on the cheek small, in 7 or 8 rows; scales on breast small. These correspond to the typical variety *auritus* in McKay's arrangement. (See Jordan and Gilbert, Synopsis, p. 477.)

22. Lepomis gibbosus (L.). W.

One large specimen taken at Waynesborough.

23. Etheostoma flabellare (Rafinesque). S., H., W.

Very abundant. These specimens are similar in color to others from Indiana and from Cayuga Lake, New York. The only difference noticeable is that the pectoral fins of the male are faintly barred in Virginia specimens, not in the others. The body in the Virginia specimens is on the average a trifle deeper, and the tubes of the lateral line are developed slightly farther on the average than in western specimens, but these differences do not justify separate names.

24. Etheostoma nigrum (Rafinesque). Var. *effulgens* Girard. S., H.

Very common, especially in shallow water among weeds; not found in the colder waters at Waynesborough.

These specimens seem to correspond to the *Arlina effulgens* of Girard, described from a tributary of the Potomac. The coloration is that usual in this species and the dark bar below eye is very well marked. The males have the dorsals extremely high, the membranes largely black, the rays spotted with white; seven dark cross-blotches on back; eight faint dark marks on side; a small spot at base of caudal. D. IX-13, A. 1, 9. Scales 43, 43, 44, 47, 49, in five specimens. Length of largest, $3\frac{2}{5}$ inches. Opercles scaly; cheeks, nape, and breast naked; usually one or two scales on cheek behind eye.

An extended comparison of specimens of "*Boleosoma*" from various parts of the country has convinced me that *olmstedi*, *effulgens*, *atromaculatum*, *vexillare*, and *maculaticeps* must all be regarded as forms, or at the most, subspecies under *Etheostoma nigrum*. Individual variations are numerous and perplexing and in large series; intergradations of all sorts appear.

[1] Common report at Luray places the introduction of the black bass at about 1876. This date, however, is certainly incorrect, for Professor Cope says in 1869 (Journ. Ac. Nat. Sci. Phila., 1869, p. 217): "It appears from statements made to me by J. Delaplaine, of Wheeling, and Prof. J. B. Davis, of Roanoke College, Virginia, that the *Micropterus* [*dolomieu*] was introduced from sixteen to twenty years ago into the headwaters of the Potomac from the Ohio, and that they have greatly increased since that time. They are now said to be very abundant in the Shenandoah. By subsequent reference to the Smithsonian Report for 1854 (p. 290), I find that this fact has been recorded there by Mr. John Eoff, of Wheeling, who states that this transfer, which has been so successful in its results, was made by Mr. William Schriver, of the same place."

Comparing specimens of *E. nigrum* from Raccoon Creek, Parke County, Ind., with the Luray fishes, I note that the western *E. nigrum* is a slenderer fish, with the dark spots smaller; the black bar below eye almost obsolete, the snout longer and less blunt, a little longer than eye in Indiana specimens, a little shorter in those from Luray. Mouth in *E. nigrum* a little larger and less oblique. Scales 48 to 50 in *E. nigrum*, the cheek always naked. D. IX, 12. *Boleosoma maculatum* Agassiz and *B. brevipinne* Cope are identical with *B. nigrum.*

25. **Cottus bairdi** Girard. H. W.

Common about springs; very abundant at Waynesborough. Our specimens correspond to var. *carolinæ,* Gill. It seems to me that the name *Cottus* should be retained for this group, rather than for the marine forms.

The original application of the word *Cottus* was to the *Miller's Thumb* of Europe, *Cottus gobio* L. The genus *Cottus* of Linnæus, however, included the marine sculpins as well as the *Miller's Thumb.* Six species are placed in *Cottus* by Linnæus in the tenth edition of the Systema Naturæ, *cataphractus*, *quadricornis*, *grunniens*, *scaber*, *scorpius*, and *gobio.* Of these species, the first, third, and fourth were early removed as types of other genera, and do not belong to the *Cottidæ* as now understood. The question at present relates only to *C. scorpius* and *C. gobio*, as to which should be considered the type of the genus *Cottus.*

The name *Cottus* is taken from Artedi, the author who first used the word in a properly generic sense. The species described by him form the bases of the Linnæan names, and were *gobio*, *quadricornis*, *scorpius*, and *cataphractus.* From the synonymy given by Artedi it appears that the name *Cottus* was adopted by him from Gaza and other early writers, all of whom used it only for the *Cottus gobio.* The word is followed back by Artedi to the *Βολτσς* of Aristotle, which he says is written *Κοιτος* (*Κόττος*) in old manuscripts in the Vatican library. So far as ancient usage goes, the name *Cottus* would belong to *Cottus gobio.* But under our present rules ancient usage would count for nothing in determining the type of a modern genus. Each of the species called *Cottus* by Linnæus would have an equal right to be regarded as the type of the genus. We should therefore ascertain which species was so selected by later authors who have subdivided the genus *Cottus.*

About 1735, Steller discovered one of the species of this group, apparently the one since called *polyacanthocephalus* (Pallas) and *jaok* (Cuv. & Val.), a near relative of *C. scorpius.* The description left by Steller was published by Tilesius in 1811 (Mém. Acad. Petersb., 1811, IV, 273) under the name of "*Myoxocephalus stelleri.*"

The word "*Stelleri,*" as is evident from the usage of Tilesius elsewhere, is not intended as a specific name, but as the authority for the generic name *Myoxocephalus.* No specific name is given by Steller, who was a non-binominal writer, previous to Linnæus, and none is supplied by Tilesius. The name *Myoxocephalus* may therefore be disregarded.

The next authors concerned are Cuvier and Valenciennes (Hist. Nat. Poiss., IV, 1829, 142), who make this remark of the genus *Cottus*, restricted by them to the "Chabots" *gobio*, etc.), and the "Chaboisseaux" (*scorpius*, etc.): "Ce genre avait pour type primitif un petit acanthopterygien de nos rivières" (*i. e., C. gobio* L.). This statement should apparently be regarded as a selection of *Cottus gobio* as the type of *Cottus* in the modern sense of the word "type."

In 1842 DeKay gave the generic name *Uranidea* to an American species (*quiescens=gracilis*), congeneric with *C. gobio*. Evidently DeKay was unacquainted with *C. gobio*, and regarded his *Uranidea* as a new type in the family.

In 1850 Girard, recalling that the type of *Cottus* of Gaza, Artedi, and Cuvier was *C. gobio*, proposed to separate the genus *Cottus* as then understood into smaller genera, retaining the name *Cottus* for the "Chabots" of Cuvier, and giving to the "Chaboisseaux" the new name of *Acanthocottus*.

Girard remarks: "Had the name of *Cottus* belonged to the marine species of the group, instead of being founded on the fresh-water *C. gobio*, the new name *Acanthocottus* would have been unnecessary. In that case we might have called the fresh-water species *Uranidea*, and the marine ones *Cottus*, with equal propriety, although the original idea of the genus *Uranidea* was a mistake of the author." (Girard, Mon. Cottoids, 1850, 9.)

In 1863 Putnam remarks:

"We do not see the necessity of the name *Acanthocottus*, proposed by Girard for the marine species of the old genus *Cottus*, when DeKay, many years before, by giving the name of *Uranidea* to one of our fresh-water species, recognized the two genera. It may be that DeKay did not have the *Cottus gobio* in view when he proposed the name of *Uranidea*, but his *U. quiescens* is the American representative of the *Cottus gobio* of Europe; and, therefore, as he was the first to distinguish the two genera included under the name of *Cottus*, his name should be retained for the fluviatile species, and that of *Cottus* for the marine, called by Girard *Acanthocottus*.

"If the principle adopted by Girard were followed it would involve the change of such a large number of generic names as to create the greatest confusion in nomenclature." (Bull. Mus. Comp. Zoöl., 1, 2, 1863.)

Later American writers have adopted these views of Putnam, while European authors, without exception, have left the two groups together under the name of *Cottus*. It seems to the writer most natural to regard the two groups as separate genera.

To decide which of these genera should be known as *Cottus*, we may now recapitulate the evidence.

(1) If we take ancient usage as our guide, the type of *Cottus* is *C. gobio*, and the *scorpius* group should stand as *Acanthocottus*, the earliest generic name applied by a binomial author.

(2) If we take the first definite and explicit assignment of a type to *Cottus* (Cuvier, 1829, or Girard, 1850), we have the same result.

In my opinion the view stated under (2) should be adopted, and *Cottus* should stand for *Cottus gobio*, and *Acanthocottus* for *C. scorpius* and its marine congeners.

The following is an outline of the synonymy of the two groups:

COTTUS (Artedi), Linnæus.

(Miller's Thumbs; Chabots.)

Cottus Gaza, Rondelet, and of the ancients.
<Cottus Artedi, Genera Piscium, etc., 1738.
<Cottus Linnæus, Systema Naturæ, 1758, 264 (including diverse elements besides *gobio*, *scorpius*, etc.).
Cottus Cuvier, Règne Animal, II, 1827 (restricted to the "Chabots" (*gobio*, etc.) and the "Chaboisseaux" (*scorpius*, etc.).

Cottus Cuvier & Valenciennes, Hist. Nat. Poiss., IV, 1829, 142 (*gobio*, mentioned as "type primitif").
Uranidea DeKay, N. Y. Fauna, Fishes, 1842, 61 (*quiescens=gracilis*).
Cottus Girard, Proc. Bost. Soc. Nat. Hist., 1850, III, 183, 303 (*gobio*).
Cottopsis Girard, Proc. Bost. Soc. Nat. Hist., III, 1850, 303 (*asper*).
Uranidea Putnam, Bull. Mus. Comp. Zool., I, 1863, 2 (*gracilis*), and of recent American writers.
Potamocottus Gill, Proc. Bost. Soc. Nat. Hist., VIII, 40, 1861 (*punctulatus*).
Tauridea Jordan & Rice, Jordan, Man. Vert. E. U. S., ed. 2, 1878, 255 (*ricei*).

ACANTHOCOTTUS, Girard.

(Sculpins; Chaboisseaux.)

<**Cottus** Artedi, Genera Piscium, etc., 1738.
<**Cottus** Linnæus, Systema Naturæ, 1758, 264 (in part).
Myoxocephalus Steller MSS, Tilesius, Mém. Acad. Petersb., 1811, IV, 273 (non-binomial; no specific name; description from *M. polyacanthocephalus*, Pallas).
<**Cottus** Cuvier, Règne Animal, II, 1827 (Chaboisseaux).
Acanthocottus Girard, Proc. Bost. Soc., III, 1850, 183, 303 (*variabilis*, *scorpius*, etc.).
Cottus Putnam, Bull. Mus. Comp. Zool., I, 1863, 2 (*scorpius*).
Boreocottus Gill, Proc. Acad. Nat. Sci. Phila., 1859, 166 (*axillaris*).
Porocottus Gill, Proc. Acad. Nat. Sci. Phila., 1859, 166 (*quadrifilis*).
Megalocottus Gill, Proc. Acad. Nat. Sci. Phila., 1861, 166 (*platycephalus*).
Oncocottus Gill, Proc. Nat. Sci. Phila., 1862, 13 (*quadricornis*; possibly a valid genus).

The oldest name possibly applicable to this species is *Cottus cognatus* of Richardson, based on specimens from Great Bear Lake. As our species is very abundant in Lake Superior, it is not unlikely that this *cognatus* is the same. Richardson's description agrees well with our Lake Superior specimens, but it is too brief to give certainty of identification. The *Cottus richardsoni* of Agassiz, from Lake Superior, seems to be not specifically different from specimens from Virginia, Kentucky, and Missouri. The name *richardsoni* should not be used, as the earlier *Trachidermis richardsoni* of Heckel is also a *Cottus* (=*Cottus asper*, Richardson). The oldest unquestionable name is apparently that of *Cottus bairdi* Girard.

For the present, then, the commonest American *Cottus*, the miller's thumb, blob, mull-head, bull-head, or muffle-jaws, may stand as *Cottus bairdi.*

Crayfishes were abundant at Waynesborough, but none were seen at Luray. The fish fauna of the Shenandoah, as a whole, does not seem to be a rich one, notwithstanding the favorable character of the waters. This fact accords with the view already stated by me (Science Sketches, p. 114), that connection with a large hydrographic basin is one of the chief elements in giving to a river a varied fish fauna. A large number of the species found in the Kanawha or the Holston would doubtless live and multiply in the Shenandoah if they could get there. Probably the channel cat (*Ictalurus punctatus*) could be as profitably and as successfully introduced as the black bass has been.

B.—THE JAMES RIVER.

The James River has its rise in the Alleghany Mountains in West Virginia. It breaks through the Alleghany Chain and the Blue Ridge, and then, a considerable river, flows eastward to the sea. Its waters for the most part are clear, and in its upper course comparatively cold. Most of its tributaries are swift, spring-fed mountain streams; even those of the lower part of the course have the same general character, although most of these streams become muddy and yellow after rain. Heavy rains and consequent floods in the early part of September prevented the completion of our work in the basin of the James River. All our collections were made in streams of the hill country. It is known, however, that the fauna of the lowland course of the James resembles that of the Blackwater and of the Tar, described farther on. Collections were made in the James River basin at the following points:

1. *James River* at Lick Run, six miles east of Clifton Forge, at a point near where the river breaks through the Alleghany Mountains. Collections made September 8. The locality is a good one for collecting, but the heavy rains had so raised the river that little work could be done. The same cause prevented any work being done at Gala Water, a station below Clifton Forge. This point will probably be found, in favorable weather, to be the best point for making collections in the upper course of the James. It should be visited again. Species collected at Lick Run are marked L.

2. *Elk Creek* opposite Natural Bridge station, 4 miles southeast of the Natural Bridge. Collections made July 30; temperature about 68°. Elk Creek or "Dry Run" flows into James River from the south, its mouth being a short distance below a point opposite the railroad station of Natural Bridge. It is one of the most attractive streams examined by us; a very clear, cold trout-brook, running over rocks and shingle, and having at intervals deep pools, some of them 4 to 8 feet deep, and most of them shaded by alders and other trees. The stream is remarkably well stocked with fall-fish, some of them in the larger pools reaching a length of more than a foot. Trout are also very abundant, as is shown by the fact that five were caught with the Baird seine. A few specimens (*Lepomis gibbosus*, *Boleosoma nigrum*, *Notropis amœnus*, *Micropterus dolomieu*) were caught in James River, at the mouth of this creek. Species from Elk Creek are marked E in the following list. In our work about Natural Bridge, we are under especial obligations to Colonel Parsons, proprietor of the hotel at Natural Bridge. Colonel Parsons accompanied us himself to Elk Creek, and freely offered us the use of his team.

3. *Cedar Creek* at Natural Bridge.—Cedar Creek is a small brook fed by springs, with cold and rather clear water. Across its gorge stands the famous Natural Bridge. Below the bridge it flows to the James River through a rocky ravine. Our collections were made July 30 in a pool underneath the Natural Bridge. The stream being small and swift, contains but few species. By far the most abundant of these is *Squalius vandoisulus*.

4. *Buffalo Creek* at and above Buffalo Mills, about 5 miles south of Lexington, Va. Collections made July 28; temperature 74°. Buffalo Creek is a rather clear, very swift stream, flowing over a very rocky bottom, and containing many broad shallows, deep pools, and some small water-falls. The north side of the stream is largely abrupt and rocky, the south side shaded by sycamores and willows. The water is warm, but in most respects the stream is well adapted for collecting, especially below the dam at Buffalo Mills. Buffalo Creek is a tributary of North River, joining the latter near its mouth. Species from this stream are marked B.

5. *North River* at Loch Laird Station, about 6 miles northwest of Balcony Falls, Va. Collections made July 27; temperature 76°. North River is a rather clear, swift hill-stream, rising near Lexington, Va., and flowing into the James River above

Balcony Falls. It was in earlier times converted into a canal by an elaborate system of dams and locks. Our collections were made at a point a few rods above the wagon bridge at Loch Laird. The dam below this point is now broken through. The stream is shallow and rather swift, running over gravelly bottom. The banks are covered with willows, and along the shore is a thick growth of *Ruellia.* Not much time was spent here, and the space fit for seining which can be worked is small. Species taken in the North River are marked N.

6. *Swift Creek,* about 5 miles north of Petersburgh, Va. Collections made September 6. The collections in this stream were made during a heavy rain and under unfavorable circumstances. Immediately below the dam in Swift Creek the stream is very rocky; lower, its current is less rapid, with deep holes here and there. Although this stream is one of the tributaries of the lower course of the James, its fauna is essentially that of the upland streams. The noteworthy difference consists in the presence of the shad, rockfish, gizzard shad, and pike. The shad and rockfish come up the stream to spawn in spring and the young remain in the stream through the summer. In the lowland course the large-mouthed black bass takes the place of its more active congener. The species from Swift Creek are marked S.

1. **Ameiurus albidus** (Le Sueur). N., L. "Channel Cat."

Not rare. A. 21, 23. Color rather dark in young specimens.

2. **Ameiurus nebulosus** (Le Sueur). B., N.

Not rare, in sluggish places in the larger streams.

3. **Noturus insignis** (Richardson). B. "Mad-Tom."

Not rare in weedy places.

4. **Catostomus teres** (Mitchill). B., L., E.

Common in sluggish waters.

5. **Catostomus nigricans** (Le Sueur). B., L., N., E.

Common in swift waters.

6. **Moxostoma cervinum** (Cope). B., E.

Very common in swift waters, especially in water-falls and in the pools at the foot of dams.

Young specimens in life have the back dark brown, mottled with black blotches which extend on the sides; side with a well-defined coppery band, broader than the eye; belly below this band abruptly silvery, a blackish blotch on tail before base of caudal; base of caudal pale orange; caudal dull orange, the membranes black; nostril and edge of opercle pale orange. Older specimens lose the orange lateral band, and in still older ones light stripes follow the rows of scales on the back.

This little sucker is too small to be of much economic value. It rarely exceeds 8 to 10 inches in length.

7. **Hybognathus nuchalis** Agassiz. L.

Scarce in the river channels.

8. **Exoglossum maxillingua** (Le Sueur). C., B., N. "Nigger-Dick."

Very common, though not in cold nor very swift water. A rather sluggish species, living on the bottom.

9. Notropis procne (Cope). S., B.

Common, especially in the creeks, in water not very cold. Specimens from Swift Creek have the back rather broader and less elevated than in those from Luray. Scales 35; scales of back dark-edged; a lateral streak made of dark points; two faint dark spots, one behind the other, at base of caudal. This is a very characteristic color-mark, at least traces of it being found in all specimens.

10. Notropis saludanus (Jordan & Brayton). S., E.

Common in Swift Creek only. Color pale; a dark caudal spot in young only. Interorbital width, 3 in head; head, $4\frac{3}{5}$ in length.

11. Notropis rubrifrons Cope (var.?). B., E.

Common in the creeks, especially in Buffalo Creek. Color silvery; snout, chin, and bases of all the fins rosy in the males only; twenty scales before dorsal. Usually no black at base of anal. This species shows much variation in form. Some are very slender, the depth 6 in length, but most have the depth $5\frac{1}{2}$. These all have the dorsal about two scales nearer in its insertion to snout than to fork of caudal.

Two specimens from Buffalo Creek agree in most respects, but are decidedly deeper and more compressed, the depth $4\frac{2}{3}$ in length; the lateral line proportionately more curved and the dorsal further forward, only a scale nearer base of caudal than to tip of snout. In these the pectoral is also longer, almost reaching base of ventrals. The eye in all is 3 to $3\frac{1}{2}$ in head. Probably all belong to one species, but, if so, the variations in form are unusual. Compared with Indiana specimens of *N. rubrifrons* these have the eye a little larger and the head a little shorter (eye $3\frac{1}{3}$ to $3\frac{1}{2}$ in head, not $3\frac{2}{3}$ to 4). *Notropis dilectus* (Girard), Arkansas to Texas, is very close to *N. rubrifrons*.

Specimens from Red River, Arkansas, are more compressed, with shorter snout, bluntish and not as long as the small eye, which is 3 in head. Head $4\frac{1}{4}$ in length, twenty scales before dorsal.

12. Notropis amœnus (Abbott). L., S., N.

Common in the channels of the larger streams. This species is quite variable, and some examples are scarcely distinguishable from *N. rubrifrons*. It reaches, however, a larger size. It is usually deeper in body, with smaller scales before dorsal and no red even in the males. A. 11. In Swift Creek specimens are usually but nineteen scales before dorsal. One of these specimens has a much deeper body, nine anal rays, and twenty-four scales before dorsal. Its appearance suggests a possible hybrid of *amœnus* and *megalops*, though it may prove to be the young of the variety of *N. megalops*, which is common in the Roanoke.

13. Notropis analostanus (Girard). L., S., B., N., E.

Common; specimens vary a good deal in form, but most are deeper in body than western specimens (depth $3\frac{2}{3}$ to $4\frac{1}{3}$), and the scales in the lateral line are usually but thirty-five.

14. Notropis macdonaldi Jordan & Jenkins. B., N.

One specimen from Buffalo Creek; another from Loch Laird.

15. Notropis megalops (Rafinesque). L., S., B., N., E.

Common; similar to northern and western examples.

16. Hybopsis kentuckiensis (Rafinesque). L., S., B., N., E.

Common.

17. **Semotilus bullaris** (Rafinesque). E., L., S. Fall-fish.

Common in clear streams, in deep pools below swift water. Extremely abundant in Elk Creek, where it reaches a length of 15 inches or more.

18. **Semotilus atromaculatus** (Mitchill). B.

Scarce; in small streams only. Scales 50 to 52.

19. **Rhinichthys cataractæ** (Cuv. & Val.). B.

Not rare, in swift waters. Scales 68.

20. **Rhinichthys atronasus** (Mitchill). E., C., B.

Common, especially in cold, swift waters. Very abundant and brilliant in Elk Creek. Males in life sulphur yellow below the dark lateral band, this color fading to silvery on belly. Lower fins, especially pectorals, scarlet; a scarlet dash at base of caudal. Black lateral band very distinct in all cases, not giving place to a red band as is usually the case in males northward.

21. **Squalius vandoisulus** (Cuv. & Val.). C., E., B., L.

Abundant, especially in swift brooks. The chief species found in Cedar Creek.

The larger specimens are more elongate than the others (depth $4\frac{1}{4}$ in length). These have also a more or less distinct black lateral streak with a paler streak above it, both belly and pale streak being crimson in life. The smaller specimens have the lateral streak very obscure and confined to the caudal peduncle. These are deeper in body (depth about $3\frac{3}{4}$). The number of scales ranges from 49 to 54 in both forms, and in both, the eye is longer than snout, 3 to $3\frac{1}{4}$ in head. All specimens except the very young have the lower parts, especially forward, flushed with crimson. This color is much deeper in the larger and more elongate specimens, which are also frequently beset with small tubercles. These are evidently the males, and the others the female and young of the same species.

It is probable that the nominal species *funduloides*, *affinis* (=*vandoisulus*) are all based on sexual or other variations of one species. *Squalius estor*, from the Cumberland River, is according to Dr. Gilbert not distinct from *S. vandoisulus*.

22. **Clupea sapidissima** (Wilson). S. "Shad."

Young shad were taken in Swift Creek.

23. **Dorosoma cepedianum** (Le Sueur). S.

Common in Swift Creek and lowland streams, not ascending to the uplands.

24. **Salvelinus fontinalis** (Mitchill). E.

Brook trout are found in all suitable tributaries of the James in the Blue Ridge and Alleghany Mountains. Some half dozen specimens were taken with the seine in Elk Creek about a mile above its mouth.

25. **Lucius reticulatus** (Le Sueur).[1] S.

Specimens were taken in Swift Creek, but the species does not ascend to the mountains.

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[1] In the earliest subdivision of the Linnæan genus *Esox*, that made by Rafinesque in 1810, *Esox belone* was selected as the type of *Esox*, while to the genus of pikes the name *Lucius* was given. This arrangement must apparently stand. The pikes and pickerels will then constitute the genus *Lucius* Rafinesque and the family *Luciidæ*.

26. Micropterus salmoides (Lacépède). S.

The Large-mouthed Black Bass is found only in the lowland streams. It is common in Swift Creek.

27. Micropterus dolomieu (Lacépède). L.

The Small-mouthed Black Bass abounds in all suitable places in the upland tributaries of the James. Several localities, as Eagle Rock, Gala Water, Craig's Creek, etc., are noted among anglers for the abundance of bass. The species seems to be indigenous in this river, though not in the Potomac. It rarely ascends the small creeks like Buffalo or Elk.

28. Lepomis auritus (L.). L., B., N., S. "Yellow Belly."

This species is generally common in the tributaries of the James. It ascends streams further than the next species.

29. Lepomis gibbosus (L.). L., S., N.

Generally common, especially in the Lower James.

30. Roccus lineatus (Bloch). S. "Rock."

Young specimens taken in Swift Creek.

31. Etheostoma flabellare (Rafinesque). B.

Generally common, especially in swift shallow brooks.

32. Etheostoma nigrum (Rafinesque) var. *vexillare* Jordan. B., L., N., S.

Extremely common, except in the trout-brooks; very variable.

Many specimens from Buffalo Creek and the specimens from Loch Laird and Elk Creek apparently belong to the form called *Boleosoma vexillare*. None of these exceed 2 inches in length. The female of this form has the ordinary speckled coloration; the male is gray with the edges of the scales above more or less dusky, and the head is nearly black; spots on back and sides faintly marked. First dorsal very high, chiefly black, especially anteriorly; second dorsal and caudal spotted; ventrals and anal dusky or black.

Cheeks and nape naked, opercles scaly. D. VIII–12, IX–11, IX–11, IX–12, IX–12, in five specimens. Scales 38, 39, 40, 40, 41, 42, 38, 38, 39, in nine specimens. Lateral line usually not quite complete.

The original type of *vexillare* (from Rappahannock River at Warrenton) had D. VIII–10, scales 35, but was otherwise similar to these. *Vexillare* doubtless represents a slight variety of *E. nigrum*, which may be called *E. nigrum vexillare*.

The three specimens from Swift Creek are a little more slender, with smaller scales and the usual pale, speckled coloration. Scales 43, 45, 47, in three specimens. One of these has the cheek well scaled as in var. *olmstedi*. The others have the cheek naked as in vars. *nigrum*, *effulgens*, and *vexillare*.

33. Etheostoma longimane Jordan. B., N., E.

This graceful little darter is very abundant in the tributaries of the Upper James, especially in weedy places where the current is swift. In Buffalo and Elk Creeks it was found to be the commonest of the darters.

34. Etheostoma aspro (Cope & Jordan). L.

A single specimen, similar to those found in the Roanoke, was taken in the James River at Lick Run. Scales 64; cheeks scaly.

35. **Etheostoma peltatum** Stauffer. S. (*Hadropterus maculatus* Girard, not *Alvordius maculatus* Girard, which is *E. aspro*, and not *Etheostoma maculatum* Kirtland. *Etheostoma nevisense* Cope; *Alvordius crassus* Jordan & Brayton.)

A renewed comparison of large series of examples has convinced me that the nominal species, *nevisensis*, *peltatus*, and *crassus* are identical, notwithstanding the differences in coloration and in the squamation of the head.

The two specimens from Swift Creek have the coloration of *E. nevisense* with the almost naked head of *peltatum*. The largest is 2¼ inches in length.

Light straw color, the markings are all very dark, verging on jet black. Back with dark cross-blotches and irregular wavy and longitudinal markings above lateral line, much as in *E. aspro*. Sides with six large conspicuous square black blotches, about as broad as the interspaces and alternating with fainter bars of black. A faint dusky streak along lateral line. Top of head black; a black bar below eye; snout and opercle mostly black; nape with a pale spot surrounding a dark one; a dark band in axil; 6 to 8 round spots on back; first dorsal with a submedian black band and some black spots toward tip; second dorsal and caudal obscurely barred; ventrals and pectorals dusky.

General form of *E. aspro*, from which this species scarcely differs except in the larger size of its scales. Head rather heavy, the snout bluntish in profile and about as long as eye; lower jaw slightly included, maxillary reaching just past front of eye, $3\frac{2}{5}$ in head. Gill membranes scarcely connected.

Cheeks wholly naked; opercle with about 3 small scales above, sometimes naked on one side. Caducous ventral shields large and few in number; nape and breast naked; scales 6–52–9. D. XIII, 12. A. II, 10. Head 4 in length; depth $5\frac{2}{3}$. Eye 4 in head.

Fins all comparatively low and small; pectoral a little shorter than head, barely reaching tips of ventrals, and nearly as large as second dorsal, its second spine a little slenderer and longer than first; caudal lunate.

Specimens from Carlisle, Pa., agree with these specimens, except that the black lateral spots are smaller and rounded. Scales 56.

Etheostoma ouachitæ (Jordan and Gilbert), (specimens from Saline River, Benton, Ark., and from the Wabash River at New Harmony, Ind.), is extremely close to *E. peltatum*. *E. ouachitæ* has the head a little more slender, the pectorals longer, reaching past tips of ventrals, and four distinct black cross-blotches on back.

Both species might be regarded as varieties of *E. aspro* were it not for the larger scales.

36. **Cottus bairdi** Girard. E. "Mull-head."

Very abundant in clear streams and spring runs. A mischievous fish; very destructive to the eggs of trout.

C.—THE DISMAL SWAMP (ELIZABETH RIVER).

The Dismal Swamp, which lies in the southeastern part of Virginia and the adjacent portion of North Carolina, is a large marshy area, most of it heavily timbered with cypress and other trees. Near the center of the swamp is Lake Drummond, nearly circular in form, with a diameter of 5 or 6 miles. The waters of the swamp and the lake are free from sediment, but stained of a dark-brown color by the vegetable matter of the swamp. The lake water, in fact, is regarded as excellent for drinking purposes.

The fish fauna of the Dismal Swamp is essentially that of other marshy lowlands of the Southern States, in which the underlying clays are covered by vegetable deposits. Some of the species characteristic of the Florida fauna seem to find here their northern limit. Collections were made in the following localities within the borders of the Dismal Swamp.

1. *Jericho Canal* near Suffolk, Va.—August 31; temperature, 73°. This canal is the outlet to Lake Drummond. At the time of collecting, the water was low, and the bottom of the canal had a dense growth of aquatic plants. The water was clear, but of the color of cider. The region seined extended from the point where the main road leading from Suffolk crosses the canal, down to its mouth in Shingle Creek. Species found here are marked J.

2. *Shingle Creek* near Suffolk, Va.—August 31. This stream is a tributary of the Elizabeth River. Tides enter the stream, the waters of which are consequently brackish. It was seined during low tide at the place where the Jericho Canal enters it. Species found in this stream are marked S.

3. *Spring Creek* near Suffolk, Va.—August 31. This is another tributary of Elizabeth River, similar in its character to Shingle Creek. Fishes from this locality are marked P.

4. *Canal and canal feeder* near Wallaceton, Va.—September 2. The Dismal Swamp Canal passes north and south through the swamp just east of Lake Drummond. It is connected with Lake Drummond by a short canal or "feeder," which joins the canal just south of the large farm of Mr. Wallace, or Wallaceton post-office. Both canal and feeder were found to be so full of snags that seining was almost impossible, the feeder especially so. For the same reason no work could be done in the lake. The water in the canal is clear, but very dark; the bottom is full of black muck, formed of decaying vegetation, which fills the seine. It is said that the gar (*Lepisosteus osseus*) and *Amia calva* reach a very large size in the lake. No specimens were taken, however. Species taken in this locality are marked D.

5. *Ditch on Dover farm* at Wallaceton.—September 2. "Dover farm" is a square district of about 700 acres, which has been "carved out" of the swamp. The whole farm is surrounded by an embankment, which keeps out the water of the swamp. It is drained by ditches, which join into one, and this is led off by a tunnel under the canal. The water in the ditches is several feet lower than that of Lake Drummond or the canal. The main ditch was seined at its outlet after its waters had passed under the canal. Species from this locality are marked W.

1. **Ameiurus nebulosus** (Le Sueur). D.

Three specimens, quite dark; caudal somewhat concave. A. 22.

2. **Ameiurus erebennus** Jordan. J., S.

Rather common. Color black everywhere; anal high and long, its rays 25 to 27. The commonest catfish in the swamp, although not before noticed north of Florida.

3. **Noturus insignis** (Richardson). S.

Scarce.

4. **Anguilla anguilla rostrata** (Le Sueur). D., S.

Probably common.

5. **Erimyzon sucetta** (Lacépède). S.

Common. In life ventrals and pectorals bright red, tipped with blue, a bright blue patch on opercle; rays of dorsal reddish, the membranes blackish; body with a black lateral shade. Scales 45, but regularly arranged. These specimens seem referable to the northern var. *oblongus* rather than to the true *sucetta*.

6. **Moxostoma papillosum** (Cope). S.

A few specimens.

7. **Hybognathus nuchalis** Agassiz. S., P.

Most of these specimens correspond to the *Hybognathus regia* of Girard. The largest specimens ($4\frac{1}{2}$ inches in length) are larger than any western specimens of *nuchalis* which I have seen. The body in these large examples is deeper (depth 4 to $4\frac{1}{4}$ in length) than in *nuchalis* (depth $4\frac{3}{4}$), and the caudal peduncle is stouter. A comparison of numerous specimens reduced these and other supposed differences to a minimum, and only the larger size and proportionately greater depth of body remain to distinguish *regia* from *nuchalis*.

8. **Notemigonus chrysoleucus** (Mitchill). S., P., D., W.

Very common. A. 13, scales 49; A. 14, scales 51; A. 15, scales 51; A. 14, scales 47; A. 13, scales 50; A. 15, scales 54, in six specimens. These specimens should be referred to the northern or typical var. *chrysoleucus*.

9. **Notropis saludanus** (Jordan & Brayton). S.

One specimen, dark in color.

10. **Notropis procne** (Cope). S.

Rather scarce; lateral stripe jet black, this stripe extending through eye around snout. Scales 35. Back high; caudal peduncle slender; dorsal high.

11. **Notropis amœnus** (Abbott). S.

Common. Color dark; 18 scales before dorsal; base of anal with dark dots.

12. **Notropis niveus** (Cope). S., P.

The specimens differ considerably from the typical *niveus* (Catawba River), and may belong to a different species.

The mouth in these specimens is rather less included below the snout, the eye is larger ($3\frac{1}{4}$ in head, $3\frac{2}{5}$ in *niveus*) and the color is much darker, there being a distinct plumbeous lateral band. The body in these specimens is rather more elongate. A. 8, scales 37.

Compared with *N. whipplei*, these specimens are much more slender, with notably larger eye, slenderer head, and considerably lower dorsal. Probably the specimens from Shingle and Spring Creeks represent a lowland variety of *Notropis niveus*.

13. **Stolephorus mitchilli** (Cuv. & Val.). S.

Many young anchovies were taken in Shingle Creek.

14. **Clupea pseudoharengus** (Wilson). S.

A few young alewives were taken in Shingle Creek.

15. **Dorosoma cepedianum** (Le Sueur). S., P.

Common.

16. Fundulus diaphanus (Le Sueur). S.

Color very dark; body with 14 narrow, black cross-bands. D. 13; A. 19. One specimen.

17. Gambusia patruelis (Baird & Girard). J., D., W., S., P.

Very common.

18. Chologaster avitus Jordan & Jenkins. J.

Very common in the Jericho Canal; not seen elsewhere.

19. Umbra pygmæa (De Kay). J.

In view of the constant differences in pattern of coloration shown by the eastern form, the latter may perhaps stand provisionally as a distinct species. The characters are well given by Blatchley (Proc. Ac. Nat. Sci. Phila., 1885, 12).

20. Lucius americanus (Gmelin). J., S.

Common.

21. Lucius reticulatus (Le Sueur). J., S., P.

Common.

22. Aphredoderus sayanus (Gilliams). J., D., W.

Common. D. III, 10; A. II, 6; scales 39 to 42; 23 scales before dorsal; color very dark; a pale streak along lateral line; a dark streak above base of anal and parallel with it.

Specimens from Delaware River have scales 47 to 48, 24 before dorsal, but are otherwise similar.

Specimens from Illinois River have the color much paler, the streak above anal obsolete, and the scales very much smaller, about 58 in a lengthwise series; 36 before dorsal. These certainly form a tangible variety or subspecies, *gibbosus* Le Sueur. (*Aphredoderus gibbosus* Le Sueur = *Sternotremia isolepis* Nelson = *Aphredoderus cookianus* Jordan = *Asternotremia mesotrema* Jordan. The last three synonyms represent different stages of growth). Other specimens, Wabash River, show 48 to 51 scales, and are apparently intermediate between *gibbosus* and *sayanus*.

23. Centrarchus macropterus (Lacépède). J.

D. XII, A. VII; scales 41. Common.

24. Pomoxis sparoides (Lacépède). J.

Common.

25. Acantharchus pomotis (Baird). J.

Two specimens; scales 45.

26. Enneacanthus obesus (Baird). J., W.

Common. Compared with the next species (*E. gloriosus* or *simulans*, from Trenton, N. J.), *E. obesus* is more elongate, the forehead above eye less depressed, the lateral line less arched, the eye smaller, the black lateral bands very distinct. The most striking character is in the size of the opercular spot. This, in *obesus*, is as wide as long in the adult, and four-fifths diameter of eye. In *gloriosus* it is longer than wide, and little more than half diameter of eye. Both species have pale spots on the body and fins, but in *obesus* those on the body are smaller and farther apart.

27. **Enneacanthus gloriosus** (Holbrook). S.

Rather scarce. Depth, 2½ in length; ear flap not larger than pupil; a faint trace of cross-bands. I see no reason to doubt the identity of *Bryttus gloriosus* Holbrook, with *Hemioplites simulans* Cope, and *Enneacanthus margarotis* Gill & Jordan. The ear flap is small in *gloriosus* as in *simulans*, and no difference of any importance is shown in the descriptions.

28. **Lepomis auritus** (L.). S.

Scarce.

29. **Lepomis gibbosus** (L.). S.

Not rare.

30. **Lepomis holbrooki** (Cuv. & Val.). J., D., W., S.

Not rare. This species differs from *L. gibbosus* in its plainer color; greenish, with faint bronze spots; breast yellow; dorsal unspotted. Its snout is sharper and longer than in *L. gibbosus*, scales 44; 4 rows on cheek. Dorsal higher than in *L. gibbosus*; longest spine, 1⅞ in head, as long as snout and eye. Eye about as long as snout.

Lepomis notatus (Lower Mississippi) seems to be a different species, distinguished by the larger scales (lat. l. about 35).

31. **Micropterus salmoides** (Lacépède). S.

Common.

32. **Roccus lineatus** (Bloch). S., P.

Young specimens common.

33. **Morone americana** (Gmelin). S., P.

Common.

34. **Etheostoma vitreum** (Cope). S.

Common in sandy places.

35. **Etheostoma nigrum olmstedi** (Storer). S., P.

Very common. Cheeks closely scaled in all specimens examined. D. IX–15.

36. **Etheostoma peltatum** Stauffer. S.

One specimen.

37. **Etheostoma fusiforme** (Girard). W.

One specimen. Body very slender, the depth 6¼ in length. Scales 53; two rows of scales above lateral line; tubes on 16 scales. D. IX–10. Top of head naked; cheeks, opercles, nape, and breast scaly; scales on cheek large. Base of caudal with four dark spots in a vertical row; body with dark markings in the form of a faint interrupted dark lateral band with dark shades above and below it.

This specimen seems to agree with the type of Girard's *fusiforme*. *Hololepis erochrous* Cope also agrees fairly with it, and may be regarded as the same.

Throughout the entire lowland region, from Dakota to Texas, Michigan, Massachusetts, and Florida, small darters are found, which agree more or less closely with this specimen, so closely, indeed, that I do not know how to draw specific distinctions among them. To these have been given the specific names of *eos* (N. Indiana); *palustris* (S. Indiana); *exilis* (Dakota); *warreni* (Dakota); *gracilis* (Texas); *elegans* (Texas);

butlerianus (Mississippi), and *barratti* (South Carolina). Some of the results of a recent examination of material may be here given.

a. Clam Lake, Michigan (*eos*): These specimens are a little stouter and darker in color, the scales on the cheeks obscure. Scales, 55.

b. Thayer Lake, Michigan (*exile*): Still stouter, more barred, the cheeks naked.

c. Northern Illinois (*eos*): Stouter, the depth 5 in length; scales 56, 4 rows above lateral line; scales on cheeks evident; three spots at base of caudal.

d. Southern Illinois (*barratti*). Still stouter, depth $4\frac{1}{2}$; scales 49, 3 rows above lateral line; cheeks well scaled; color nearly plain; sides with faint bars and a single spot at base of caudal.

e. Terre Haute, Ind. (*palustre*). Depth 5; scales 50, 3 rows above lateral line; snout rather short; cheeks well scaled; a single faint caudal spot; markings obscure; bluish bars in life.

f. Trinity River, Dallas, Tex. (*gracile*). Similar to *c* in color and form, a little stouter; cheeks well scaled; scales 50, 3 rows above lateral line; three spots at base of caudal.

g. Saline River, Benton, Ark. (*gracile*). Very similar to *f*. Scales 49; three spots at base of caudal.

h. Mount Vernon, Ind. (*palustre*). Stout, depth $4\frac{1}{3}$; scales 53, one row above lateral line; one caudal spot; snout bluntish; no dark lateral stripe.

Possibly these several varieties may be separated by the following characters:

a. Cheeks naked; body faintly barred .... *exile*.
aa. Cheeks scaly.
  b. Body stoutish; no lateral stripe; depth $4\frac{1}{2}$ to $5\frac{1}{4}$ in length.
    c. Snout moderate; scales on cheek small; sides with crimson spots .... *eos*.
    cc. Snout bluntish; no bright red; sides with greenish cross-shades .... *palustre*.
    ccc. Snout rather sharp; no red.
      d. Body more or less barred and spotted .... *gracile*.
      dd. Body nearly plain greenish .... *barratti*.
  bb. Body very slender; depth 6 in length; a dark lateral band and more or less of red markings .... *fusiforme*.

But the value and constancy of each of the above characters are yet to be proved.

38. Achirus fasciatus Lacépède. S., P.

This small sole ascends the streams from the sea and is abundant on sandy bottoms in the creeks.

D.—THE CHOWAN RIVER.

The Chowan River opens by a broad shallow mouth or estuary into the north side of Albemarle Sound. Its principal tributary is the Blackwater, which rises in the southeastern part of Virginia and takes its way southward through densely wooded swamps of cypress, pine, etc., flowing into the head of the estuary of the Chowan. The water of the Blackwater is clear, but, as the name indicates, it is stained to the color of coffee by the drainage from the cypress swamps.

1. *Blackwater River* at Zuni.—This stream was seined at Zuni, a little town on the railway west of Suffolk. Collections were made above and below the railroad bridge at Zuni. The river at this point is very full of snags, but in the shallow places the bottom was sandy. Temperature 73°, September 6.

The fish fauna is essentially that of the neighboring Dismal Swamp.

1. Noturus insignis (Richardson).

Not rare.

2. Anguilla anguilla rostrata (Le Sueur).

Common.

3. **Notropis amœnus** (Abbott).

A few large specimens very dark in color and looking as though starved.

4. **Notropis niveus** (Cope).

Very abundant, similar to specimens from the Dismal Swamp, the color darker, the snout sharper, the mouth more oblique and more terminal than in specimens from Cape Fear River.

5. **Notropis procne** (Cope).

Specimens quite slender, the back less elevated than in upland examples, the color very dark, but the markings similar. Chin always pale (black in the next species).

6. **Notropis chalybæus** (Cope).

Very close to *N. anogenus* Forbes, differing chiefly in the more backward dorsal and smaller ante-dorsal scales, the general form, markings, size of eye and form of mouth the same in the two species. Head $4\frac{1}{5}$ in length; depth 5; D. 8; A. 7 to 9. Scales 33, 16 to 17 series before dorsal. Length, 2 inches.

Body moderately elongate, compressed, the back a little elevated, the tail contracted; top of head not very broad: scales before dorsal small; lateral line nearly straight, somewhat interrupted. Snout short, not two-thirds the large eye, rather blunt, mouth short, very oblique, the chin projecting. Eye 3 in head. Dorsal inserted behind ventrals, at a point one and one-third times length of head, behind the nape. Dorsal and anal very short and high; pectorals and ventrals short. Color quite dark, a jet black lateral band, which passes around the snout and includes the chin; a darker spot at base of caudal; a dark streak along base of anal.

Compared with specimens of *Notropis anogenus* taken by Professor Meek in Cayuga Lake, the latter differs in the paler color, broader head, more anterior dorsal (only a head's length behind nape), and in the larger size (13 in number) of the scales before the dorsal.

7. **Clupea sapidissima** (Wilson). *Shad.*

Young, abundant.

8. **Gambusia patruelis** (Baird & Girard).

Few taken.

9. **Lucius reticulatus** (Le Sueur).

A few taken.

10. **Micropterus salmoides** (Lacépède).

Common.

11. **Lepomis auritus** (L.).

Common.

12. **Lepomis gibbosus** (L.).

A few.

13. **Perca flavescens** (Mitchill). *Raccoon Perch.*

Two taken.

14. **Etheostoma vitreum** (Cope).

Abundant.

15. **Etheostoma nigrum olmstedi** (Storer).

Abundant; cheeks covered with small, partly imbedded scales.

16. Etheostoma aspro (Cope & Jordan). (Var.)

Several specimens, similar to those from the Roanoke. Scales 62, 62, 64. Compared with *E. peltatum* from the Neuse, these specimens have smaller scales, and the blotches on the sides coalesce into a nearly continuous black band, nearly as wide as eye, its edges uneven. In some the cheeks are naked, in others scaly.

17. Etheostoma quiescens (Jordan).

The original type of this species came from Allapaha River, a tributary of the Suwanee River in southern Georgia. The four specimens taken at Zuni agree with this type except in the form of the body. This is very slender in the Suwanee specimen, but rather stout in those from the Blackwater.

Head $3\frac{2}{3}$ in length ($4\frac{1}{2}$ with caudal); depth $4\frac{2}{3}$ ($4\frac{4}{5}$). D. XI–12, A. II, 7. Scales 3–54–8. Pores on 27 scales. Length $1\frac{2}{5}$ inches. Body not greatly elongate, compressed, the back elevated, the back higher and the tail shorter than in *E. eos*. Maxillary extending to front of pupil; jaws equal; preopercle a little crenulate above. Cheeks, opercles, and whole top of head closely scaled: breast and nape scaled; snout, jaws, and preorbital naked; lateral line running very high as in *E. fusiforme*, from which this species is chiefly distinguished by the scaly crown, a character seen also in *E. tuscumbia*, a species not closely related to *E. quiescens*. Caudal $1\frac{1}{3}$ in head; pectoral as long as head. Color dark brown, the pale parts chiefly bright red in life; back with some dark markings; side with a broad black lateral band, mottled and interspersed with red; an area of red along lateral line; some black spots on lower part of side; a black spot at base of pectoral; three black bars about eye; four black spots in a cross-series at base of caudal, the middle ones largest. Fins checkered; dorsal, anal, and caudal finely barred; ventrals, anal, and pectorals plain.

E.—THE ROANOKE RIVER.

The Roanoke River has its sources in the Blue Ridge Mountains in southwestern Virginia, from which region it flows southeastward through the uplands, and ultimately passes into the lowland region of east North Carolina. Its mouth is a broad estuary, Roanoke Sound, which opens into Albemarle Sound. The general character of the river basin is similar to that of the James. Our examinations of this river were all made near the source of its main branch, the Staunton River, in Montgomery and Roanoke Counties, Virginia. The work was here done under very favorable circumstances, and it is probable that so far as the fishes of the upland course are concerned, our list is nearly complete. The water of most of the tributaries of the Upper Roanoke is very clear, and the streams are extremely picturesque. Collections were made at the following points:

1. *Bottom Creek*, about 5 miles south of Alleghany Springs, August 3; temperature 77°.

The infant Roanoke is formed by the union of two mountain streams, Bottom Creek and Lick Fork, which come together on the west side of Bent Mountain, some 4 miles above Alleghany Springs. Of these streams the larger, Bottom Creek, was examined by us. Its waters are very clear, forming a succession of rapids and deep pools, the swift places having the bottom lined with a river weed (*Podostemon ceratophyllus*). The water is, however, warm, scarcely colder than that of the river. The fishes are substantially the same as those in the river below. The only difference worthy of note is in the much greater abundance of *Chrosomus oreas*, *Squalius funduloides*, *Etheostoma podostemone*, and *Notropis megalops cerasinus*. Even the eel and the rock bass are found in Bottom Creek. It is said that brook trout are occasionally taken here, but none were seen.

2. *Roanoke* (*Staunton*) *River* at Salem and Roanoke, Va., July 31, August 1, August 2; temperature 82°.

The Roanoke or Staunton River from Salem to Roanoke is comparatively clear, with alternations of shallow, swift places, where the river flows over shingle and rocks, and long, still stretches where the bottom is more or less muddy. The shoal areas, many of which are used as fords, are about one-half mile apart, and some of them are excellent as collecting grounds. Collections were made below the mill, southwest of Salem; about the mouth of Mason's Creek, 2 miles below Salem; at the bridge, 2 miles southwest of Roanoke, and at various places within 3 miles of this bridge, in the direction of Salem. All these localities are good. The shoal immediately under and below the bridge at Roanoke is probably the best.

3. *Mason's Creek*, 2 miles east of Salem. August 1; temperature 82°. A small, clear stream, its water scarcely colder than that of the river. It was seined near its mouth. Its fishes are the same as those found in the river.

4. *Back Creek* at Poage's Mill, 10 miles south of Salem. August 1; temperature 77°. This is a small, clear, sandy stream, its waters quite warm. It rises on the eastern side of Bent Mountain opposite the source of Bottom Creek. The following species were found here:

1. **Moxostoma cervinum** (Cope).

Under the mill-dams.

2. **Campostoma anomalum** (Rafinesque).

Common.

3. **Chrosomus oreas** (Cope).

Very common. Some of the specimens remarkably brilliant in color.

4. **Notropis megalops cerasinus** (Cope).

Very abundant and very brightly colored.

5 **Hybopsis kentuckiensis** (Rafinesque).

Specimens very short and deep; abundant in the mill-pond; scales 41.

6. **Rhinichthys atronasus** (Mitchill).

Common.

7. **Squalius vandoisulus** (Cuv. & Val.).

Scarce.

8. **Etheostoma flabellare** (Rafinesque).

Scarce.

The following is a list of the species found in the river:

1. **Noturus insignis** (Richardson). *Mad Tom.*

Very common, especially in grassy places in the river. In life, pale yellow, nearly uniform; all specimens, large and small, with the dorsal, anal, and caudal broadly edged with jet-black, the basal part of the fin pale. Caudal long, rounded at tip.

There is considerable variation in the width of the head and in the length of the pectoral spines ($1\frac{3}{8}$ to $2\frac{1}{4}$ in head). A 16. Pectoral spine retrorse-serrate on the outer margin, the inner margin with coarse teeth near the base.

2. **Noturus gilberti** Jordan & Evermann.

About two-fifths of the specimens of "Mad Tom" obtained at Roanoke and Salem belong to this species, well distinguished by its color, and by the form of its adipose fin, caudal fin, and pectoral spines.

3. **Moxostoma papillosum** (Cope).

A few young specimens taken at Roanoke.

4. **Moxostoma cervinum** (Cope).

Common at the foot of mill-dams and in swift waters.

5. **Catostomus nigricans** (Le Sueur). "Dutchman."

Common; specimens dark in color. Lat. l. 47.

6. **Catostomus teres** (Mitchill).

Common.

7. **Campostoma anomalum** (Rafinesque).

Not rare. Lat. l. 49 to 52.

8. **Exoglossum maxillingua** (Le Sueur). "Nigger Fish."

Very common; a sluggish fish living near the bottom. Lat. l. 57.

9. **Chrosomus oreas** (Cope).

Very abundant in the clear brooks; rare in the river; the most ornate of all our *Cyprinidæ*. In life head, belly, and lower parts deep scarlet; fins bright yellow, with scarlet at base; back with black vertical bars; a black band from snout through eye to the anal fin, very broad and very distinct in males; another band beginning above this one, separate from it at a point before the vent, and going straight to caudal. These markings are quite distinct from the two nearly parallel black bands seen in *C. erythrogaster*. *C. oreas* also differs in having a slightly longer snout, longer preorbital, and longer maxillary, which extends nearly to the eye. It should probably be ranked as a distinct species.

10. **Notropis procne** (Cope).

Not rare; a few specimens are extremely pale, having no black on scales on sides of head. These, however, have the same form as the others and show traces at least of the spots at base of caudal.

11. **Notropis megalops** (Rafinesque).

Common. Of this species two distinct forms or varieties, possibly distinct species, are found, neither of them quite like any form of *N. megalops* which I have met in any other stream. The two forms are very different from each other and may be distinguished even when very young. The one called var. *cerasinus* by Professor Cope abounds in the small streams, the other which I call var. *albeolus* is found in the river.

Notropis megalops cerasinus is small in size, seldom exceeding 4 inches. In life it is steel-blue above, the body flushed with pink and the fins all bright red. The sides are always marked by irregular blackish cross-blotches and bars, formed by a broad, dark edging on some of the scales. This marking seems to be constant, but the size and arrangement of the bars vary much. Eye rather small, 3½ in head; snout rather short and blunt; body rather deep (depth 3⅗). Lat. l. 37. 15 scales before dorsal. Dorsal and anal rather high, the free edges concave.

Notropis megalops albeolus reaches a larger size; it is olivaceous above, the sides and fins pure silvery white, the tip of the snout pinkish in the male. The snout in var. *albeolus* is sharper than in var. *megalops*, and the caudal peduncle and fin are especially longer. Depth of adult, 4 in length; eye 3½ in head; lat. l. 38; 14 scales before dorsal. The dorsal and anal are high, their free edges concave. The form of the mouth in both varieties is the same as in the typical *megalops*. The young of var. *albeolus* resembles *N. macdonaldi*, but the mouth is larger in the latter and the body still more slender.

12. Notropis ardens (Cope).

Very common. Male steel blue in life, with more or less of bright red on fins, head, and anterior part of body; base of dorsal anteriorly black; females very pale. I have compared this species with its western analogues *N. atripes*, Cache River, Illinois; *N. lythrurus*, Raccoon Creek, Parke County, Indiana; and *N. umbratilis*, Hundred and Two River, Iowa. It differs from all these in the much more slender body (the depth 4⅗ in the length, even in the adult males), and in the larger eye (3½ in head). It should, I think, be regarded as a different species, although the difference is but slight. *N. umbratilis* is well distinguished by its different coloration and large eye. The three remaining nominal species of this type found in the Upper Mississippi region (*N. cyanocephalus*, *N. lythrurus*, and *N. atripes*) differ very little from each other, and may be regarded as varieties of one, for which the oldest tenable name is *N. cyanocephalus* (Copeland).

13. Notropis niveus (Cope).

Common.

14. Hybopsis kentuckiensis (Rafinesque).

Very common.

15. Rhinichthys atronasus (Mitchill).

In brooks. Barbel a little more conspicuous than usual.

16. Squalius vandoisulus (Cuv. & Val.).

Rare; in Back Creek only.

17. Anguilla anguilla rostrata (Le Sueur).

Common.

18. Micropterus dolomieu (Lacépède).

Scarce.

19. Ambloplites rupestris cavifrons (Cope). "Red Eye."

Two specimens taken; one very large example, 9 inches long, in a pool of Bottom Creek, and a small one in the river. The stomach of the large specimen was filled with minnows and "Mad Toms." The smaller corresponds to the description of *Ambloplites cavifrons* Cope. On comparing the adult examples with *Ambloplites rupestris* from Rawson Lake, Michigan, I find but a single tangible difference. In *A. cavifrons* the scales on the cheek are minute and imbedded, wholly invisible over most of the area. In *A. rupestris* the cheek scales are well developed, usually in about nine rows. The scales on the breast are also more obscure in *A. cavifrons*, but the scales on the body are alike in the two forms. There is no tangible difference in the profile, but the different squamation of the head seems to justify the recognition of *A. cavifrons* as a slight geographical variety.

20. **Lepomis auritus** (L.).

Common. The specimens belong to the northern variety, with small scales on breast and cheeks. *Lepomis ophthalmicus* (Cope), from some tributary of the Roanoke, is probably the same species.

21. **Lepomis gibbosus** (L.).

Scarce.

22. **Etheostoma podostemone** Jordan & Jenkins.

Very common, especially in swift waters among river weeds. Most abundant in Bottom Creek.

23. **Etheostoma nigrum** (Rafinesque).

One specimen of var. *vexillare* (scales 40, 41,) from Salem; many from Bottom Creek, above Alleghany Springs.

24. **Etheostoma roanoka** Jordan & Evermann.

Very common in swift and grassy waters; one of the most elegant of the darters.

25. **Etheostoma aspro** (Cope & Jordan).

Several specimens, the longest 4½ inches in length; most common in Bottom Creek in rather deep water. D. XII-13, XIV-13 in two specimens; A. II-9, scales 60, 64, 64 in three specimens. These specimens agree fairly with *E. aspro* from Illinois River. The dark blotches on the sides are smaller, less broadly confluent, but rather resembling widenings of a narrow black band. The scales are a little larger, those on the cheeks faint and imbedded, and in one specimen wanting altogether.

26. **Etheostoma rex** Jordan & Evermann.

Two specimens of this superb darter were taken in the Roanoke River. The larger of these (5½ inches long) was taken in the rapids under the bridge 2 miles southwest of Roanoke.

27. **Etheostoma flabellare** (Rafinesque).

Common; scales 46. These specimens are not different from others from Indiana.

F.—THE PAMLICO RIVER.

The Pamlico River is a broad, tide-water estuary opening into the southern part of Pamlico Sound. Its principal tributary is known as Tar River, a stream which rises near the Virginia line, and flows southeast through pine forests into the head of the Pamlico. Collections were made in the Tar River, at a point 2 miles below the village of Rocky Mount. August 29; temperature 73°.

In the Tar River, at the point referred to, a large dam crosses the stream. This dam rests on a ledge of granite, and for a long distance below the dam the bottom of the river is very rocky. There are a few deep holes in the river, and some other points suitable for collecting. The rocks are covered with water-plants. The water in the river was muddy, although it had not been raised by rains.

1. Lepisosteus osseus (L.).

Two small specimens, about a foot long, and many large ones were taken.

2. Noturus furiosus Jordan & Meek. "Tabby Cat."

A single specimen, similar to the types of the species from the Neuse River.

Numerous very large examples of this species were taken some twelve years ago in the Tar River, near Tarborough, by Mr. James W. Milner. These are now in the U. S. National Museum. They were at first identified by me as *Noturus eleutherus*, and afterwards as *Noturus miurus*. They are closest to *N. miurus*, but apparently distinct from both species, having a stronger armature and a more strongly marked coloration than either.

3. Noturus insignis (Richardson).

Abundant. Color very dark; edges of fins little darker.

4. Ameiurus erebennus Jordan.

Two small specimens.

5. Ameiurus nebulosus (Le Sueur).

Common. Anal rays 22; caudal slightly concave.

6. Catostomus nigricans (Le Sueur).

Common.

7. Moxostoma papillosum (Cope).

Common. Body rather elongate; the back low; lower lip small, deeply incised; its surface plicate, but the folds broken up into papillæ. D. 13.

8. Moxostoma cervinum (Cope).

Common. Color strongly marked; back purplish black; belly abruptly white; a pale streak along the centers of each row of scales; dorsal, anal, and caudal dark, the tips inky black.

9. Hybognathus nuchalis Agassiz.

Common. Specimens all small.

10. Notropis procne (Cope).

Common.

11. Notropis megalops albeolus Jordan & Meek.

Two small specimens, similar to those from the Roanoke; lower jaw not shorter than upper.

12. Notropis matutinus (Cope).

Common. This species is a member of the group called *Lythrurus*, and it is closely related to *Notropis lirus*. In spirits it is very pale, with a lateral band of dark points and a small black spot at base of dorsal in front, preceded by a dark streak along the middle line of the back. Head $4\frac{1}{4}$; depth $5\frac{1}{2}$ in length; scales 44; 20 to 25 scales before the dorsal.

In life, snout, tip of lower jaw, iris, and membranes of upper half of dorsal red.

13. Notropis niveus (Cope).

Abundant. Similar to that found in the Dismal Swamp.

14. **Notemigonus chrysoleucus** (Mitchill).

Common. Anal rays 16; scales 48; hence referable rather to the southern variety *bosci*.

15. **Hybopsis kentuckiensis** (Rafinesque).

Common. Scales 44.

16. **Semotilus atromaculatus** (Mitchill).

One young specimen approaching *S. thoreauianus*. Color dark; a small black spot at base of dorsal, a larger one at base of caudal; a distinct black lateral band from snout to base of caudal; head rather broad and flattish above; mouth moderate, slightly oblique, the maxillary extending to the front of the very large eye; jaws equal; dorsal inserted behind ventrals; lateral line decurved, only three or four pores developed in this (young) specimen. Head $3\frac{4}{5}$ in length; depth $4\frac{1}{2}$; A. 8; scales 48, 30 before dorsal.

17. **Gambusia patruelis** (Baird & Girard).

18. **Umbra pygmæa** (De Kay).

Rather scarce.

19. **Lucius reticulatus** (Le Sueur).

Common.

20. **Aphredoderus sayanus** (Gilliams).

Rather scarce. Scales 45.

21. **Pomoxis sparoides** (Lacépède).

Common.

22. **Enneacanthus gloriosus** (Holbrook).

A few specimens.

23. **Acantharchus pomotis** (Baird).

Black lengthwise stripes numerous and very distinct in the young.

24. **Lepomis auritus** (L.).

Common.

25. **Etheostoma nigrum effulgens** (Girard).

Common. All the specimens examined have the cheeks naked. Scales 42.

26. **Etheostoma vitreum** (Cope).

Very abundant.

27. **Etheostoma peltatum** Stauffer.

One specimen.

28. **Etheostoma roanoka** Jordan & Jenkins.

Two specimens; head naked; scales 45.

The fauna of the Tar River is essentially that of the Neuse. Probably an extended exploration would show that every species of the one is found also in the other.

G.—THE NEUSE RIVER.

The Neuse River is one of the largest streams of eastern North Carolina. It rises in the middle-northern part of the State and flows east through the pine woods, discharging its waters through a broad estuary into Pamlico Sound.

Collections were made at three points in the basin of the Neuse.

1. *Neuse River* at Millburnie, near Raleigh, N. C., August 27. A dam built upon a ledge of granite crosses the river at Millburnie. Below the dam the river flows rapidly over rocks, with falls and rapids, and among the rocks are many deep holes and pools. The rocks are in many places covered with river-weeds (*Podostemon*, etc.). Below the rocky district are deep holes, with shoals and ripples, the bottom being largely sandy or gravelly. The water in the river, although low, was quite muddy. This is an excellent locality for collecting. Specimens taken in Neuse River, at Millburnie, are marked N in the following list:

2. *Little River* at Goldsborough. August 29; temperature 78°. Collections were made in Little River, near its junction with the Neuse, at points above and below where it is crossed by the railroad from Raleigh. The stream flows through a level region. It consists of deep holes with intervening shoals, the former with bottom of mud or sand, the shoals sandy or gravelly. The bottom of the river is full of submerged logs and snags. The water is clear, but stained somewhat brown from the drainage of cypress swamps. Specimens from Little River are marked L.

3. *Moccasin Swamp.*—Moccasin Swamp is a stream flowing through a cypress swamp and emptying into the Neuse below Goldsborough. The Swamp was not visited, but numerous specimens of food-fishes were obtained from a fisherman who had seined the Swamp at a point about 15 miles from Goldsborough. The species obtained are marked M in the following list:

1. **Amia calva** Linnæus. M. "Black Fish."

Common in the swamps.

2. **Noturus furiosus** Jordan & Meek. L., N. "Tabby Cat;" "Mad Tom."

Common in the Neuse River at Millburnie, where fifteen specimens were taken. One specimen taken in the Little River and one in the Tar.

Specimens were taken at Goldsborough in 1877 by Brayton and Gilbert.

This species is closely allied to *Noturus miurus*, from which it differs in its much larger spines and more pronounced coloration.

3. **Noturus insignis** (Richardson). L., N.

Very abundant, especially in the Neuse. Coloration pale, black margins to caudal narrow and faint, none at all on dorsal and anal; base of dorsal dusky, the fin otherwise pale.

4. **Ameiurus natalis** (Le Sueur). L., M.

Color black; body very plump, the head broad and the spines quite short.

5. **Ameiurus erebennus** Jordan. M.

Common in the swamp. Very close to *A. natalis*, the head becoming broader with age and thus resembling the latter. The pectoral and dorsal spines are however much longer than in the latter.

6. **Ameiurus niveiventris** (Cope). L. N. "Fork-tailed Cat."

Only young specimens. The body seems slenderer, the caudal more deeply forked than in the young of *A. albidus*. A. 21 to 23. Color silvery, the fins darker.

7. **Catostomus nigricans** (Le Sueur). N.

Common.

8. **Erimyzon sucetta** (Lacépède). M., L., N.

Very common; scales 46.

9. **Moxostoma papillosum** (Cope). L., N.

Very common. Snout projecting beyond the very small mouth; head short and broad, with large eye. D. 14, the edge of the fin straightish; caudal lobes equal. Pharyngeal bones weak.

10. **Moxostoma conus** (Cope). L.

A single young specimen. Head very short and small, the short, narrow snout projecting beyond the small mouth; lips full, the posterior truncate. D. 12, the fin high, its free border concave, the first rays being much produced. Caudal deeply forked, the upper lobe a little longer. This species is very closely related to the species found in the Ohio River and Lake Erie, which is apparently *Moxostoma breviceps*[1] (Cope).

11. **Moxostoma crassilabre** (Cope). L.

One large specimen. Body robust, the back elevated; head short, broad, flattish above; mouth moderate, the lips full, the lower truncate behind; snout short, little projecting beyond mouth. Head 5 in length; depth $3\frac{1}{3}$. D. 13. Caudal lobes equal; dorsal with its free edge much incised, the anterior lobe about as long as head. Pharyngeals weak. Color rather dusky; many of the scales with a dusky shade at base; top of head, humeral bar, and especially a broad shade across dorsal fin, blackish. Some red on anal and caudal fins.

Compared with *Moxostoma breviceps* from Cincinnati, this species is much more robust, with larger, broader, and much more flattened head. The eye is larger, the snout much shorter, and the preorbital is much broader. This bone is quite narrow in *M. breviceps*. In *M. breviceps* the top of the head is very convex transversely, the dorsal lobe is $1\frac{1}{4}$ times length of head, and the upper lobe of the caudal is much prolonged.

The resemblance of *M. crassilabre* to *M. aureolum* from Toledo is much greater, the only prominent difference being that *M. aureolum* has the upper outline of the dorsal slightly convex.

M. macrolepidotum (the true eastern form, as distinguished from the western, *M. duquesnei*), from Potomac River, is also very close to *M. crassilabre*. The two have the same general form and coloration and the same form of the mouth and of the dorsal fin. In comparing a single specimen of each, I find that *crassilabre* has a still shorter and blunter head and higher back. The eye in *crassilabre* is $1\frac{1}{2}$ in snout, the head 5 in body. In *macrolepidotum* the eye is $1\frac{3}{5}$ in snout, the head $4\frac{3}{5}$ in body. It is probable that *M. crassilabre* will prove to be a slight variety of *M. macrolepidotum*. *M. duquesnei*, the western red-horse, may differ in the slightly longer head, and in not

[1] This species is described in the fifth edition of Jordan's Manual of the Vertebrates as *Moxostoma crassilabre* (Cope), which is, however, a different species.

having the free edge of the dorsal concave. Its claims to stand as a distinct species are, however, open to much doubt.

12. **Moxostoma cervinum** (Cope). N. "Crawl-a-bottom."

Common. Specimens similar to those from the Roanoke and James, but larger.

13. **Hybognathus nuchalis** Agassiz. N., L.

Very common. Some large specimens taken in the Neuse.

14. **Notropis procne** (Cope). L., N.

Common. The two specimens taken in the Neuse are very pale, with only traces of lateral band and caudal spot.

15. **Notropis hudsonius** (Clinton). L.

One taken.

16. **Notropis megalops albeolus** Jordan & Meek. N.

Scarce.

17. **Notropis niveus** (Cope). L., N.

Very common. The form variable; some specimens almost as deep as those of *N. whipplei*, of which species this may prove to be a variety.

18. **Notropis amœnus** (Abbott). N.

Common in the Neuse. This is apparently the species recorded by Cope (Proc. Am. Philos. Soc., 1870) as *Photogenis leucops=Notropis photogenis*. I am not sure, however, of its identity with the species to which the name *photogenis* was originally given.

19. **Notropis matutinus** (Cope). N.

Rather scarce in the Neuse.

20. **Hybopsis kentuckiensis** (Rafinesque). L., N.

Very common.

21. **Notemigonus chrysoleucus** (Mitchill). N., L.

Common. Scales 48; anal rays 15.

22. **Clupea sapidissima** (Wilson). L., N. Shad.

Young common. A large plant of shad was made in the Neuse at Millburnie about five years ago.

23. **Gambusia patruelis** (Baird & Girard). L., N.

Common. *Haplochilus melanops* Cope, from the Neuse, and *Zygonectes atrilatus* Jordan & Brayton, from Little River, are both based on this species.

24. **Lucius americanus** (Gmelin). L.

25. **Lucius reticulatus** (Le Sueur). M., L.

Common.

26. **Anguilla anguilla rostrata** (Le Sueur). N.

Eels abound in every stream in Carolina east of the Blue Ridge.

27. **Aphredoderus sayanus** (Gilliams). L.

Not rare.

28. Pomoxis sparoides (Lacépède). L., M., N.

Common.

29. Centrarchus macropterus (Lacépède). M., L. "Flyer."

Common in still waters.

30. Enneacanthus gloriosus (Holbrook). L.

Not very common. The large specimens described by me in 1877 under the name of *Enneacanthus pinniger* came from Neuse River, at Kinston, N. C.

31. Acantharchus pomotis (Baird). M. "Mud Perch."

Common in the swamps.

32. Chænobryttus gulosus (Cuv. & Val.). M., N.

Not rare.

33. Lepomis auritus (L.). L., N. "Yellow-belly."

Common. All of the typical northern form.

34. Lepomis holbrooki (Cuv. & Val.). L.

Scarce.

35. Lepomis gibbosus (L.). M. "Sand Perch."

Common.

36. Micropterus dolomieu (Lacépède). M., N.

Common in the streams.

37. Micropterus salmoides (Lacépède). M., L., N. "Chub."

Common, especially in the swamps.

38. Etheostoma vitreum (Cope). N., L.

Very abundant. Scales 57.

39. Etheostoma nigrum (Rafinesque) var. *olmstedi*. N., L.

Very abundant in Little River; less so in the Neuse. Nearly all of these specimens have the upper part of the cheeks partly covered with scales. Some of them are very slender in form, and some are stout; some have the middle line of the belly largely naked. Scales 50; D. IX–15.

40. Etheostoma peltatum Stauffer. N., L.

Common. There are among these specimens all gradations in coloration, from that of the specimens taken in Swift Creek, to the markings of the ordinary *peltatum*. Some specimens have a black lateral stripe scarcely widened at intervals. Some of the specimens have smooth imbedded scales on cheeks, opercles, and nape (=*nevisense* Cope), but most of them, including some of each of the patterns of coloration, have the nape and cheeks wholly naked, the opercle nearly so. *E. aspro* and *E. ouachitæ* are both extremely close to *E. peltatum*.

41. Etheostoma roanoka Jordan & Jenkins. N.

Very abundant in the Neuse River at Millburnie. The specimens are rather smaller than those from the Roanoke, and the ground color is paler, which leaves the markings more sharp.

H.—THE CAPE FEAR RIVER.

The Cape Fear River rises in the uplands of northern North Carolina, its two chief tributaries being the Haw and the Deep Rivers. It flows southward, entering the sea near the cape from which it takes its name. Its tributary streams for more than half its course flow over a soil of red clay, produced by decomposition of granite. Most of these streams are full of yellow clayey sediment all the year around, and hence are not favorable for fish life. No collections of any extent had been made in the Cape Fear Basin previous to our visit. The fauna is evidently substantially identical with that of the Santee and Great Pedee, streams which enter the sea not far from the mouth of the Cape Fear. In several respects its fauna differs from that of the Neuse River, which is more nearly like that of the Roanoke. Our collections in the Cape Fear Basin are all from tributaries of Haw River, in Guilford County, N. C.

1. *Reedy Fork of Haw River* at Fulk's Mill, 11 miles north-northeast of Greensborough. August 25; temperature 74°. This is a rather sluggish stream, stained gray by sediment, its bottom covered with gravel and mud, with many snags. The stream is not a good one for collecting, but this locality is probably as favorable as any, for below the mill the stream shows some current. Species taken here are marked R.

2. A small very clear brook or spring-run, without name, one mile south of Fulk's Mill. August 25; temperature 70°. This stream is full of small fishes; those taken here are marked S.

3. *South Buffalo Creek*, about 5 miles southeast of Greensborough. August 25; temperature 70°. This is a small creek, with rather clear water, and well stocked with small fishes. It contains some long deep pools, on a bottom of gravel. Fishes from this stream are marked B.

4. *Little Allemance Creek*, at a point about 9 miles southeast of Greensborough. August 25; temperature 69°. This is a small stream, very clear, and fed by springs. It has a bottom of gravel. Fishes from this stream are marked A.

1. **Noturus insignis** (Richardson). B., R.

Some very large specimens.

2. **Ameiurus platycephalus** (Girard). B., R.

Very abundant in the river. This species swarms in all the river bottoms from the Cape Fear to the Ocmulgee, reaching a length of something more than a foot. Unlike the other catfishes, it feeds almost exclusively on vegetation, its long intestines being always found crowded with the remains of river weeds. This fact may render it desirable for introduction into streams not adapted for any better fish. It is largely used for food in the regions where it occurs.

I am unable to distinguish *Ameiurus brunneus* Jordan, from *A. platycephalus*. The species varies considerably, and in old examples the head becomes very flat and broad. Excessively abundant as is this species in the Cape Fear, and in the streams further down the coast, it has not yet been noticed in the Neuse or the Roanoke.

3. **Moxostoma papillosum** (Cope). R.

Common. These specimens are quite elongate, and vary somewhat among themselves; fins all red in some, in others the caudal only; edge of dorsal concave. Head 4 to 4½ in length; depth 4⅓. D. 12 to 14.

4. **Minytrema melanops** (Rafinesque). R. "Black Winter Sucker."

Two specimens similar to northern examples; a distinct broad lateral stripe of purplish red in male; snout and anal tuberculate. Scales 44.

5. **Erimyzon sucetta** (Lacépède). R., A., B., S.

Common; scales 39 to 40.

6. **Hybognathus nuchalis** Agassiz. R.

Common.

7. **Notropis procne** (Cope). R., A., B., S.

Extremely common. Specimens larger than any taken farther north; the jet-black lateral band distinct; fins slightly yellowish.

8. **Notropis altipinnis** (Cope). A., B., S.

Very common in the clear streams. This species does not belong to the *atherinoides* or *rubrifrons* type, but it is a very near ally of *N. chiliticus*, *rubricroceus*, *chlorocephalus*, etc. It is most closely related to *N. chalybæus* (Cope), so closely that I am not at all sure that it is distinct from the specimens from Blackwater River, which I have referred to the latter species. The specimens of *N. altipinnis* are, however, much deeper in body, the back more elevated, and the lateral line more decurved; head a little more robust; dorsal fin high; depth 3½ in length; lateral line complete; eye large; scales before dorsal small; color in life greenish, a burnished lateral band formed of black points passing from snout to base of caudal; young with a black caudal spot; no black at base of anal; dorsal, anal, and caudal faintly reddish; snout yellowish in life; lower lip always dusky. Anal rays 9.

9. **Notropis saludanus** (Jordan & Brayton). R.

Scarce.

10. **Notropis niveus** (Cope). R.

Common in the river. These specimens show much variety of form of body and in form of snout. If *N. chloristius* (Jordan & Brayton), and *N. niveus* are really distinct species, both are represented in this collection, the *chloristius* form being more abundant. Dorsal and caudal light brownish yellow in life; snout slightly yellowish.

11. **Notropis scepticus** Jordan & Gilbert. R.

Not rare. Very pale green, the sides silvery. Eye very large, 3 in head. Head and body less elongate than in *N amœnus*, the eye still larger. Scales before dorsal larger, 13 to 15, depth 4½; A. 10. This is apparently the species recorded by Cope as *Photogenis leucops* var., but it can not be the original *Notropis photogenis*. The specimens from the Saluda referred by Jordan & Brayton to *N. photogenis* seem to belong to *N. scepticus*.

12. **Semotilus atromaculatus** (Mitchill). A., B., S.

Very common in the brooks. These North Carolina specimens are almost intermediate between the ordinary species and the more southern *S. thoreauianus*. Scales 48 to 55, usually about 49, less crowded anteriorly than in *S. atromaculatus*. The head is longer and less blunt than in *S. thoreauianus;* 3⅗ in length, 4 in *thoreauianus* (from Tuscaloosa, Ala.), of the same size, the scales in the latter 45. In life the black dorsal spot surrounded by scarlet; base of anal, ventrals, and pectorals pinkish; caudal yellowish.

13. **Notemigonus chrysoleucus** (Mitchill). B.

A. 16. Scales 46, hence of the var. *bosci.*

14. **Lucius reticulatus** (Le Sueur). B.

One specimen. (*Esox affinis* Holbrook.)

15. **Lucius americanus** (Gmelin). B., A., S.

Common in clear brooks. Body with 18 to 20 dark green cross-shades; lower fins all scarlet; upper fins edged above with carmine. Snout extremely short and broad, $2\frac{2}{3}$ in head. Scales 88. Stomach packed full of small minnows. This is *Esox raveneli* Holbrook.

16. **Fundulus rathbuni** Jordan & Meek. R., A., B., S.

Common in the small brooks; scarce in the river.

17. **Anguilla anguilla rostrata** (Le Sueur). R., B.

Common.

18. **Chænobryttus gulosus** (Cuv. & Val.). R.

One specimen. I find no difference except in shade of color, on comparison of this specimen with *Chænobryttus antistius* McKay.

19. **Lepomis auritus** (L.). R., A., B.

Common. These specimens belong to the northern or typical *auritus.*

20. **Etheostoma peltatum** Stauffer. B., A.

Scarce. Colors very bright; a few scales on opercle, none on cheeks.

21. **Etheostoma nigrum** (Rafinesque.) R.

Very abundant in river. Scales 46; some specimens much spotted, especially on head and pectoral. One male with the head black.

I.—THE GREAT PEDEE RIVER.

The Great Pedee, called in North Carolina the Yadkin, rises in the north of the central part of North Carolina and flows nearly southward to the sea, its mouth being in the eastern part of South Carolina. The whole upper course of the stream is through the red clays of the "Piedmont" region. The river itself and most of its tributaries are therefore, for the whole year around, discolored by sediment and unfavorable to fish life. A number of large species of sucker (*Moxostoma*) occur in the river, ascending the smaller streams to spawn in the spring. Large collections of these were made by Professor Cope at the time of his visit in 1869, when they were taken in numbers on the weirs. No specimens of these are, however, obtainable in August, at which time both old and young have retreated to the main rivers. Collections were made by us only in the neighborhood of Salisbury.

1. *Little Yadkin River* (or *South River*) at Lindsay's Mills (South River P. O.). August 24; temperature 72°. This point is about 8 miles north of the city of Salisbury, and not far from the junction of the South River and the Yadkin. The South River is a large and rather shallow stream, flowing swiftly over a gravelly bottom. Its water is grayish yellow, full of sediment. The number of species found is small.

2. *Second Creek*, a tributary of South River, 1 mile further south. August 24; temperature 71°. A very muddy stream, its waters red with clay. Fishes few, similar to those in the river.

3. *Jumping Run*, a small clear "spring branch," 6 miles north of Salisbury. August 24; temperature 69°. In this stream were found *Fundulus rathbuni* and *Notropis chiliticus.*

1. **Noturus insignis** (Richardson).

Common, as everywhere.

2. **Ameiurus platycephalus** (Girard).

Very abundant in the river.

3. **Ameiurus albidus** (Le Sueur).

One specimen. A. 22. Caudal forked.

4. **Hybognathus nuchalis** Agassiz.

Common.

5. **Notropis saludanus** (Jordan & Brayton).

Not rare. Very pale; head 4 to 4¼ in length; most specimens with a black caudal spot.

6. **Notropis chiliticus** (Cope).

Not rare. In life, light green, a distinct silvery lateral band. Lips, snout, and middle of dorsal, anal, and caudal vermilion. Whole body flushed with red in males; usually a black caudal spot. A strongly marked species, allied to *N. chlorocephalus*, *N. chalybæus*, *altipinnis*, etc. It is less robust in form than *N. altipinnis*, the head more slender, and the mouth larger.

7. **Notropis niveus** (Cope).

Common. These specimens seem to be of the typical *N. niveus.* One old male has the body very elongate, the dorsal high. In life more or less bluish, silvery below; a black dorsal blotch; male with dorsal and caudal pale yellowish brown; the tips of the fins and the anal milky.

8. **Notropis pyrrhomelas** (Cope).

Common. This species is well distinguished at all ages by the large eye and mouth and the long anal (of 10 rays) in connection with the black dorsal blotch. Most specimens show a black blotch at base of caudal.

9. **Hybopsis labrosus** (Cope).

Common. Males dark steel-blue, with black markings on back, and especially at base of dorsal; snout and fins all orange. Females very pale silvery, with a bluish streak along sides of tail. Barbel very long. *Ceratichthys zanemus* (Jordan & Brayton), from Saluda River, is identical with *H. labrosus.*

10. **Hybopsis kentuckiensis** (Rafinesque).

Common. This is probably the species described from the Yadkin River, at Salem, N. C., as *Ceratichthys leptocephalus* Girard.

11. **Fundulus rathbuni** Jordan & Meek.

Numerous young specimens taken in Jumping Run.

12. **Lepomis auritus** (L.).

Scarce.

13. **Etheostoma nigrum** (Rafinesque).

Not rare.

14. **Etheostoma peltatum** Stauffer.

Frequent. Scales 55.

J.—THE SANTEE RIVER.

The Santee River is formed by the confluence of a number of large rivers all of which rise on the eastern slope of the Blue Ridge. The headwaters of nearly all these streams are clear and cold, many of them abounding in trout. As these rivers flow southeastward through the red and yellow clays of the "Piedmont" region, the waters become yellow with sediment and the river ultimately formed is scarcely less muddy than the Great Pedee or the Cape Fear. The mouth of the Santee is near that of the Great Pedee, just north of Cape Romain. The name Santee is given to the lower course only of the river, below the junction of the two great branches, the Wateree and the Congaree. The Wateree, called in North Carolina the Catawba, rises in western North Carolina near Swannanoa Gap. It is the largest and the clearest of the tributaries of the Santee. The Congaree is in turn formed by the junction of the Saluda and the Broad. The Saluda, rising in Saluda Gap, South Carolina, is a comparatively clear stream, and its fauna has been investigated by Jordan & Brayton (Bull. U. S. Nat. Mus., XII 1878). The Broad River, rising in North Carolina, is comparatively muddy, as are most of its tributaries, in three of which—the Pacollet, Tiger, and Ennoree—collections have been made. Although the basin of the Santee covers a wide extent of country, with considerable variation in its physical characters, its fish fauna is quite uniform. For the most part the same species were found by us at Marion, Morganton, and Spartanburgh that had previously been found by Cope at Marion, and by Jordan and Brayton at Greenville. In the past summer collections were made at each of the following localities:

1. *Catawba River* near Marion, N. C. August 22; temperature 73°. Collections made at the upper ford, 3 miles northwest of Marion, about a mile below the mouth of Buck's Creek. The character of the river is similar to that of the upper Roanoke; gravelly bottom on shallows, alternating with deep stretches in which the bottom is muddy. The water is warm and somewhat muddy, of a light yellowish color. This is a good region for making collections. Species from this locality are marked C.

2. *Buck's Creek* at Pleasant Garden. August 22; temperature 69°. About 4 miles northwest of Marion, near the post-office of Pleasant Garden, Buck's Creek rises in mountain springs and flows into the Catawba. It is a very clear, strong, swift mountain stream, flowing over gravel and bowlders, the rocks in its bed being covered by river weed (*Podostemon*). It is extremely well stocked with small fishes, the darters especially being very abundant. Species found in this stream are marked B.

3. *John's River* near Morganton. August 23; temperature 74°. John's River flows into the Catawba at a point about 4 miles northeast of Morganton. It is a large, clear stream, having its source in the mountains. Its waters are warmer and less clear than those of Buck's Creek, and its bottom is gravelly rather than rocky. In its upper course it is, however, probably similar to Buck's Creek. Both these streams and the Linville River, which comes into the Catawba midway between them, are suitable for trout. The California rainbow trout, *Salmo irideus*, has been placed in the John's and the Linville, but I have not heard of any results from this plant. Species found in John's River are marked J.

4. *Catawba River* at Morganton. August 23; temperature 74°. The river at the bridge at the northeast of Morganton is broad and shallow, with rocky bottom; the

water very muddy. Catfishes (*Ameiurus platycephalus*) are extremely abundant in the river here. The other fishes obtained are the same as those taken at Marion; the latter locality is more favorable for collecting.

5. *Pacollet River* at Clifton Factory. August 17; temperature 87°. The Pacollet, a large tributary of Broad River, was examined at a point 7 miles northeast of the town of Spartanburgh, S. C. Collections were made below the dam of the Clifton Cotton Factory. The bottom in most places is excessively rocky and the river flows swiftly over the rocks, which are bare of vegetation. In the deep still places, however, the bottom is muddy. The water is very muddy and warm and the river is one altogether unfavorable for the production of fishes. A few specimens (*Moxostoma rupiscartes*, *M. papillosum*, *Ameiurus platycephalus*, *Lepomis auritus*) were obtained from a fisherman who had drawn a coarse seine at a point farther up the river. *Moxostoma rupiscartes* and *Ameiurus platycephalus* are the chief food-fishes in the markets of Spartanburgh. Species found in Pacollet River are marked P.

6. *Tiger River* at Cleveland Shoals. August 18; temperature 76. The Tiger River is a deep, sullen, muddy stream, running through woodland with little current, and ultimately flowing into Broad River. Our collections were made in the North Fork of the Tiger, at a point 6 miles west of Spartanburgh. The river flows in a deep valley, almost a ravine, in the woods. It is crossed by a natural dam of granite making a perpendicular waterfall some 5 feet high, known as Cleveland Shoals. Below the fall the water flows swiftly over angular rocks which are not covered with river weed. The water is rather cold but very muddy, almost red. It contains few fishes and these are of few kinds. These species are marked T.

7. *Forest Creek* near Spartanburgh. August 18; temperature 72°. Forest Creek is a small, clear "spring branch," running swiftly over sand and gravel, and flowing into Tiger River. It was seined at a point 1½ miles west of Spartanburgh. It contains darters and the rare *Notropis lutipinnis*, hitherto known only from the Oconee River.

It is probable that the following list includes almost every species that belongs to the upper waters of the Santee. In the lower course species of *Esox*, *Lepidosteus*, *Amia*, and other lowland fishes doubtless occur. I have *Notemigonus chrysoleucus bosci* from the Congaree at Columbia, S. C., and, according to Dr. Bean, the U. S. National Museum has received *Labidesthes sicculus* from the same locality.

1. **Noturus insignis** (Richardson). B., J., C., T.

Common. The specimens from the Catawba are quite dark in color, the edge of the caudal darker; body less elongate, and the head less depressed than in specimens from further north, the back a little elevated, the pectoral spines a shade shorter than usual.

2. **Ameiurus platycephalus** (Girard). C., J., P.

Very abundant in all the larger streams. Variable in form and color, the range of variation apparently including *A. brunneus*.

3. **Catostomus teres** (Mitchill). C., B.

Rather common.

4. **Moxostoma papillosum** (Cope). C., P.

Rather scarce.

5. Moxostoma rupiscartes Jordan & Jenkins. B., C., J., P., T.

The specimens from the Catawba, Saluda, Ocmulgee, and other rivers south of the Neuse, hitherto referred to *Moxostoma cervinum* by Cope and by the writer, seem to belong to a distinct species, for which we have proposed the name of *Moxostoma rupiscartes*, the latter name in allusion to the vernacular name of "Jump Rocks," by which the species is known in Georgia. It is closely allied to *M. cervinum*, differing chiefly in its smaller scales and more uniform coloration. It reaches a larger size; its lips are larger, and the form of its dorsal fin is somewhat different. It is very abundant in the Catawba, Pacollet, and all other large streams in the Santee Basin. It is less strictly confined to rapids, shoals, and waterfalls than is the case with *M. cervinum.*

6. Campostoma anomalum (Rafinesque). B., J., C.

Rather common; scales 52.

7. Hybognathus nuchalis Agassiz. C., J.

Common.

8. Notropis saludanus (Jordan & Brayton). J., P.

Not rare. It may be that the southern form of this fish is a species distinct alike from the northern *hudsonius* and from the *amarus* of the Potomac. Comparison of numerous specimens shows the following results:

The southern form, *saludanus*, James River to Ocmulgee River, has the head notably longer ($4\frac{1}{6}$ in length in specimens from John's River; $4\frac{2}{5}$ in specimens from Swift Creek); the snout is especially longer, projecting over the inferior mouth; the snout about as long as eye, which is about 4 in head. Teeth 1, 4–4, 0.

Var. *amarus* from the Potomac has head shorter and deeper ($4\frac{1}{2}$ to $4\frac{3}{5}$ in length); eye larger ($3\frac{1}{2}$ in head); caudal spot faint; teeth 1, 4–4, 0.

Var. *hudsonius* (specimens from Michigan City, Ind.), has the head still shorter ($4\frac{2}{3}$ in length); eye $3\frac{2}{5}$ in head, as long as snout; snout blunt; mouth a little more oblique than in *amarus* or *saludanus;* maxillary not to front of eye; teeth 2, 4–4, 1. Caudal spot jet black.

Var. *selene* from Keweenaw, Lake Superior, has the head still shorter ($4\frac{4}{5}$ in body); mouth quite oblique, the premaxillary on level of lower part of pupil; snout $\frac{3}{5}$ eye; maxillary reaching front of eye; caudal spot jet black. Teeth 2, 4–4, 1 or 2.

The extremes, *selene* and *saludanus*, certainly look like very distinct species, but the intergradations are such that it seems safest to regard the whole series as varieties of one species, *N. hudsonius.*

9. Notropis procne (Cope). C.

Abundant in the Catawba, in the river channels; not noticed in the other streams.

10. Notropis chlorocephalus (Cope). B.

Abundant in the clear, swift waters of Buck's Creek. Green in life; dorsal and caudal red at base; sides of head and lateral band on sides red. Adult males with the whole body cherry-red, the back green, lower jaw not black. Allied to *N. rubricroceus.*

11. Notropis lutipinnis (Jordan & Brayton). F.

Six specimens taken in the clear waters of Forest Creek; hitherto known only from a similar locality on the headwaters of the Oconee, in Georgia. In life, pale olive; broad metallic lateral band; iris red; body in male flushed with brownish red; head and fins all bright yellow, without red; scales before dorsal smaller than in related species.

12. **Notropis niveus** (Cope). J., C., P., T.
(Including *N. chloristius* (Jordan & Brayton.)

Abundant. This species is one of the most puzzling in its variations, and I am not yet sure whether it is really distinct from *N. whipplei*, or whether, on the other hand, I have not confounded two species under the name *niveus*.

All the specimens taken in the Catawba, and most of those from the Pacollet, are the typical *chloristius*. This form is very close to *N. whipplei*, the eye a little smaller, the head more slender, the blue stripe on side of tail more distinct. In these the eye is 4 in head, and the body short and deep, the depth $3\frac{3}{4}$ to $4\frac{1}{4}$; scales 36. Two of the specimens from the Pacollet, and most of those from the rivers farther eastward, correspond best to the descriptions of *N. niveus*. In this form the body is elongate, compressed, with the back more elevated. Eye $3\frac{1}{2}$ in head; depth of body $4\frac{1}{2}$ to 5; scales 39. The blue stripe on caudal peduncle is less distinct, and there is a trace of a caudal spot. Head subconic, the thickish snout projecting. The species from the Dismal Swamp region, identified by us as *N. niveus*, is not quite like either of these forms. It is certainly quite unlike *chloristius*. Our collection shows so many intermediate or indeterminable examples that I am compelled to record all under a single name, *Notropis niveus*.

13. **Notropis pyrrhomelas** (Cope). B., C., J., P., T., F.

The most abundant fish in the Santee basin, and one of the most showy of the *Cyprinidæ*, the male retaining its bright colors through the summer.

14. **Notropis scepticus** Jordan & Gilbert. J., C., T.

Not rare. Close to *N. amœnus*, but with the snout shorter and blunter, the eye larger. Specimens show considerable variation in form, but all belong to one species. Scales before dorsal 14 to 16 (Catawba) to 18 (Pacollet). Green in life; sides silvery; no red.

15. **Squalius vandoisulus** (Cuv. & Val.). B.

Abundant in Buck's Creek. Dark lateral stripe very obscure; depth $4\frac{1}{3}$ in length.

16. **Hybopsis hypsinotus** (Cope). P.

One specimen from Pacollet River. An ally of *H. amblops*. A dusky lateral band through eye and snout, ending in a faint caudal spot. Resembles *N. procne*, but with an evident barbel.

17. **Hybopsis labrosus** (Cope). B., J., P.
(*Ceratichthys zanemus* Jordan & Brayton.)

Common in clear water. Male steel-blue; a black spot on back at base of dorsal in front; a dark shade under middle of dorsal; a black blotch on membranes of dorsal, as in *Notropis whipplei* and *niveus;* a dark caudal spot; a plumbeous shade on sides; caudal with a dusky shade on membranes; a dark shade on opercle; snout and all fins bright red; female pale, with faint black blotch on dorsal, and with no red.

This species is in form and coloration remarkably unlike all the others in the genus.

18. **Hybopsis kentuckiensis** (Rafinesque). P., F., B., C., J., T.

Very common; body short and deep; scales 39.

19. **Anguilla anguilla rostrata** (Le Sueur). C., T., P.

Everywhere common.

20. **Salvelinus fontinalis** (Mitchill). B.

Brook trout abound in the headwaters of Buck's Creek, and doubtless also in the Linville and John's Rivers. None were taken by us.

21. **Lepomis auritus** (L.). B., J., C., P.

Common. The specimens from this region belong to var. *solis*, characterized by the slightly larger scales. Usually a dark shade at base of last rays of dorsal.

22. **Etheostoma nigrum** (Rafinesque). B., C., J.

Common in the river channels; scarce in the smaller streams. Scales 44.

23. **Etheostoma peltatum** Stauffer. B., C., J., P.

Frequent. Especially common in John's River. Head usually naked. Scales 52 to 54. Dorsal low, with median black band; second dorsal, caudal, and pectoral sharply banded. D. XI, or XII–14.

24. **Etheostoma thalassinum** (Jordan & Brayton). B., J., F., P.

Much the commonest of the darters, especially abundant among the weed-grown rocks of Buck's Creek. Scales 40. Caudal distinctly lunate. In life, green; mottled in various shades; body with 6 or 7 cross-bars of bluish-green; ventrals and anal bluish-green; fins mottled, not barred; orange on belly and on bases of pectoral and caudal; spinous dorsal edged with orange; a dark spot and a yellow area at base of pectoral; a pale oblique streak below and behind eye.

25. **Etheostoma flabellare** (Rafinesque). B., J.

Common in clear waters. Most specimens have but seven dorsal spines. The number of scales is unexpectedly variable. I count 40, 39, 41, 43, 44, 50, in six specimens.

K.—THE KANAWHA RIVER.

The Kanawha River, called in Virginia the New River, rises on the western slope of the Blue Ridge in western North Carolina, and flows nearly north through Virginia and West Virginia into the Ohio River. Its tributaries are generally clear mountain streams, though the river itself is more or less stained by the yellow clays over which it flows. The fauna of the Kanawha is essentially that of the Ohio, although it contains a few species (as *Exoglossum maxillingua*) not found in any other western waters.

Our collections include but a small part of the fauna of the Kanawha, as the high waters of the middle of September made it necessary to abandon work both on the Kanawha and the James. The three streams examined are all unsuitable for successful collecting.

1. *Peak Creek* at Pulaski, Va. August 4; temperature about 67°. A clear, cold stream with very rocky bottom and many deep holes among rocks. This stream was carefully seined for a distance of about half a mile above Pulaski. It contains great numbers of black bass (*Micropterus dolomieu*) and absolutely nothing else, two small

minnows (*Pimephales notatus*) being the only other fishes obtained. It would seem that dry weather often reduces this creek to a succession of pools. The bass live in these and devour everything else.

2. *Little Peak Creek*, Pulaski, Va. August 4; temperature about 79°. A small tributary of the preceding, into which it flows, in the village of Pulaski. It is a shallow, warm, clear stream, with gravelly bottom, full of little minnows and darters, thus presenting a striking contrast with the preceding creek. The species found here are marked P.

3. *Reed Creek* near Wytheville, Va. August 6; temperature 79°. This stream was seined at various points about 4 miles east of Wytheville. It is a warm, muddy stream, the water gray in color. It flows through cultivated fields and pastures. The bottom is rocky in the shallows, elsewhere muddy. The character of the water makes this an unfavorable stream for collecting.

4. *Hatchery Stream.*—The U. S. Fish Hatchery Station is located on a tributary of Reed Creek, about 5 miles west of Wytheville. The water in this little brook is very cold, the temperature being about 55°.

1. **Catostomus teres** (Mitchill). P., R.

Common.

2. **Catostomus nigricans** (Le Sueur). P., R.

Common in swift waters.

3. **Campostoma anomalum** (Rafinesque). P., R.

Common.

4. **Pimephales notatus** (Rafinesque). P., R.

Common; the only minnow found in Big Peak Creek.

5. **Exoglossum maxillingua** (Le Sueur). R.

Scarce in Reed Creek. The occurrence of this eastern species in the basin of the Kanawha is an interesting fact in geographical distribution.

6. **Notropis microstomus** (Rafinesque). R. *Hybopsis stramineus* Cope.

Rather scarce. Compared with specimens of *stramineus* from the White River at Gosport, Ind., these specimens have the back considerably elevated, the eye a little smaller, the form of the snout and mouth the same, sides silvery, with scarcely a trace of black specks along the lateral line. Scales 36; teeth 4-4.

7. **Notropis kanawha** Jordan & Jenkins. R.

Not rare in Reed Creek.

8. **Notropis scabriceps** (Cope). R.

A single specimen, the first which I have recognized as belonging to this species. The species from Arkansas referred by Jordan and Gilbert to *N. scabriceps* belong to *N. boops* Gilbert, which is probably identical with *N. illecebrosus* (Girard).

Body formed as in *Hybopsis amblops;* head broad, blunt anteriorly; eye very large, longer than snout, 3 in head; snout obtusely rounded in profile; mouth moderate, little oblique, the jaws about equal; the maxillary extending a little past front of eye; scales large, 13 before dorsal; fins small; dorsal over ventrals. A. 8. Color pale greenish above.

9. Notropis photogenis (Cope). R.

A species which I identify with Cope's description is not rare in Reed Creek. It closely resembles *N. rubrifrons* (specimens from White River, at Indianapolis); size, form, and color similar. The eye, however, is larger (3 in head), and there are 25 scales before the dorsal instead of 16. Compared with *N. amœnus*, from Luray, the eye is smaller, the body is more slender, and there are no black specks along the base of the anal fin. Color pale, a bluish streak along side of caudal peduncle; some dark points along lateral lines. Scales 40.

10. Notropis atherinoides (Rafinesque). P., R.

Common in quiet places; reaching a length of 4 to 6 inches. Color translucent green; sides bright silvery. Head $4\frac{1}{5}$ in length; depth $5\frac{1}{2}$; maxillary $2\frac{4}{5}$ in head; eye $3\frac{1}{3}$ to 3. I refer these specimens to *N. atherinoides* (=*rubellus* Agassiz), without being quite certain whether the latter name includes more than one species. This is evidently the species called by Cope *Alburnellus jaculus*.

Specimens from the Holston River agree fully, except that they are a little more slender in body; depth 6.

Specimens from Deer Creek, Indiana, called by Evermann and Jenkins *Notropis arge*, and evidently *Alburnellus arge* Cope, are a very little more robust, but have precisely the same eye, snout, and mouth.

Specimens from the falls of the Ohio (*N. dinemus* Rafinesque) are a little stouter, the eye a shade smaller; the eye, mouth, and head notably shorter; head $4\frac{4}{5}$ in length; eye equal to snout; $3\frac{1}{2}$ in head; maxillary $3\frac{1}{3}$ in head.

Other specimens (*dinemus*) from Pipe Creek (White River), near Anderson, Ind., are similar, but with the snout and mouth longer, thus approaching *arge*.

Still other specimens from Deer Creek, called *atherinoides* by Evermann and Jenkins, have the eye notably smaller and the snout sharper.

N. amœnus, from Luray, is stouter and more compressed, with stouter head and smaller scales before dorsal. It is also less silvery in color. In form of eye and mouth this species scarcely differs from *N. atherinoides* (*arge*).

11. Hybopsis kentuckiensis (Rafinesque). P., R.

Common.

12. Semotilus atromaculatus (Mitchill). P., R.

Common; scales 55.

13. Rhinichthys cataractæ (Cuv. & Val.). R.

Not common; scales about 70.

14. Phoxinus margaritus (Cope). R.

Rather scarce. Scales smaller than in eastern examples. Perhaps this may prove to be a different species. Head $4\frac{1}{2}$ in length; depth nearly the same; mouth very small, anterior; scales 52 to 54 (58 in *margaritus*); 28 scales before dorsal; dorsal quite low, inserted behind ventrals. Color dark, a very distinct caudal spot, and a well-defined black lateral band. The specimens are all small, the largest 2 inches long.

15. Micropterus dolomieu (Lacépède). P., R.

Extremely common. As already stated, the Big Peak Creek is stocked with black bass, to the exclusion of everything else.

16. Ambloplites rupestris (Rafinesque). P.

Abundant in the little mill-pond on Little Peak Creek.

17. Etheostoma blennioides (Rafinesque). P., R.

Not rare.

18. Etheostoma flabellare (Rafinesque). P., R.

Abundant in clear, shallow waters in Little Peak Creek.

19. Cottus bairdi Girard. R.

Not rare.

L.—THE HOLSTON RIVER.

The Holston is one of the three main tributaries of the Tennessee River. Of these three it is the largest and the one most nearly in line with the general course of the river. The Holston is formed by the union of three streams nearly equal in size and similar in physical respects which flow in parallel valleys separated by low mountains or hills. These are the South Fork, the Middle Fork, and the North Fork. All these streams were carefully seined, and it is believed that the present collection includes very nearly all the fishes occurring in the upper tributaries of the Tennessee. Of the large catfish, buffalo-fishes, drums, etc., found in the lower course of the river, no specimens were obtained.

1. *South Fork of the Holston River* at Holstein Mills, Va. August 7; temperature 72°. Holstein Mills lies about 9 miles south of Marion, Va. The river here is very clear, rather cold. Its bottom is rocky and gravelly, and the waters rather swift, there being often an alternation of rapids and deep pools. The stream was fished between the dams in the village, and also below the lower dam. The latter locality is a most excellent one for making collections, one of the very best of all those found by us. Darters (*E. simoterum*) swarm on the bottom, and the swift waters below the dam are literally full of *Notropis rubricroceus* and *N. coccogenis*, both species marked with brilliant red in life. Trout (*Salvelinus fontinalis*) are found above the dams, but the catfish and the black bass do not ascend so far. The California rainbow trout (*Salmo irideus*) has been introduced into this river, and a specimen was lately taken with the hook above Holstein Mills. Species from Holstein Mills are marked S.

2. *Middle Fork of the Holston* at Marion, Va. August 7; temperature 71°. Seined in the town and for about half a mile above the railway station. The stream is similar to the preceding, and equally clear and cold. It has less volume of water, and the bottom is more rocky. The same species were found, and the locality is perhaps equally good for collections. The species obtained are marked M.

3. *Middle Fork of the Holston River* near Glade Spring, Va. August 8; temperature 75°. Seined at a point about 5 miles south of the village of Glade Spring, in and about a ford on the Byers farm. The stream is here considerably larger than at Marion. The water is much warmer and with less current. It flows through pasture land, and the water thereby rendered somewhat gray from clay washed into the river. The bottom is partly rocky, partly gravelly. The locality is not a very good one for collecting, although one species was obtained which has not been seen elsewhere. Species from Glade Spring are marked G.

4. *North Fork of Holston River* at Saltville, Va. August 9; temperature 75°.

The North Fork at Saltville is somewhat larger than either of the other branches at the localities examined. It was seined at the ford, about a mile north of Saltville, and in different places for about one-quarter mile above the ford and nearly a mile below it. The best collecting ground is at the ford itself. Lower down, the river can hardly be seined at all, its bottom being covered with large rocks, which have fallen from a high bluff on a bend of the river. The stream is moderately swift, not very clear, the water warm. In some places large numbers of water plants grow, forming lurking places for small fishes. This is a fair locality for making collections, and two or three new species have been described from this locality by Professor Cope. Species from the North Fork are marked N.

5. *Beaver Creek* near Bristol, Tenn. August 10; temperature 79°. Seined at a point about 4 miles south of the town of Bristol, where the stream approaches the main road. A small, clear tributary called Cedar Creek was also examined, but nothing of special interest found. Beaver Creek is a rather small stream, about 15 feet wide, shallow, and swift. At the locality examined are many smooth, flat rocks inclined at angles. Over these the stream slides in small water-falls interspersed by shallow pools. The stream is warm and rather muddy, flowing mostly through open pastures. Its fauna is scanty, and it was probably less worthy of a visit than any other stream examined by us. Species from Beaver Creek are marked B.

6. *Watauga River* from Elizabethton to Watauga Point, Tenn. August 11; temperature 79°. The Watauga is a large tributary of the Holston, having, like the French Broad, its rise in the plateau of western North Carolina. Its headwaters are cold mountain streams, which abound in trout. At Elizabethton it is a considerable river, with a very rough bottom, often crossed by dam-like ridges of perpendicular rocks. In the shallow places the current is swift, and in the deep still stretches the bottom is so covered with ooze and sawdust that the net can not be used. The water is warm and not very clear, being stained red by the clay soils of the region. It is well stocked with fishes, its channel especially having very large darters. It is, however, a stream not easily worked. Collections were made at all suitable points from the mouth of Doe River, in Elizabethton, to the mouth of Buffalo Creek. Fishes from the Watauga are marked W.

7. *Doe River* at Elizabethton. August 11; temperature 78°. Doe River, near its mouth in Elizabethton, is a very clear stream, having its source in the flanks of Roan Mountain. Its waters are warm, and its bottom is covered with large round bowlders and shingle brought down from the mountains. These rocks have no river weed or other vegetation, and there are but few fishes among them. For so attractive a stream Doe River is a very disappointing one. The absence of darters is doubtless due to the absence of bottom vegetation. Fishes from this stream are marked D.

1. **Noturus miurus** (Jordan). N.

Not rare in the weeds above the ford. The specimens are quite large and the color is rather pale. In general they agree with Indiana examples.

2. **Leptops olivaris** (Rafinesque). W.

Large yellow-cats are taken in the deep channels of all the branches of the Holston. The specimens seen by us were from the Watauga.

3. **Catostomus teres** (Mitchill). S., M., G., B., W.

Common.

4. Catostomus nigricans (Le Sueur). S., M., G., B., W., D.

Common in swift waters.

5. Moxostoma duquesnei (Le Sueur). M., G., N., B., W.

Common in the larger streams. The specimens agree with the common northern red-horse, except that the free edge of the dorsal is decidedly concave. D. usually 13; lower fins red, the caudal pale.

6. Lagochila lacera (Jordan & Brayton). N.

A few specimens taken at Saltville. Scales 45. In life steel-blue; lower fins creamy; snout black; dorsal and caudal creamy, dusky-edged.

7. Campostoma anomalum (Rafinesque). S., M. G., N., B., W., D. "Mammy."

Everywhere common, ascending small streams.

8. Notropis spectrunculus (Cope). M., S., N., G.

A small fish characteristic of the mountain streams. Common at Marion and Holstein Mills; rare at Saltville and Glade Spring. Very pale olive; fins in life pale, dull red or salmon color, no red on snout; black caudal spot always distinct.

9. Notropis microstomus (Rafinesque). N., D.

Scarce. Back rather more elevated than in the specimens called ***stramineus***, some dark specks along lateral line; 13 scales before dorsal.

10. Notropis megalops (Rafinesque). S., G., N., B., W.

Common, but confined to the larger streams, not ascending the colder waters. But one taken at Holstein Mills and none at Marion. The specimens belong to Cope's var. *frontalis* (Agassiz), having 17 scales before the dorsal.

11. Notropis lacertosus (Cope). S., N.

Two young specimens only taken. This seems to be a rare species. It has been known hitherto only from a brief description of a specimen taken by Professor Cope at Saltville.

Color green above; sides silvery; a dark speck on front of opercle. Very close to *N. megalops*, the young of which it resembles in form and squamation, almost the only tangible difference being that the mouth is somewhat larger in *N. lacertosus* and the lower jaw projects. Head $4\frac{1}{5}$ in length; depth $4\frac{1}{3}$; eye a little longer than snout, 3. Maxillary reaching to just past front of eye, 3 in head; mouth oblique, the lower jaw prominent. Lateral line decurved. Scales 5-38-3. 17 before dorsal. Fins all low. Dorsal slightly behind ventrals. A. 8. (Specimen $2\frac{3}{4}$ inches long.)

12. Notropis leuciodus (Cope). S., M., G., N., B., W., D.

Very common, but not ascending the spring branches so far as N. *telescopus*.

Closely related to *N. telescopus*, but distinguished by the short anal, rather smaller eye, usually paler coloration and very distinct caudal spot. Snout a little more obtuse than in *N. telescopus*. Anal rather short and high with 8 rays. Eyes 3 in head; mouth rather smaller and less oblique than in *N. telescopus*, the maxillary $3\frac{1}{2}$ in head, the lower jaw slightly included. Insertion of dorsal midway between tip of snout and base of caudal, a little behind base of ventrals; 13 scales before dorsal. Depth 5 in length. These two species make up the bulk of the small minnows of the Holston region.

13. **Notropis telescopus** (Cope). S., M., G., N., W., D.

Very common; not found in warm creeks (like Beaver Creek), but ascending cold streams farther than the preceding or the next.

Green, silvery below; fins pale; no red, often a faint dusky caudal spot. Scales of back conspicuously dark-edged; the two uppermost rows running into outline of back, the one under the dorsal, the other just behind it. Anal with concave edge and 10 rays. Eye very large, $2\frac{3}{4}$ in head, longer than the sharp short snout; mouth oblique, the jaws equal. Insertion of dorsal midway between snout and base of caudal, a little behind ventrals; 13 scales before dorsal. Depth $4\frac{3}{4}$ to $5\frac{1}{2}$. It reaches a larger size than the preceding, but less than the next.

14. **Notropis atherinoides** (Rafinesque). G., N., W., D.

Abundant in quiet places in the river channels. Very large specimens, 5 inches long, in the Watauga. Eye as long as snout, $3\frac{1}{3}$ in head. Snout sharp; depth 6 in length; 15 scales before dorsal. The specimens are similar to those from the Kanawha basin, but a little more elongate.

15. **Notropis ariommus** (Cope). W.

One specimen taken. Very pale; a silvery lateral band; eye excessively large, $2\frac{2}{3}$ in head, nearly twice length of snout, which is evenly rounded; maxillary $3\frac{1}{3}$ in head, reaching front of eye; mouth oblique; fins low; dorsal over ventrals; head $4\frac{1}{4}$ in length; depth 5; 15 scales before dorsal; anal rays 9.

16. **Notropis coccogenis** (Cope). M., S., G., N., B., W., D.

Everywhere very common, especially in the clear streams, the most abundant of the larger minnows.

Color in life, steel-blue, silvery below; a dash of scarlet on upper lip; axil of pectoral, front of dorsal, and a vertical bar on front of opercle, bright scarlet. Base of caudal milky, tinged with reddish anteriorly; anal and ventrals white.

17. **Notropis galacturus** (Cope). S., G., N., B., W., D.

Associated with the preceding and reaching a similar size, but less abundant and not ascending the small streams so far. Very large specimens have the tip of snout, dorsal, tip of caudal, pectorals, anal, and ventrals flushed with red. Base of caudal conspicuously yellowish-white.

18. **Notropis rubricroceus** (Cope). M., S., D.

Excessively abundant in the clear streams, outnumbering all other species at Marion and Holstein Mills; rare in the rivers; a single specimen only taken in Doe River.

In life, bright green, a steel-blue lateral stripe, becoming darker behind and ending in a distinct caudal spot; a silvery streak below the lateral band; below this a red stripe; snout and lips deep brick-red; base of pectoral scarlet; belly and cheeks, and sometimes back also, flushed with red in old males. This brilliant species reaches a length of nearly 4 inches, and even the young and the females show more or less of red.

19. **Hybopsis amblops** (Rafinesque). S., M., G., N., B., W., D. (*Hybopsis gracilis* Agassiz; *Ceratichthys hyalinus* Cope.)

Rather common in all streams except the coldest; much less abundant than *N. coccogenis*, *rubricroceus*, *leuciodus*, and *telescopus*. No red markings; dark lateral stripe rather distinct. Eye a little smaller than in Indiana specimens, $3\frac{1}{4}$ instead of 3 in head; otherwise similar.

20. **Hybopsis monachus** (Cope). N.

Scarce. Agrees with Cope's description, and well distinguished by the small eye and dark dorsal spot.

21. **Hybopsis watauga** Jordan & Evermann. N., W.

Rather rare in the river channels. Closely related to *H. dissimilis*, but with smaller scales, lat. l. 52, 22 before dorsal, and with more elongate body and less spotted coloration.

22. **Hybopsis kentuckiensis** (Rafinesque). S., M., G., N., B., W., D.

Common everywhere.

23. **Rhinichthys cataractæ** (Cuv. & Val.). S.

In cold streams. But one taken.

24. **Rhinichthys obtusus** Agassiz. S., M. (*Rhinichthys lunatus* Cope, not type.?)

Very abundant in cold streams, not descending to the larger rivers.

In life, back mottled olive, with many scales blackish; a very faint dark lateral band in most specimens; belly silvery; a broad band of creamy yellowish below the black lateral band, this extending on cheeks and lips; fins all creamy; a dark spot at base of caudal; barbel longer than in *atronasus*, the size larger. Scales 70; caudal little forked; upper jaw considerably projecting; eye 5 in head. Insertion of dorsal midway between caudal and eye.

This seems at first sight to be a species quite different from the ordinary *R. atronasus* of the Atlantic rivers. The difference is, however, chiefly one of color. The eye is larger and the barbel shorter in *atronasus*, while the jet-black lateral band is much more prominent.

Specimens from Torch Lake, Michigan (*R. lunatus* Cope), are much like the Holston examples. The coloration is less mottled, the lateral band is obsolete; the mouth is more inferior with shorter and wider cleft. Eye 5 in head, depth 5 in length, scales 62. Dorsal midway between nostril and base of caudal. To the same species or variety the specimens from Clear Creek, Bloomington, Ind., must be referred. This genus is still in need of careful study in order that its scarcely differentiated species and numerous varieties may be known. The distinctive characters given by Mr. Garman in his revision of the group are not very reliable.

25. **Phenacobius uranops** Cope. G., N., B., W.

Common in the river channels; not ascending cold streams. Scales 60; caudal spot distinct.

26. **Fundulus catenatus** (Storer).

Not rare in the river at Saltville; not seen elsewhere.

27. **Micropterus dolomieu** (Lacépède). G., B., W., N.

Common in the river channels; not ascending the colder streams, hence not found at Marion or at Holstein Mills.

28. **Lepomis pallidus** (Mitchill). G.

Sunfishes of all kinds are scarce in the upland streams.

29. **Lepomis megalotis** (Rafinesque). N.

Scarce.

30. **Ambloplites rupestris** (Rafinesque). S., M., G., B., W.

Generally common.

31. **Etheostoma caprodes** (Rafinesque). N., W.

Four large specimens taken in the Watauga River. These are exactly like northern examples. Two specimens, the largest $3\frac{1}{2}$ inches long, taken at Saltville. These, as already noticed by Professor Cope, constitute a "marked variety." The difference is one of color only, these having instead of the usual cross-bands a row of 8 blackish rounded blotches, alternating with smaller ones, much as in *Etheostoma aspro.* Pectorals plain.

32. **Etheostoma macrocephalum** (Cope). G., N.

Rather rare; three specimens from Saltville, one from Glade Spring. Head longer and more slender than in *E. aspro;* maxillary reaching front of pupil, $3\frac{1}{4}$ in head; nape scaly; cheek naked, or with a few rudimentary scales behind eye; opercle with more or less of very small cycloid scales above, never quite naked; eye longer than snout; gill membranes separate; scales on middle line of belly enlarged; scales on body 73, 76, 77, 82, in the four specimens. D. XVI–13. A. II, 10. Head 4 in length. Nine black spots on side, confluent, squarish in form, sharply defined and edged above by a continuous undulating pale streak from eye to base of caudal; fins all, including ventrals, barred; a small, very distinct spot at base of caudal; a median dark shade across spinous dorsal.

33. **Etheostoma squamatum** (Gilbert & Swain). W.

A large species found in the river channels; two taken in the Watauga. In life, dull olive, with eleven obscure dusky spots on side confluent into a narrow dark lateral shade; a black humeral spot and a faint caudal spot; first dorsal orange-shaded anteriorly with a black streak across it. Second dorsal and caudal yellowish orange, barred with dusky; other fins pale yellow. Cheeks, nape, and breast scaly, most of the scales cycloid and not imbricate. Gill membranes united across isthmus, but meeting at an angle. Anal larger than second dorsal; scales 76; those on median line of belly slightly enlarged; lower jaw as long as upper.

This strongly-marked species is a near relative of *E. phoxocephalum* Nelson.

Comparing large specimens of the latter from New Harmony, Ind., with *E. squamatum,* I notice that the color is nearly the same, the lateral band plainer and narrower in *squamatum.* In *phoxocephalum* the spots are more numerous, about fifteen in number, and transverse rather than rounded. The fins are similar in form and color in both, as are also the gill membranes. Head in *squamatum* a little sharper and more depressed, the body slenderer and more compressed. Scales smaller in *squamatum,* 10 to 12 above lateral line, 7 or 8 in *E. phoxocephalum.*

34. **Etheostoma aurantiacum** (Cope). N., W.

Another large species inhabiting river channels. Two young ones taken at Saltville; three large ones in the Watauga.

Color in life olive, tinged with orange; a black lateral band of confluent black blotches; chin and throat deep orange; deep orange on front of spinous dorsal, shad-ing to yellow behind; orange on front of pectoral; a round yellow spot above each interspace in lateral band; a row of small brown spots on each side of back; nape with orange; gill membranes separate; belly evenly covered with fine scales like those on sides; scales firm and even, 101 in lateral line; cheeks, opercles, and nape finely and closely scaled; head bluntish, the mouth rather large; the eye median.

35. Etheostoma simoterum (Cope). B., S., M.

Very abundant in cold, clear waters, but not found in the larger streams. Excessively common about Holstein Mills, the larger specimens beautifully colored. In life, pale green, the dark markings dark green; various scales on the back bronze-red in the center, the neighboring scales light yellow, the bronze markings forming very irregular streaks; belly pale yellow, more or less flushed with bright orange; spinous dorsal pale at base, then a black streak, then pale, each membrane with an orange spot throughout the pale streak, the first two spots of a brilliant scarlet; edge of the fin snuffy-brown; soft dorsal with the rays pale yellowish, the membranes spotted with bronze-brown, a black spot at base of each ray; caudal yellowish, with three wavy black bars; anal and ventrals pale yellowish; pectoral yellowish, faintly barred; head with various green markings; scales 51; breast naked, or partly scaly.

36. Etheostoma swannanoa Jordan & Jenkins. M., S.

Two large specimens of this beautiful species taken at Marion and two at Holstein Mills. It is evidently a species of the cold, clear waters, as it was found rather abundant in the Swannanoa River, near its source.

37. Etheostoma zonale (Cope). B., G., N.

This species seems to be irregularly distributed, perhaps most abundant in the river channels, where the water is neither cold nor clear. The species seems to be very variable in coloration as well as in squamation. The specimens from Saltville are nearly typical; green, with about eight conspicuous cross-bars of grass-green (fainter in female); a brownish-red band across first dorsal (wanting in female); ventrals and pectorals in both sexes creamy orange, barred with green; other fins yellowish, barred with darker; throat naked in some, partly scaly in others; scales 6–49–9 (erroneously given as 11–50–12 in Jordan and Gilbert, Synopsis).

In the single specimen from Glade Spring the markings are very much sharper, the spots well defined, and the dark cross-bars much narrower and more definite, about twelve in number, narrower than interspaces; coloration otherwise similar; scales 50; a few on upper part of cheek only.

In several examples from Beaver Creek the coloration is that of the specimen from Glade Spring; the opercles are scaly, but the cheeks are naked; the scales are, however, much smaller, 7–60–8 (59–60–61 in three examples).

The specimens taken in the French Broad and its tributaries agree essentially with those from Saltville.

38. Etheostoma verecundum Jordan & Jenkins. G.

The single type of this species was taken at Glade Spring.

39. Etheostoma blennioides (Rafinesque.) G., N., D.

Not rare in the larger streams. Scales 76.

40. Etheostoma rufolineatum (Cope). S., M., G., N.

One of the gaudiest of our fishes, frequenting weed-covered rocks in clear water, especially in streams shaded by trees.

In life, male green, the body with longitudinal stripes, each stripe as wide as one row of scales and formed by darker edges of the scales; some of the scales with center spots of bright orange-brown. In each series, usually from 2 to 6 consecutive scales are orange-brown, then an equal number are olive, the olive and orange areas irregularly alternating. Head with an olive-black band through snout to nape; an interrupted band below this, still lower two blackish spots; usually about five black dashes on each side of head, a characteristic color mark; angle of mouth orange. Lips orange except in front; lower jaw with an orange spot; interopercle, opercle, cheek, and first three branchiostegals each with orange spots. Belly orange-yellow; breast deep blue. Fins all bordered with scarlet; a very narrow blackish edge; a narrow pale streak between it and the scarlet. Spinous dorsal straw-color dotted with black and edged with orange; second dorsal similar, more yellow. Caudal scarlet, its center yellow, its base with a large blue-black spot which extends into the yellow. Base of caudal yellow; an orange spot above and below. Anal bright yellow at base, then scarlet with narrow pale and dark edgings. Ventrals similar. Pectorals yellow, with a blackish and a scarlet crescent at base and a subterminal scarlet band.

Females green with 8 faint dark cross-bars, obscure and interrupted. Scales on sides with yellow streaks arranged like the brown streaks on the male. Fins all yellow. Anal and ventrals tinged with orange. Pectorals tinged with orange anteriorly, all the fins with bars of dark spots. Caudal blackish, its base yellow. Head with black markings similar to those on the male, but without scarlet.

41. Etheostoma flabellare (Rafinesque). S., M.

A species of the springs and other cold, clear waters, not descending to the river channels.

42. Cottus bairdi Girard. M., S., G., N., W., D. "Mull-head."

Very common, especially in cold waters.

Few river basins are more favorable for fish life than those of the Holston and Tennessee. The combination of clear, cold waters, a bottom of rock and gravel, and a warm climate is one extremely favorable to fish development.

M.—THE FRENCH BROAD RIVER.

The French Broad is one of the three great rivers whose union forms the Tennessee. Unlike the Clinch and the Holston its course is at right angles to the direction of the mountain ranges. It is therefore far more swift and turbulent than either of the others, and its course lies mostly over metamorphic rather than limestone rocks. The French Broad has its rise in innumerable mountain springs in the plateau of western North Carolina. Above Asheville, a considerable part of its course is through comparatively level pasture land. The soil is here a red clay produced by the disintegration of metamorphic rocks. The stream is therefore more or less red and discolored after rains. Its tributaries are, however, for the most part clear at all times. Some of these are among the most beautiful trout-brooks in the whole course of the Alleghany chain of mountains. High water interfered somewhat with our work in the French

Broad River itself, but two of its tributaries were very fully and satisfactorily explored. It is evident that in no essential respect is its fauna different from that of the Holston. Collections were made at the following points:

1. *French Broad River* at Long Shoals, about 9 miles southeast of Asheville. August 15; temperature 77°. The river at this point is broad, rather swift, and sufficiently shallow to permit fording in low water. The bottom is mostly sandy, with numerous bowlders. The water at the time of our visit was warm and not very clear. It is a poor locality for collections and not much was obtained, only the common minnows, with *Etheostoma zonale* and *Ambloplites rupestris*. From a farmer in the vicinity (Mr. Alexander) we obtained information of the occurrence of the following species of food-fishes:

"River Trout." *Stizostedion vitreum* (Mitchill).
"Jack." *Esox masquinongy* (Mitchill).
"Drum." ? *Ambloplites rupestris* (Rafinesque).
"Sand Sucker." *Catostomus teres* (Mitchill).
"Hog Sucker." *Catostomus nigricans* (Le Sueur).
"White Sucker." *Moxostoma duquesnei* (Le Sueur).
"Blue Cat." *Ictalurus punctatus* (Rafinesque).
"Yellow Cat." *Leptops olivaris* (Rafinesque).

2. *French Broad River* at Hot Springs.[1] August 14; temperature 79°. The river is here, as elsewhere, deep and swift, with very rocky bottom. In the few quiet places the bottom is covered with soft mud. Several hauls with the large seine were made, but not many fishes were taken. Streams of the character of the French Broad can be worked to advantage only at a time of very low water, when the current is not such as to prevent the seining of pools among the rocks. Probably the neighborhood of Marshall, some distance above Hot Springs, will prove the better for making collections than the place selected by us. Collections were made along the front of the hotel property at Hot Springs on both sides of the river and as far down as the mouth of Spring Creek. Species taken in the river are marked F.

3. *Spring Creek* at Hot Springs, N. C. August 13 and 14; temperature 76°. This is a fine clear mountain stream, very swift, with rocky bottom. The water is warm, too warm in its lower course for trout. Collections were made all along the stream from its mouth at Hot Springs to about a mile above the hotel. Only in the lower course of the stream, from the railroad bridge to the mouth, are the rocks covered with river-weed (*Podostemon*). In this region, darters are very numerous and large, but among the bare, angular rocks farther up, scarcely any are found. Above the dam the stream is full of rock bass (*Ambloplites rupestris*), some being taken in every haul of the net. It is stated that a car-load of these fishes sent out by the U. S. Fish Commission were some years ago planted in this stream. If so, the results have been striking enough. This stream, with the Swannanoa and the three forks of the Holston, are recommended as suitable for the introduction of the rainbow trout. Species from Hot Springs are marked H in the following list. Specimens of the "Hellbender" (*Cryptobranchus alleghaniensis*) were taken both in Spring Creek and in the French Broad.

4. *North Fork of Swannanoa River*, at Burnett's Mill, near the foot of Mount Mitchell. August 20; temperature 68°. A clear, cold mountain stream, clearer than any other mentioned in this paper; water swift, with some deep pools; bottom gravelly or with small bowlders, the rocks mainly granite.

[1] Formerly called Warm Springs.

The seven species found here (*Salvelinus fontinalis*, *Rhinichthys obtusus*, *Notropis spectrunculus*, *N. rubricroceus*, *N. telescopus*, *N. coccogenis*, and *Etheostoma flabellare*) are those especially characteristic of the mountain streams of the west slope of the Alleghanies. On comparing the list of the species found in the Swannanoa River with those found in Buck's Creek on the other side of the Swannanoa Gap, it will be seen to what degree the Blue Ridge has been a barrier to the distribution of species in North Carolina. The higher main chain of the Great Smoky Mountains has been no barrier at all because it is broken for the passage of the Watauga, the French Broad, and, farther west, the Little Tennessee. Species from the North Fork of the Swannanoa are marked N. Collections were made near a point 4 miles northwest of Black Mountain Station on the road to Mount Mitchell, just above the pond at Burnett's Mill.

5. *South Fork of Swannanoa River* (called Flat Creek), at Black Mountain Station. August 21; temperature 69°. Collections were made at a point one-half mile south of the station, and for some distance above and below this point.

This is a swift, clear stream, similar to the preceding, the bottom gravelly rather than rocky, the water rather warmer, and the banks less shaded. The Swannanoa River is formed by the union of these two forks, the colder, North Fork having its source in the flanks of Mount Mitchell, the South Fork in the Blue Ridge at Swannanoa Gap. The stream flows into the French Broad above Asheville. The waters become warmer and less clear lower in its course, but the general character remains the same, and the stream is certainly one of the most picturesque in North Carolina. Its fauna is interesting from the abundance of darters. Their presence is however chiefly confined to the rocks bearing river-weed (*Podostemon*). Species from the South Fork are marked S.

6. *Swannanoa River* near Asheville. August 15 and 17; temperature 77°. Collections were made at various points from near the railway station to a point about two miles higher. The water is warm and moderately clear. Its current is fairly swift with alternations of quiet stretches. The gravelly and rocky shoals are excellent for collecting. The fauna differs little from that of Spring Creek or the upper waters of the Holston. The species here taken are marked A.

1. **Noturus eleutherus** Jordan. F.

One young specimen, with very small eyes, apparently identical with the type of *N. eleutherus*.

2. **Leptops olivaris** (Rafinesque). F., S.

Young, not rare in the river channels.

3. **Ictalurus punctatus** (Rafinesque). F.

Young, abundant in the river channels.

4. **Catostomus teres** (Mitchill). A., S., H.

Common in quiet waters.

5. **Catostomus nigricans** (Le Sueur). A., S., H.

Common in shoal waters.

6. **Moxostoma duquesnei** (Le Sueur). F., H.

Young, not rare. In June large numbers of *Placopharynx carinatus* run in the river, but none were seen by us at this time.

7. **Campostoma anomalum**(Rafinesque). H., A., S.

Common.

8. **Notropis spectrunculus** (Cope). H., S., N.

Exceedingly abundant in the headwaters of the Swannanoa; scarce elsewhere.

Body in life very pale greenish; a bluish lateral band; belly white; caudal spot very distinct; fins in the male all pale yellowish red; snout without red.

9. **Notropis galacturus** (Cope). H., A., S.

Rather common.

10. **Notropis coccogenis** (Cope). H., A., S., N.

Very abundant.

11. **Notropis rubricroceus** (Cope). S., N.

In the mountain streams; abundant. In life green, a bright yellowish green lateral streak; a steel-blue lateral band; snout and lower jaw bright red; head and belly red in males; fins all pale yellowish, not red even in largest males.

12. **Notropis telescopus** (Cope). H., A., S., N.

Common.

13. **Notropis leuciodus** (Cope). H., A., F.

Common, but not ascending mountain streams. Some of the specimens from Hot Springs are extremely pale, the caudal spot almost obsolete.

14. **Notropis atherinoides** (Rafinesque). H., A., F.

In channels of the larger streams; specimens similar to those from the Holston.

15. **Phenacobius uranops** Cope. H., A.

Not rare.

16. **Hybopsis monacus** (Cope). H., A.

Not common.

17. **Hybopsis dissimilis** (Kirtland). H., A.

Not rare; specimens highly colored, the blue black spots on back and sides very distinct.

18. **Hybopsis amblops** (Rafinesque). H., A.

Common in the larger streams.

19. **Hybopsis kentuckiensis** (Rafinesque). H., F., A., S.

Everywhere abundant.

20. **Rhinichthys obtusus** Agassiz. S., N.

In mountain streams only.

21. **Salvelinus fontinalis** (Mitchill). N.

Abundant in the headwaters of the Swannanoa and of most other tributaries of the French Broad. Four specimens, each 6 to 8 inches in length, were taken in a single haul of a short seine near Burnett's Mill.

22. **Micropterus dolomieu** (Lacépède). H., A.

Not rare in the larger streams.

23. **Lepomis pallidus** (Mitchill). H.

Scarce.

24. **Ambloplites rupestris** (Rafinesque). H., A.

Abundant in the larger streams, ascending the mountain streams farther than other sun-fishes. Most of the species of this group belong properly to the lowland fauna.

25. **Etheostoma caprodes** (Rafinesque). A.

One specimen taken, of the variety obtained at Saltville.

26. **Etheostoma squamatum** Gilbert & Swain. H.

Four large specimens, the largest $4\frac{3}{8}$ inches in length.

Body green, with dark green markings. First dorsal yellowish green at base, then a dusky band, above this an orange one and finally a dusky edge. Second dorsal pale olive, with brown rays; caudal similar; both fins spotted; anal dusky, mottled; pectorals dull yellow, mottled; ventrals dusky.

27. **Etheostoma evides** Jordan & Copeland. H., A., F.

Abundant; only young specimens taken in the river. These agree in essential respects with specimens from White River, Indiana, but the scales are in most specimens larger. The dark bars on sides are more or less connected by black cross-lines above. The pectorals are barred, these fins being plain in *E. evides.* In *E. evides* there are usually 60 to 65 scales in the lateral line. In specimens from the Swannanoa, I count 52, 54, 55, 55, 53, 52, 58, 60, 60, 62, 63, 62–65, in twelve specimens, the last figures, 62–65, being that of opposite sides of the same specimen.

Color in life: Male, olive, with 8 deep blue-green cross-bars; an orange-brown lateral band forming brown squares between the dark cross-bars; belly orange; breast, throat, and lower jaw orange yellow; cheeks, opercles, jaws and snout, deep rusty orange; a blue-black bar behind eye; a very conspicuous golden crescent before this; spinous dorsal deep rusty orange, its last rays black, the median area more yellow; soft dorsal orange at base fading above and more or less speckled; caudal with two orange spots at base; the fin yellow, with two or three faint black bars; pectoral and anal, yellowish, faintly barred. Female, with very pale yellowish instead of orange; the markings on side black; membranes of dorsal orange at base and tip.

28. **Etheostoma blennioides** Rafinesque. H., A.

Common; specimens from Spring Creek very large, the markings very dark green. D. XIV-13. Scales 67 to 68.

29. **Etheostoma zonale** (Cope). H., A., F.

Rather common; colored like the specimens from Saltville; cheeks more or less scaly; breast naked. Scales 44, 47, 48, 48, 49, 49, 50, in seven specimens.

30. **Etheostoma swannanoa** Jordan & Jenkins. S.

Six specimens taken in the South Fork of the Swannanoa.

31. **Etheostoma rufolineatum** (Cope). H., A.

Common among the river weeds. Scales 45, 47, 48, in three specimens.

32. **Etheostoma camurum** (Cope). H.

One specimen, $2\frac{3}{8}$ inches long, taken in Spring Creek. D. XI–13. Scales 58. Female: in life, green; many scales brown; fins yellowish olive; caudal red; all the vertical fins edged with blackish.

33. **Etheostoma flabellare** (Rafinesque). N., A., S.

Common in clear and cold waters.

34. Cottus bairdi Girard. S., H.

Common in cold waters; those from the South Fork paler and more spotted than usual; those from Hot Springs very dark.

N.—ST. JOSEPH'S RIVER.

St. Joseph's River has its rise in southwestern Michigan. It flows southward into northern Indiana. At South Bend it makes an abrupt turn to the northward, flowing back to Michigan, and ultimately into Lake Michigan. Like most of the Michigan streams, its waters are clear and cold, and it is fed largely by springs. Collections were made at a point between Mishawaka and South Bend, about a mile below the former place. September 17 and 18; temperature 60°; air 55°. The stream is here large, flowing over a bottom of coarse gravel, with sand in the deeper and more quiet portions. The rocks are well covered with algæ and other water-plants, *Chara* being abundant in places. The water was too cold for successful work and the species obtained are those characteristic of the Upper Wabash. This shows that the low and often swampy water-sheds separating the Wabash, Kankakee, and St. Joseph's are of little consequence as a barrier to the distribution of fishes.

1. Catostomus teres (Mitchill).

Scarce.

2. Catostomus nigricans (Le Sueur).

Scarce.

3. Moxostoma aureolum (Le Sueur).

Scarce. Young specimens; the head much shorter, the mouth smaller and lower, than in *M. duquesnei*.

4. Campostoma anomalum (Rafinesque).

Common.

5. Pimephales notatus (Rafinesque).

Common.

6. Notropis microstomus (Rafinesque). (*Hybopsis stramineus* Cope).

Not rare. A small dusky blotch on the middle line of the back before the dorsal is a color mark characteristic of this species.

7. Notropis megalops (Rafinesque).

Common.

8. Notropis rubrifrons Cope.

Common.

9. Hybopsis kentuckiensis (Rafinesque).

Common.

10. Semotilus atromaculatus (Mitchill).

Scarce.

11. Ambloplites rupestris (Rafinesque).

Common.

12. Lepomis megalotis (Rafinesque).

Common.

13. **Lepomis gibbosus** (L.)
Common.

14. **Micropterus dolomieu** (Lacépède).
Common.

15. **Etheostoma nigrum** (Rafinesque).
Scarce; cheeks naked.

16. **Etheostoma aspro** (Cope and Jordan).
Scarce; cheeks naked; opercles scaly. Scales 69.

17. **Etheostoma cœruleum** Storer.
Abundant. Scales 47.
Unios were found very abundant, but cray-fishes were scarce.

O.—KANKAKEE RIVER (ILLINOIS BASIN).

The Kankakee River, the easternmost tributary of the Illinois, rises at a point not far from South Bend, and flows in a southwestward direction, largely through swamps and lakes, into the State of Illinois. One of its chief tributaries in Indiana is Yellow River, which enters it from the east. This stream was seined near Plymouth, Ind., September 18, 1888; temperature, 62°. At Plymouth, the river is rather large, its water very clear, flowing over a bottom chiefly of coarse gravel. The rocks and stones are covered with *Chara*, algæ, and other water-plants. There are also deep pools with stretches of sand and of black mud. Collections were made from the flouring-mill at Plymouth up the stream to the dam. Few streams have been found so well stocked with darters as this, although the number of species is small. Cray-fishes were also excessively abundant.

1. **Noturus flavus** Rafinesque.
Abundant.

2. **Ameiurus natalis** (Le Sueur).
Common in the pools.

3. **Catostomus teres** (Mitchill).
Common.

4. **Catostomus nigricans** (Le Sueur).
Scarce.

5. **Erimyzon sucetta** (Lacépède).
Common.

6. **Minytrema melanops** (Rafinesque).
Scarce.

7. **Moxostoma duquesnei** (Le Sueur).
Scarce.

8. **Campostoma anomalum** (Rafinesque).
Common.

9. **Pimephales notatus** (Rafinesque).
Scarce.

10. Notropis microstomus (Rafinesque).

Scarce.

11. Notropis heterodon (Cope).

Not rare. Lower jaw black at tip; lateral line nearly or quite complete.

12. Notropis megalops (Rafinesque).

Common.

13. Notropis whipplei (Girard).

Common. These specimens are rather slender and seem to represent the form called *Photogenis spilopterus* by Cope.

14. Notropis rubrifrons (Cope).

Scarce.

15. Hybopsis kentuckiensis (Rafinesque).

Common.

16. Lucius vermiculatus (Le Sueur).

Common among weeds.

17. Aphredoderus sayanus (Gilliams).

One specimen, very dark. Scales 51.

18. Ambloplites rupestris (Rafinesque).

Common.

19. Chænobryttus gulosus (Cuv. & Val.).

Common.

20. Lepomis pallidus (Mitchill).

Common.

21. Lepomis megalotis (Rafinesque).

Common.

22. Micropterus dolomieu (Lacépède).

Common.

23. Micropterus salmoides (Lacépède).

Scarce.

24. Etheostoma nigrum (Rafinesque).

Abundant.

25. Etheostoma aspro (Cope and Jordan).

Very abundant. Specimens of very large size, some of them more than 4 inches long, and all extremely plump, and very dark in color. These look quite unlike the ordinary *E. aspro*, but they differ in no structural character. Scales 63.

26. Etheostoma zonale (Cope).

Very abundant. Coloration usual; the ventrals speckled; the green bands extending around body below. Cheeks and breast scaly. Scales 50.

27. Etheostoma cœruleum (Storer).

Abundant.

28. Cottus bairdi Girard.

Scarce.

P.—UPPER WABASH RIVER.

The Wabash River has its rise in the streams and springs of western Ohio and northern Indiana. The main stream flows from Ohio westward across the northern central part of Indiana, then turns gradually to the southward, and forms nearly half of the boundary line between Indiana and Illinois. The Upper Wabash and most of its tributaries are clear streams, many of the latter having their source in lakes. Collections have been made by Mr. Evermann at the following points:

1. *Blue River*, Columbia City, Ind. (Collection of W. E. Clapham, November 5, 1888.) Blue River is a small tributary of Eel River, itself a branch of the Wabash. It has a gravelly bottom, with many large bowlders. Water plants are few. The water is moderately clear and cold. Collections were made at points from the Eel River railroad bridge, down the stream to the brewery. Species from this locality are marked B.

2. *Eel River* at Logansport. September 21; temperature 68°. The Eel River rises in Whitley County east of Columbia City, and flows southwestward, entering the Wabash at Logansport. It is a rather clear stream. In the neighborhood of Logansport its bottom is of limestone and very rough, being full of pot-holes and large stones. The stream was seined from the second dam to the mouth. Near its mouth are some gravelly stretches and a few patches of water plants. Species taken in Eel River are marked E.

3. *Lake Maxinkuckee.* September 19; temperature 68° to 70°, the latter in shallow water, the former at 8 feet depth. This is a clear lake, some 3 miles long by 2 broad, in Marshall County, Ind. Its outlet is a small stream which flows into Tippecanoe River. Collections were made in shallow water along the shore at Long Point. The bottom here is sand or fine gravel, in many places covered with algæ. The seine was drawn in the outlet of the lake, on muck bottom, among lily pads. The species obtained are marked M. The number of species found in the lake is here, as elsewhere, less than the number to be obtained from the tributary streams.

4. *Tippecanoe River*, Marshland, Ind. September 20; temperature 68°. The Tippecanoe River is a very clear, cold stream, having its rise in the deep lakes about Warsaw, Ind., flowing south-westward, and entering the Wabash above La Fayette. At Marshland, 5 miles south of Lake Maxinkuckee, the water is very clear, with gravelly bottom and many water plants. Collections were made at a point just above the Vandalia Railroad bridge.

This is one of the best streams in the State for the collection of darters. Species from Tippecanoe River are marked T.

5. *Deer Creek*, Camden, Ind. September 21. Deer Creek is a rather small, clear stream, flowing into the Wabash from the east, its mouth being at Delphi, Ind.

Collections were made at points from the head of the mill-race above Camden to the wagon bridge south of the town. The bottom is generally of coarse gravel, with swift places alternating with quiet stretches over sandy bottom. Specimens from Deer Creek are marked D.

1. **Lepisosteus osseus** (L.). M.

Common in the lake.

2. **Ameiurus natalis** (Le Sueur). M., T., D.

Common.

3. **Noturus gyrinus** (Mitchill). M.

Scarce.

4. **Noturus miurus**, Jordan. T., D.

Common among weeds. Specimens from Tippecanoe River are very plump and dark in color.

5. **Ictiobus difformis** (Cope). E.

6. **Catostomus nigricans** (Le Sueur). T., E., D., B.

Common.

7. **Erimyzon sucetta** (Lacépède) (var. *oblongus*). T.

Common.

8. **Moxostoma duquesnei** (Le Sueur). E., D.

Common.

9. **Campostoma anomalum** (Rafinesque). E., D., B.

Common.

10. **Pimephales notatus** (Rafinesque). M., T., E., D.

Common.

11. **Ericymba buccata** Cope. D.

Rather rare, in sandy or gravelly streams only.

12. **Notropis heterodon** (Cope). M.

Scarce.

13. **Notropis microstomus** (Rafinesque). E.

Scarce.

14. **Notropis whipplei** (Girard). T., E., D.

Common.

15. **Notropis megalops** (Rafinesque). T., E., D., B.

Common.

16. **Notropis atherinoides** (Rafinesque). T., E.

Large specimens of the form called *Notropis arge*.

17. **Notropis rubrifrons** Cope. T., E., D.

Common in the smaller streams.

18. **Hybopsis watauga** Jordan & Evermann. T.

A few specimens similar to those from the Holston. Scales 46; 20 before dorsal.

19. **Hybopsis amblops** (Rafinesque) T., E.

Common.

20. **Hybopsis kentuckiensis** (Rafinesque) T., E., D., B.

Common.

21. **Semotilus atromaculatus** (Mitchill). D.

In small brooks.

22. **Umbra limi** (Kirtland). D., B.

Rather scarce.

23. **Fundulus diaphanus** (Le Sueur). M.

Abundant in the lake. These belong to var. *menona* Jordan & Copeland, distinguished from the eastern *diaphanus* by the more distinct dark cross-bands and by the presence of dark spots on the back.

24. **Zygonectes notatus** (Rafinesque). D.

Scarce.

25. **Zygonectes dispar** Agassiz. M.

Not rare in the lake.

26. **Lucius vermiculatus** (Le Sueur). M., T., B.

Common.

27. **Labidesthes sicculus** Cope. M., T., E., D.

Common.

28. **Aphredoderus sayanus** (Gilliams). B.

Scarce.

29. **Pomoxis sparoides** (Lacépède). M.

Common in the lake.

30. **Ambloplites rupestris** (Rafinesque). M., T., E., D., B.

Common.

31. **Lepomis pallidus** (Mitchill). M.

Common in the lake.

32. **Lepomis megalotis** (Rafinesque). M., T., E.

Common.

33. **Lepomis gibbosus** (Linnæus). M.

Common in the lake; not found in the Lower Wabash.

34. **Micropterus dolomieu** (Lacépède). M., T., E., D.

Common in swift waters.

35. **Micropterus salmoides** (Lacépède). M., B.

Common in quiet waters.

36. **Perca flavescens** (Mitchill). M.

Common in the lake; not found in the Lower Wabash.

37. **Etheostoma pellucidum** Baird. E.

Common in sandy clear rivers.

38. **Etheostoma nigrum** (Rafinesque). M., E., B., T., D.

Common.

39. **Etheostoma blennioides** (Rafinesque). T., E., D., B.

Common; very large specimens in Tippecanoe River.

40. **Etheostoma caprodes** Rafinesque. E.

41. **Etheostoma phoxocephalum** Nelson. E.

42. **Etheostoma aspro** (Cope & Jordan). E., D., B.

Rather common.

43. Etheostoma scierum (Swain). T.

Very abundant in Tippecanoe River; the largest specimens yet seen; the largest about 5 inches in length. Colors dark, and the body very plump, much as with *E. aspro* in Yellow River. Scales 68; cheeks and opercles scaly; breast usually so; base of caudal with 3 to 4 dark spots in a cross-series. In *E. aspro* there is usually a single spot at base of caudal, more distinct than in *E. scierum.*

44. Etheostoma evides (Jordan & Copeland). T., E.

Not rare. Scales 55.

45. Etheostoma camurum (Cope). T.

Several fine specimens. Colors in life: Sides light brown, with 12 to 15 very narrow greenish lines running from pectorals to caudal; three rather plain vertical bars of the same color, but much broader just back of the pectorals, faint traces of 5 or 6 others between them and the tail; about 50 to 60 small deep orange spots scattered irregularly over the sides; axils dusky; belly pale bluish green; throat and chin deeper blue; top of head and cheeks light brown, more or less mottled with darker. Spinous dorsal uniform light brown, or greenish; soft dorsal deeper brown with a series of reddish spots near the top; above these a pale line above which is a still darker line forming the border of the fin, and same as soft dorsal; pectorals pale brown, darkest on outer half; ventrals same, but outer half a little darker than pectorals; caudal light brown with some dark near the middle, a reddish brown bar near the tip; outside this a pale bar, the extreme tip of the fin being a pale green. Scales 53; snout bluntly decurved.

46. Etheostoma maculatum Kirtland. T., D.

One specimen of this rare species taken in Deer Creek, and four in Tippecanoe River. Scales 56; cheeks without the dark spots found in its nearest relative *E. rufolineatum.*

47. Etheostoma *Species nova.* T.

Four specimens of this handsome little fish taken in Tippecanoe River.

They apparently belong to an undescribed species, closely allied to *E. cœruleum*, but with the head more pointed, the lower jaw more prominent, the dark cross bands nearly vertical, and the scales thickly dusted with dark points. We wait until larger specimens are obtained before giving it a name.

48. Etheostoma cœruleum Storer. M., E., T., D., B.

Very common.

49. Etheostoma flabellare (Rafinesque). T., D., B.

In cold waters; rather scarce.

50. Cottus bairdi Girard. B.

Scarce.

Q.—THE LOWER WABASH RIVER.

Towards its junction with the Ohio the Wabash becomes a large river with moderate current, the water not very clear, and the bottom covered with gravel and sand in which grow many water plants. The tributary streams are mostly sluggish and yellow with clay and mud. The fish fauna of the Lower Wabash was found to be unexpectedly rich, its most striking feature being the abundance of several species

(*Noturus nocturnus*, *Etheostoma uranidea*, *E. ouachitæ*, *E. histrio*) supposed to be confined to the rivers of Arkansas, as well as of other species (*E. phoxocephalum*, *E. chlorosoma*, *E. jessiæ*, *E. shumardi*) more at home on the western side of the Mississippi.

A similar feature in distribution is the presence along the Lower Wabash (according to Prof. John M. Coulter) of numerous southwestern plants, nowhere else found so far north.

1. *Wabash River* at Vincennes. September 15; temperature 74°. Collections were made at a point 1½ miles north of Vincennes. Here the river is shallow on the Indiana side. No great depth is reached within a hundred yards of the shore. The bottom is of gravel and sand at this point, the gravel near shore being covered with *Spirogyra* and other algæ. The current is swift, although not breaking into ripples. Some muddy bayous tributary to the river were also seined. Species from the Wabash at Vincennes are marked V.

2. *Wabash River* at New Harmony. September 13; temperature 74°. Many years ago the New Harmony "community" dug a canal across the peninsula just below New Harmony. At the lower end of this "cut-off" was built a dam and a mill. The main current of the Wabash now flows through this channel. Collections were made at the old dam. At this point the bed of the stream is of sandstone. The current is broken up into narrow rapids and little falls, furnishing excellent localities for darters. Collections were also made on a shallow gravel bar near the mouth of Black River, near New Harmony. Species from the Wabash River at this point are marked W.

A number of species from the Wabash River at New Harmony were seen in the collection of Mr. James Sampson, of New Harmony. Such species are marked S.

3. *Black River* at New Harmony. September 12; temperature 76°. This is a small stream with muddy bottom and sluggish current. Collections were made from a point some 300 yards above the mouth down to the mouth of the stream. In one place the stream flows over gravel with considerable current. Species taken in Black River are marked B.

4. *Gresham's Creek*, New Harmony. September 12; temperature 77°. Collections were made at a point 1½ miles east of New Harmony. The stream is very small and shallow, the water a few inches deep, the bottom and shores sandy. Species obtained in Gresham's Creek are marked G.

5. *Patoka River* at Patoka, Gibson County. September 14; temperature 75°. The Patoka is a very sluggish and muddy stream of considerable size. It rises in the central part of southern Indiana, and flows westward, entering the Wabash near the mouth of White River, about half way between Vincennes and New Harmony. At the point examined at Patoka (just below the dam and one-fourth mile below the Evansville and Terre Haute Railroad bridge) the stream is shallow and swift for a hundred yards or more, and the bottom is covered with shingle from an outcropping ledge of coarse shale. Darters are abundant, the species being nearly the same as those found by Jordan & Gilbert in a similar stream; Poteau River, in Indian Territory. Species from Patoka River are marked P.

6. *Big Creek*, Lynn Township, Posey County, Ind. September 10; temperature 77°. Big Creek is a small, sluggish stream with warm and muddy water, and bottom and banks of mud. It flows westward through Posey County, entering the Wabash River below New Harmony. Collections were made at a point 6½ miles north of Mount

Vernon, Ind. In one locality an outcrop of sandstone gives a hard bottom for some distance. Elsewhere the stream is full of logs and snags. Species found in this creek are marked C.

7. *Wabash River* at Mackey's Ferry, Posey County. September 11; temperature 75°. At Mackey's Ferry, 7 miles west of Mount Vernon, and about 10 miles north of the mouth of the Wabash, considerable collections were made. The seine was used on a long, shallow, sandy bar on the Indiana side. Numerous catfishes, sunfishes, and cyprinodonts were taken in a neighboring pond or bayou. This overflows in spring and is then connected with the river. It is a long, narrow channel, very stagnant, filled with snags in most places, and having an extremely muddy bottom. Species from the pond or river at Mackey's Ferry are marked M.

1. **Petromyzon concolor** (Kirtland). S.
2. **Polyodon spathula** (Walbaum). S.
3. **Acipenser rubicundus** Le Sueur. S.
4. **Lepisosteus osseus** (Linnæus). S.
5. **Lepisosteus platystomus** (Rafinesque). V., W., M.
6. **Lepisosteus tristœchus** (Bloch & Schneider). S.
7. **Amia calva** Linnæus. M.
8. **Noturus gyrinus** (Mitchill). C.
9. **Noturus miurus** Jordan. V., P., W.
10. **Noturus flavus** Rafinesque. V., W.
11. **Leptops olivaris** (Rafinesque). P.
12. **Ameiurus melas** (Rafinesque). G.
13. **Ameiurus natalis** (Le Sueur). M., C.
14. **Ictalurus punctatus** (Rafinesque). V., P., W., B., M., C.
15. **Ictiobus cyprinella** (Cuv. & Val.). M.
16. **Ictiobus bubalus** (Rafinesque). V., W., M.
17. **Ictiobus difformis** (Cope). V., P., W., M., C.
18. **Catostomus nigricans** (Le Sueur). V.
19. **Erimyzon sucetta** (Lacépède). G. Var. *oblongus*.
20. **Minytrema melanops** (Rafinesque). W., G., M.
21. **Moxostoma duquesnei** (Le Sueur). V., P.
22. **Moxostoma aureolum** (Le Sueur). W.

Head 4¾ in length; outline of dorsal somewhat concave.

23. **Moxostoma anisurum** (Rafinesque). B. (*Ptychostomus velatus* and *collapsus* Cope. *Catostomus carpio* Val. *Moxostoma valenciennesi* Jordan.)

Not rare. Lips moderate, the lower strongly ʌ-shaped; its surface rather finely plicate and also papillose; the papillæ coarser than in *M. papillosum*, to which this species is related; mouth not large, the snout projecting beyond it; dorsal high, of 15 rays, its free edge straight; eye large, 3⅔ in head; head large, broad, and flat above; body deep, compressed.

24. **Campostoma anomalum** (Rafinesque). V., G.
25. **Hybognathus nuchalis** (Agassiz). W., M., C.
26. **Pimephales notatus** (Rafinesque). V., P., W., G., C.
27. **Cliola vigilax** (Baird & Girard). V., W., B., M., C.
28. **Notropis microstomus** (Rafinesque). W.

29. **Notropis heterodon** (Cope). V.

30. **Notropis megalops** (Rafinesque). V., P., W., B., M., C.

31. **Notropis whipplei** (Girard). V., P., W., B., G., C.

One very large specimen, besides many of the usual type.

32. **Notropis atherinoides** (Rafinesque). V., P., W.

These specimens are smaller, more compressed, with shorter snout and paler coloration than the ordinary *atherinoides* (*jaculus*, *arge*). The eye is similarly large, and no other difference is evident.

33. **Notropis dilectus** (Girard) var. W., C., G., M.

Compared with specimens of *Notropis dilectus* from Red River, Arkansas, these examples have the eye much smaller—about $3\frac{2}{3}$ instead of 3—in head. In all other respects they seem to agree. Compared with *N. rubrifrons* these specimens have smaller eye, shorter and blunter head ($4\frac{1}{2}$ in length), and the body more compressed. For the present we refer them to *N. dilectus*. No group of minnows is in more confusion than the one to which this species belongs.

34. **Ericymba buccata** Cope. G.

Found in clear waters with sandy bottom.

35. **Hybopsis hyostomus** Gilbert. V., W.

36. **Hybopsis dissimilis** (Kirtland). V., W.

37. **Hybopsis storerianus** (Kirtland). V., W., M., C.

38. **Semotilus atromaculatus** (Mitchill). G.

39. **Opsopœodus emiliæ** Hay. W., M., C.

40. **Notemigonus chrysoleucus** (Mitchill). W., G., M., C.

41. **Dorosoma cepedianum** (Le Sueur). P., W., M..

42. **Clupea chrysochloris** Rafinesque. M.

43. **Hiodon alosoides** (Rafinesque). W.

44. **Gambusia patruelis** (Baird & Girard). M., B., G.

45. **Zygonectes dispar** Agassiz. V., M.

46. **Zygonectes notatus** (Rafinesque). C., M., G., B., W., V., P.

47. **Lucius vermiculatus** (Le Sueur). M.

48. **Lucius lucius** (Linnæus). S.

This species was described from New Harmony by Le Sueur, as ***Esox deprandus***.

49. **Labidesthes sicculus** Cope. M., P., W.

50. **Aphredoderus sayanus** (Gilliams). S., C.

Scales 48.

51. **Pomoxis annularis** Rafinesque. W., M.

52. **Pomoxis sparoides** (Lacépède). V., P., W.

53. **Chænobryttus gulosus** (Cuv. & Val.). V., W., M.

54. **Lepomis cyanellus** Rafinesque. V., G.

55. **Lepomis pallidus** (Mitchill). V., W., M.

56. **Lepomis megalotis** (Rafinesque). P., W., M.

57. **Lepomis garmani** Forbes. M.

Rather common in the pond at Mackey's Ferry.

58. **Lepomis humilis** (Girard). C.

59. **Lepomis notatus** (Agassiz). M.

60. Micropterus dolomieu (Lacépède). V., M.

In the river only.

61. Micropterus salmoides (Lacépède). P., M., V., W., B.

In ponds and bayous chiefly.

62. Etheostoma pellucidum Baird. W., M.

63. Etheostoma asprellus (Jordan). V., W.

Specimens of very large size, the largest 5½ inches long. Scales 98. Three broad oblique black shades across back, extending downwards and forwards to lateral line; these about as wide as the interspaces.

64. Etheostoma nigrum (Rafinesque). V., W., P., B., G., M., C.

Very common.

65. Etheostoma chlorosoma (Hay). W., C., M. (*Boleosoma camurum* Forbes.)

Scales 45; lateral line incomplete.

66. Etheostoma copelandi (Jordan). W., V.

Scarce. Scales 48.

67. Etheostoma histrio Jordan & Gilbert. P.

Seven specimens, some of them considerably larger than any of the original types. Blotch at base of caudal very distinct. Cheeks naked; opercles naked or with some large scales. Scales 53; dorsal spines 10. Premaxillaries protractile, in some specimens with a slight frenum at base, crossed by a crease. The species seems to be an ally of *E. simoterum*, and should be placed with the latter in the subgenus *Ulocentra.*

68. Etheostoma shumardi (Girard). V., W.

Many fine large specimens, 3 to 3½ inches in length; belly largely orange-yellow in life. Anal very high. Scales 52; scales of belly small, those of the middle line caducous; premaxillaries usually distinctly protractile, one specimen, however, with a small but unmistakable frenum at base of premaxillaries.

69. Etheostoma uranidea (Jordan & Gilbert). V., W.

Many specimens 3 to 3½ inches long, much larger than the original types; grayish above, yellow or orange below; an obscure lateral band of dark blotches; four black oblique bands extending downward and forward on back. Cheeks naked; opercles scaly. Scales 52; median line of belly with slightly enlarged scales, which are probably caducous. This handsome species is closely allied to *E. shumardi* and belongs to the group called *Imostoma.*

70. Etheostoma caprodes Rafinesque. M., V., W., P., B.

71. Etheostoma phoxocephalum Nelson. C., V., W., P.

Common.

72. Etheostoma aspro (Cope & Jordan). W., C.

Rather scarce.

73. Etheostoma ouachitæ (Jordan & Gilbert). P.

Five specimens, 2½ to 3 inches long, larger than the original types from Washita (Ouachita) River, Arkansas. Scales 52 to 56. The close resemblance of this species to the eastern *E. peltatum* has been already noticed.

74. Etheostoma scierum (Swain). V., P., W.

Common. Scales 68; ventral scales slightly enlarged but probably caducous; color very similar to that of *E. aspro*, but with usually three dark spots at base of caudal instead of one; lateral shades broader. Gill-membranes considerably united; preopercle serrulate, at least in young specimens.

75. **Etheostoma evides** (Jordan & Copeland). W., V.

Common in the river. Scales 61.

76. **Etheostoma cœruleum** Storer. V.

Less common than farther north. Scales 46.

77. **Etheostoma jessiæ** (Jordan & Brayton). V., W., C.

This species seems here to approach very closely to *E. cœruleum*, there being very little difference in the specimens from Vincennes except that *cœruleum* has naked cheeks while in *jessiæ* the cheeks are scaly. Scales 50, 54, 55, 55 in four specimens. The species or group of species called *E. jessiæ* (*E. asprigene*, *E. swaini*) is much in need of farther study.

E. iowæ Jordan & Meek has a form more like that of *E. eos* (*fusiforme* var.), and color markings similar to those of the latter, including three spots at base of caudal; its lateral line is, however, nearly straight, as in *E. jessiæ*.

78. **Etheostoma squamiceps** Jordan. G., B.

In shallow, sandy streams. This species is allied rather to *E. whipplei* than to *E. flabellare*. Scales 55 to 60; opercles scaly; cheeks scaly or naked; three dark spots across base of caudal; no bright red or blue markings; body covered with dark specks.

79. **Etheostoma fusiforme** (Girard). W., C.

Rather scarce. These specimens represent the form or variety called *palustre*.

80. **Aplodinotus grunniens** (Rafinesque). P., W., M.

Common.

R.—LOWER OHIO RIVER.

Collections were made in two streams tributary to the Ohio in southwestern Indiana.

1. *Big Pigeon Creek* at Evansville, Ind. September 10. This is a sluggish, muddy stream, usually with muddy bottom. Collections were, however, made at a point where the bottom is of sandstone and shingle. The rocks are smooth and bare, there being no algæ or other vegetation in the stream. The following is the list:

1. **Noturus nocturnus** Jordan & Gilbert.

Head much less broad than in *N. gyrinus* and less blunt; no black streak along side of body; pectoral spine $2\frac{1}{4}$ in head, *its inner edge entire*. In the latter respect these two specimens differ from the Arkansas types of *N. nocturnus*.

2. **Leptops olivaris** (Rafinesque).
3. **Ictalurus punctatus** (Rafinesque).
4. **Ictiobus bubalus** (Rafinesque).
5. **Ictiobus difformis** (Cope).
6. **Moxostoma duquesnei** (Le Sueur).
7. **Hybognathus nuchalis** (Agassiz).
8. **Notropis megalops** (Rafinesque).
9. **Notropis whipplei** (Girard).

10. **Notropis dilectus** (Girard).
11. **Dorosoma cepedianum** (Le Sueur).
12. **Clupea chrysochloris** Rafinesque.
13. **Zygonectes notatus** (Rafinesque).
14. **Pomoxis annularis** Rafinesque.
15. **Micropterus salmoides** (Lacépède).
16. **Etheostoma flabellare** (Rafinesque).
17. **Aplodinotus grunniens** (Rafinesque).

2. *Cypress swamp*, Mount Vernon, Ind. September 11; temperature 74°. A small collection was made in a cypress swamp 5 miles east of Mount Vernon. It is a rather deep, stagnant slough, full of logs and brush, with much *Lemna* and *Chara*. The following species were taken:

1. **Opsopœodus emiliæ** Hay.
2. **Zygonectes notatus** (Rafinesque).
3. **Zygonectes dispar** (Agassiz).
4. **Lepomis pallidus** (Mitchill).
5. **Chænobryttus gulosus** (Cuv. & Val.).
6. **Pomoxis sparoides** (Lacépède).
7. **Etheostoma chlorosoma** (Hay).
8. **Etheostoma fusiforme** (Girard).

8.—WHITE RIVER.

The White River rises in various branches in the eastern and central part of the State of Indiana, running southwestward and entering the Wabash near Patoka. It is for the most part a clear stream, flowing with a gentle current over sand and fine gravel. Of the two large and nearly equal branches the west fork is the clearer, and its bottom is more sandy and freer from mud than that of the other. The extensive collections already made in the west fork by the writer and others at Indianapolis, Gosport, and Bloomington, have been elsewhere recorded.

Collections were made by Messrs. Evermann and Bollman at Spencer, Ind., and also in a tributary called Eel River at Cataract, in Owen County, north of Spencer.

At Spencer the bottom of the river is mostly muddy or sandy, with an occasional stretch of rocky ripples. Collections were made just above the wagon bridge. Here the water is shallow, with moderate current, the rocks covered with algæ, while near one shore are patches of *Ruellia* and other water plants.

The following species were taken:

1. *White River (West Fork)*, Spencer, Ind.

1. **Ictalurus punctatus** (Rafinesque).
2. **Noturus flavus** Rafinesque.
3. **Noturus miurus** Jordan.
4. **Catostomus nigricans** (Le Sueur).
5. **Moxostoma duquesnei** (Le Sueur).
6. **Moxostoma breviceps** (Cope).

This is the species called *Moxostoma crassilabre* by Jordan, Man. Vert., ed. 5. It is probably not *M. crassilabre* (Cope). It may be *M. conus* (Cope), and is probably Cope's *M. breviceps*, though the latter may really be *Placopharynx carinatus*. This species is found in the great lakes in abundance, and it is not improbable that it is *Moxostoma lesueuri* (Richardson).

7. **Campostoma anomalum** (Rafinesque).
8. **Notropis rubrifrons** Cope.
9. **Notropis whipplei** (Girard).
10. **Notropis megalops** (Rafinesque).
11. **Notropis microstomus** (Rafinesque).
12. **Hybopsis kentuckiensis** (Rafinesque).
13. **Hybopsis storerianus** (Kirtland).
14. **Hybopsis dissimilis** (Kirtland).
15. **Ericymba buccata** Cope.
16. **Micropterus dolomieu** (Lacépède).
17. **Micropterus salmoides** (Lacépède).
18. **Etheostoma nigrum** (Rafinesque).
19. **Etheostoma blennioides** (Rafinesque).
20. **Etheostoma caprodes** Rafinesque.
21. **Etheostoma phoxocephalum** Nelson.
22. **Etheostoma scierum** (Swain).
23. **Etheostoma cœruleum** Storer.

2. *Eel River* at Cataract, Ind.

The Eel River (Owen County) is a rather clear but sluggish stream with greenish water full of clayey sediment after heavy rains. At Cataract there are two considerable water-falls. Collections were made at a point just below the upper falls. The bottom is of limestone, with intervals of mud in which are many water plants. Fishes are scarce in this locality, the following species being taken:

1. **Noturus flavus** Rafinesque.
2. **Ameiurus melas** (Rafinesque).
3. **Campostoma anomalum** (Rafinesque).
4. **Notropis whipplei** (Girard).
5. **Notropis megalops** (Rafinesque).
6. **Hybopsis kentuckiensis** (Rafinesque).
7. **Semotilus atromaculatus** (Mitchill).
8. **Lucius vermiculatus** (Le Sueur).
9. **Micropterus dolomieu** (Lacépède).
10. **Lepomis cyanellus** Rafinesque.
11. **Etheostoma flabellare** (Rafinesque).

All common species.

Wabash River, Terre Haute, Ind.—Collections were also made in the Wabash and its tributaries about Terre Haute, Ind. The following species are the only ones worthy of special note:

1. **Etheostoma phoxocephalum** Nelson.
2. **Etheostoma shumardi** (Girard).
3. **Etheostoma copelandi** (Jordan).
4. **Etheostoma fusiforme** (Girard).
5. **Umbra limi** (Kirtland).

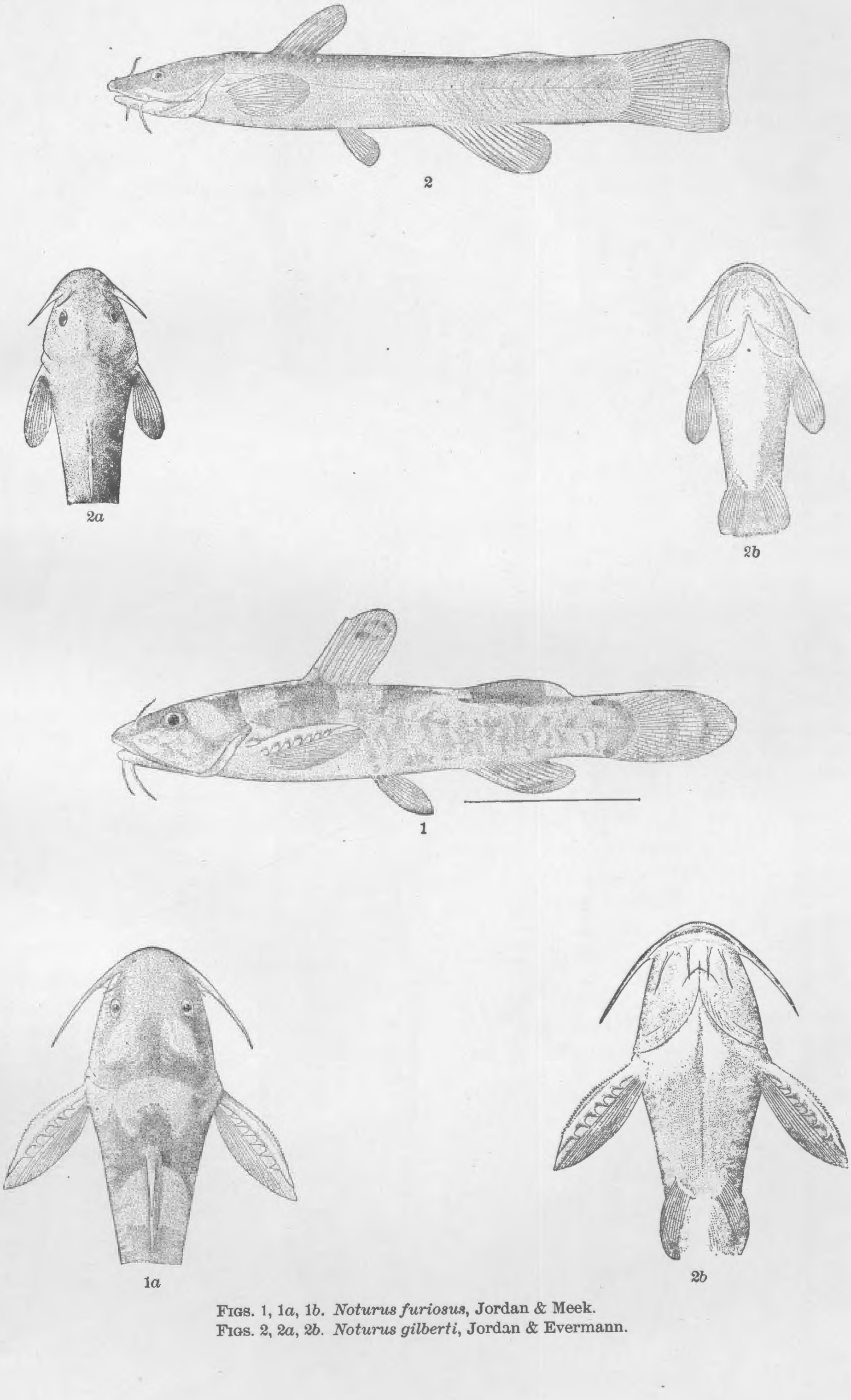
GENERAL CONCLUSIONS.

The results of the observations recorded in the present paper are fully in accord with the general conclusions as to the geographical distribution of fresh-water fishes advanced in a paper on the subject in Science Sketches (1888, pp. 83–133). It is evident that the question of distribution reduces itself to the question of barriers of various sorts. Each species extends its range in every direction and holds the ground thus taken if in the struggle for existence it is able to do so.

To quote from the work just mentioned: "The present distribution of fishes is the result of the long-continued action of forces still in operation. The species have entered our waters in many invasions from the Old World or from the sea. Each species has been subjected to the various influences implied in the term Natural Selection, and, under varying conditions, its representatives have undergone many modifications. Each of the six hundred species we now know (in rivers of the United States) may be conceived as making each year inroads on territory occupied by other species. If these colonies are able to hold their own in the struggle for possession they will multiply in the new conditions and the range of the species will become widened. If the surroundings are different, new species or varieties will be formed with time and these new forms may again invade the territory of the parent species. Again, colony after colony of species after species may be destroyed by other species or by uncongenial surroundings. The ultimate results of centuries on centuries of the restlessness of individuals are seen in the facts of geographical distribution. Only in the most general way can the history of any species be traced, but could we know it all, it would be as long and as eventful a story as the history of the colonization and settlement of North America by immigrants from Europe. But by the fishes, each river in America has been a hundred times discovered, its colonization a hundred times attempted. In these efforts there is no co-operation. Every individual is for himself, every struggle a struggle of life and death, for each fish is a cannibal, and to each species each member of every other species is an alien and a savage."

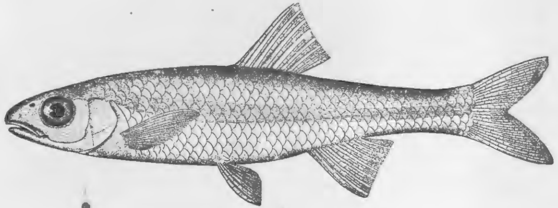
The fact of the analogy existing between the fauna of rivers and the land faunæ of islands is rendered very evident. As the fauna of the islands is limited by the barrier of the sea, so that of the rivers is limited by barriers of land, and analogous laws determine what species can obtain a hold in either case.

Additional confirmation has been given to the idea that the lowland swamp fishes of the United States are remains of an earlier and, in part, now extinct fauna. To such a fauna, it is generally admitted, belong the genera *Amia* and *Lepisosteus*. To this list I would add *Umbra*, *Lucius*, *Chologaster*, *Aphredoderus*, *Jordanella*, *Elassoma*, *Acantharchus*, *Pomoxis*, *Enneacanthus*, *Mesogonistius*, and doubtless *Percopsis*. The upland fishes seem to be mostly of more recent origin, the species of *Notropis* and *Etheostoma* probably latest of all.



FIGS. 1, 1a, 1b. *Noturus furiosus*, Jordan & Meek.
FIGS. 2, 2a, 2b. *Noturus gilberti*, Jordan & Evermann.

PLATE XIV.



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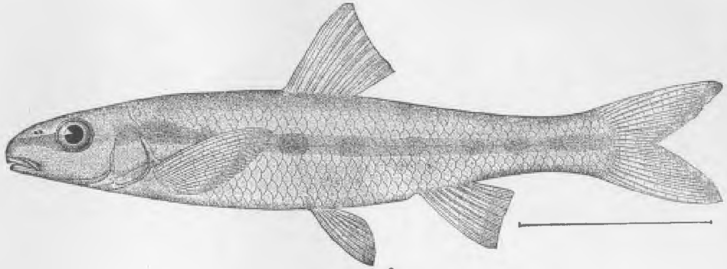

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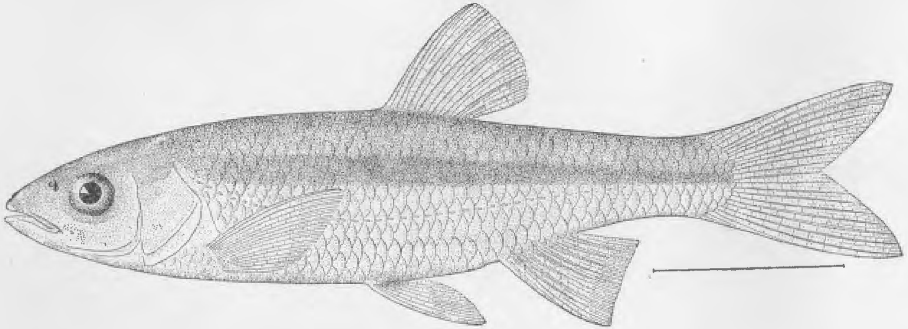

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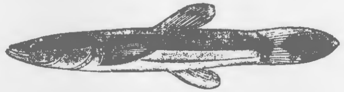

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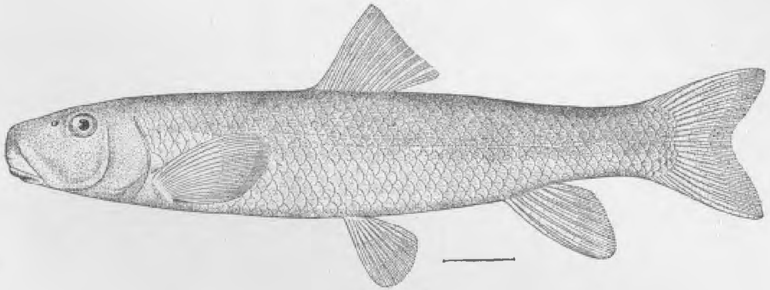

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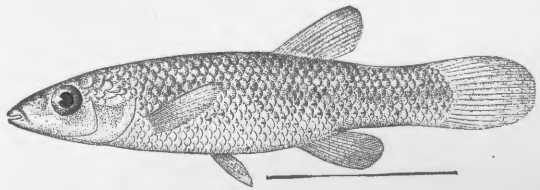

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FIG. 3. *Moxostoma rupiscartes*, Jordan & Jenkins.
FIG. 4. *Notropis macdonaldi*, Jordan & Jenkins.
FIG. 5. *Notropis kanawha*, Jordan & Jenkins.

FIG. 6. *Hybopsis watauga*, Jordan & Evermann.
FIG. 7. *Fundulus rathbuni*, Jordan & Meek.
FIG. 8. *Chologaster avitus*, Jordan & Jenkins.

INDEX.

3.—SUGGESTIONS FOR THE EMPLOYMENT OF IMPROVED TYPES OF VESSELS IN THE MARKET FISHERIES, WITH NOTES ON BRITISH FISHING STEAMERS.

BY J. W. COLLINS.

A.—INCREASE IN THE FRESH-FISH TRADE.

At this time no feature of the American fisheries is more noticeable than the increase in the demand for fresh fish in our markets. This is especially the case so far as the marine species are concerned. With improved methods of refrigeration, and a continuous increase in the facilities for inland transportation, it is possible to place before the consumer, even in places remote from the great markets, fish that are as fresh, delicate in flavor, and firm in texture as they were when taken from sea, lake, or river. Thus, while there will doubtless always be a call for certain kinds of salted fish, the tendency of the hour is to use a larger quantity of fresh-fish food and less of the salted article. And whatever tends to place fresh fish before the consumer in the best and most attractive condition will aid in increasing the demand for this kind of food and lead to an enhancement of profits to the producer. In view of the rapid growth of population in the United States, it is reasonable to suppose that the "fresh-fish trade" will grow to proportions not yet anticipated if such attention is given to it as its increasing importance seems to demand.

But while the fresh-fish business has derived many advantages from improvements in methods, increase in population and in facilities for transportation, much yet remains to be done in order to secure that full measure of success which is desirable. The important question at this time is that of securing rapid transportation from the fishing grounds to the markets, or the adoption of other means whereby fish may reach the point of shipment, and ultimately the consumer, without deterioration, even when taken far out at sea.

Besides the other benefits which may accrue as a result of improved sea transportation, an additional advantage will be secured to the market fisherman, inasmuch as he can extend his operations to more distant localities, where fish are abundant, but where he has not heretofore been able to go because of the impracticability of carrying his catch in good condition from there to market.

It is then evident that the prosperity and development of this industry are more dependent upon the adoption of new types of vessels and boats than upon anything else. Indeed, the maximum of success in the fisheries can not be reached until the highest results have been attained in the direction of securing vessels that are best adapted to the special work they are built to perform. If safety, speed, and special fitness can be obtained at a reasonable expenditure, then much may be gained, though it is to be expected that local conditions will demand very dissimilar types.

B.—SUGGESTIONS FOR THE EMPLOYMENT OF STEAMERS IN THE NEW ENGLAND MARKET FISHERY.

Allusion has already been made to the increase in the market fishery of the United States, but in no other locality is this more strikingly noticeable than in New England. Twenty-five or thirty years ago a few comparatively small vessels and open boats found employment in fishing for market on the grounds near the coast. This fishery was then confined largely, if not exclusively, to the winter season. At the present time fleets of the largest, swiftest, and best fishing schooners in the United States find employment from early autumn till spring, and a somewhat less number throughout the year, in supplying the markets of the principal ports of Massachusetts, New Hampshire, and Maine, among which Boston, Gloucester, Portsmouth, and Portland are the most important.

Although many, if not the majority, of the vessels above alluded to are not of the most modern type, the advantage to be derived from the employment of the swiftest and most sea-worthy vessels has been so manifest that a constant change is now going on in the market fleet. There has been a marked improvement recently in the sailing vessels engaged in the Atlantic sea fisheries, and special attention has been given to the attainment of the maximum of speed, due chiefly to the requirements of the market fishery.

With several eminent naval architects in the field, as designers of fishing schooners, it is not surprising that some of the latest additions to the New England market fleet should be so highly specialized as to make it apparent that the limit of swiftness has been pretty nearly reached in the construction of sailing vessels. Although the cost of building such schooners is somewhat increased in proportion to their carrying capacity, the additional profit to be obtained by getting the catch to market in the briefest possible time has been so fully demonstrated that comparatively little is thought of a considerable increase in expenditure, if a vessel can be obtained which will outstrip all rivals.

As has been intimated, the success in the direction of improving the speed and sea-going qualites of the schooners has been very gratifying, and there is reason to suppose that the introduction of the very best sailing vessels will be rapid. Nevertheless, it is a fact too well known to admit of discussion that even the swiftest sailing vessels may be, and often are, seriously delayed by calms and head winds. Therefore, when they have to operate on distant fishing grounds, their catch may frequently become more or less deteriorated before they reach market. The result of such delay and injury to the quality of the fish is that the fisherman receives less for his labor, and a bad influence is exerted on the trade, since the consumer gets an inferior article of food, which tends to lessen the demand.

While this may not occur often enough in some localities to seriously handicap the fisheries, it is, nevertheless, a factor of such great importance in most regions that it is worthy of serious consideration, and whatever tends to decrease uncertain-ties of this kind will, beyond question, add to the prosperity of the business, providing the expense incurred is not disproportionate to the advantages to be obtained.

In view of what has been stated, it seems timely to consider the question of utilizing steam as a motive power on the vessels engaged in the off-shore Atlantic market fishery. If a swift and thoroughly sea-worthy screw steamer—one that can keep the sea and make passages in heavy weather—can be built and operated at a comparatively moderate expense, there is reason to believe that such a vessel would prove successful in the market fishery north of Cape Cod.

It is true that experiments have been made in the direction of employing screw steamers in the winter haddock fishery and that the results obtained were not satisfactory. But those trials have proved nothing excepting that the vessels were entirely unfit for the winter fishery. Indeed, they had been built for the menhaden fishery, which is prosecuted in summer, and by necessity in comparatively smooth water. What seems to be needed for the market fishery, if steam is to be employed, is a type of vessel that, while being of moderate size, will be swift and sea-worthy; is comparatively inexpensive to build and run, and will have, at the same time, sufficient carrying capacity to enable it to bring into market as many fish as it is liable to take.

The small screw steamers which are employed from England and Scotland in the long-line or trawl-line fishery, the beam-trawl fishery, and the drift-net fishery (and have been introduced also into other European countries), appear to possess the qualifications that may be required in a vessel to adapt it to the market fishery on the Atlantic coast of the United States. These steamers, though moderate in dimensions, are specially designed for sea service in all weathers. They are safe, swift under steam, and, in order that their expenditure of coal may be kept down to the minimum, they are provided with a considerable sail area. When cruising on the fishing grounds, sails alone can be used, when there is wind, and they serve as an important auxiliary power when making passages.

Appended are descriptions and plans of some of the best types of European fishing steamers. It is believed by the writer that similar vessels, modified so as to meet local requirements, would be well adapted to engage in the New England market fishery. The question of building such vessels of wood, iron, or steel, is one that must be necessarily left entirely to the judgment of those who should have them constructed. In England iron is generally preferred, for the reason that it is so much more durable than wood. But, on the other hand, the Scotch fishermen have shown a preference for wooden vessels, though it is probable that they, also, will prefer iron instead as soon as they consider the period of experimentation has been passed.

It will doubtless be found feasible to introduce on steamers the system of refrigerating fish by use of ammonia, and at very small expense, since all the motive power required could be furnished by the engines without any material increase in cost.

C.—NEED OF STEAMERS IN THE FISHERIES OF THE PACIFIC.

To secure the best results in the market fishery of the Pacific, it seems eminently desirable that steamers should be employed, and the need for such vessels in that region is greater than on the Atlantic coast. In summer, calms and light winds are very prevalent along the Pacific coast, while ice is expensive and often difficult to obtain. The lack of ice makes it impracticable to keep fish in a fresh condition for any considerable length of time, and since a boat or vessel may be delayed for days almost within reach of port, for want of wind, the need of some motive power which will make it possible to carry the fish to market without loss of time is apparent.

Small screw steamers, like those used by the Scotch and English, could, no doubt, be profitably employed in the fresh-halibut fishery which is just opening up from the ports of Puget Sound and Oregon. It would also seem that such vessels might find a fair field in the market fishery of San Francisco, either by working independently or as carriers for the fleet of sailing boats now employed from that port. It is, perhaps, possible that such small steam-vessels could visit grounds much more remote from San Francisco than those now resorted to by the sailing boats and bring thence to market fish in the best condition.

If practicable, it would, no doubt, be financially to the advantage of the fishermen of San Francisco if arrangements were made whereby the daily catch of each boat could be put on board of a swift steamer and carried directly to market, the boats remaining on the ground, if the distance from port was such as to make the going and returning a matter of much moment. This would not only insure a larger catch of fish by a given number of men and boats, but also the placing of the products of the fisheries upon the market in such condition as to vastly increase the demand.

D.—EMPLOYMENT OF STEAMERS IN THE CHESAPEAKE BAY FISHERIES.

Although the increase in pound-net fishing and the number of pounds operated on Chesapeake Bay has been something phenomenal in recent years, it is, nevertheless, a fact that there are localities in which it is believed excellent fishing could be obtained which are not now utilized. This is perhaps due to the fact that, up to date, steam has not been employed as it seems it might be. The fishermen, depending on sailing boats to carry their catch to market, or to the various landings on the bay for shipment by steamer or rail, are limited, of course, as to the distance to which they can extend their operations. If the weather is calm, as is frequently the case in spring and summer, they are compelled to depend upon rowing to reach the shipping point.

A small steamer, which would be comparatively inexpensive to run, could carry fish from almost any point to a landing where they might be shipped to market, and thus many localities not now utilized could be made profitable for the fishery. Among those that may be mentioned are Wolf-Trap Spit, and in the vicinity of Smith's Point. The last-mentioned locality is about 30 miles from a steamer landing, and it is evident that it would be impracticable to transport fish in a sailing craft that distance and be sure of making the landing at the proper time.

E.—NEED OF SMALL WELLED VESSELS OR BOATS FOR THE MARKET FISHERY OF SOUTHERN CALIFORNIA.

At present, the coast towns of southern California are supplied with fresh fish that are taken in small boats (generally sailing boats), that go out to the grounds within easy reach. Fish are reported to be abundant in that region, but owing to the prevalence of light winds and calms, and to the fact that ice is not used, the catch of the fishermen frequently, if not generally, is not in the best condition when it reaches the consumer; occasionally it may have to be thrown away before it can be sold. The

Fig.1.

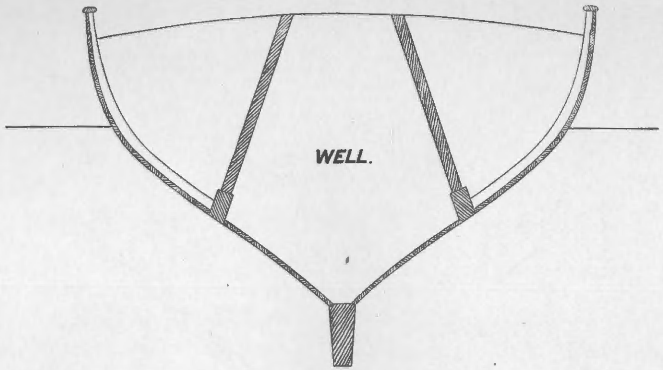
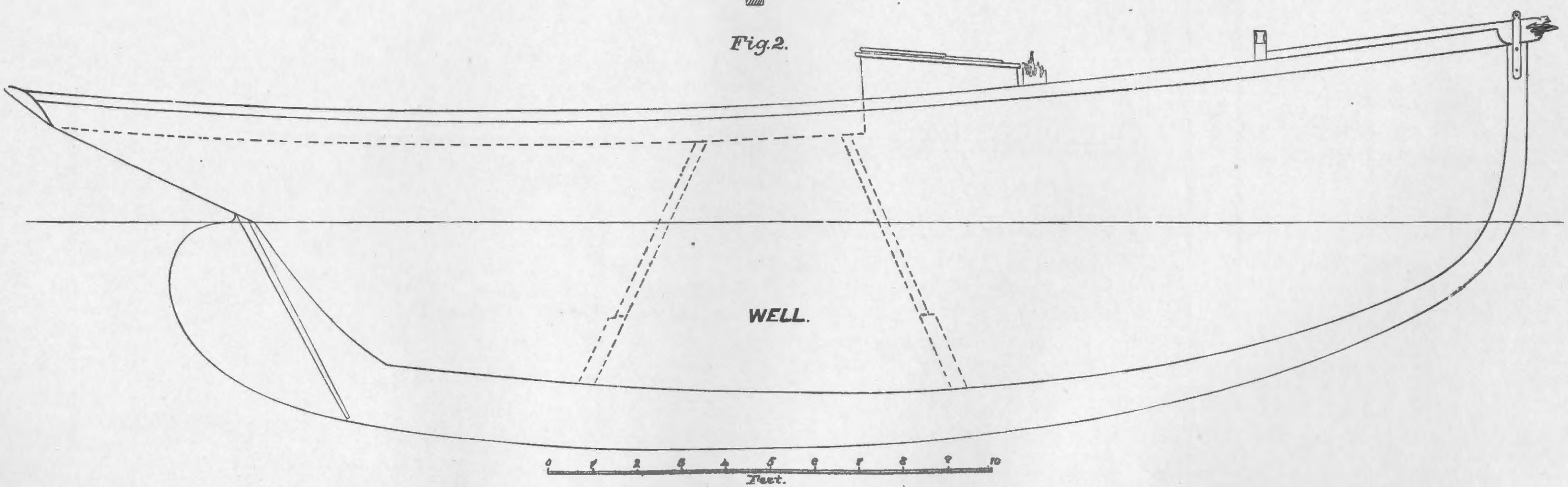


Fig.2.

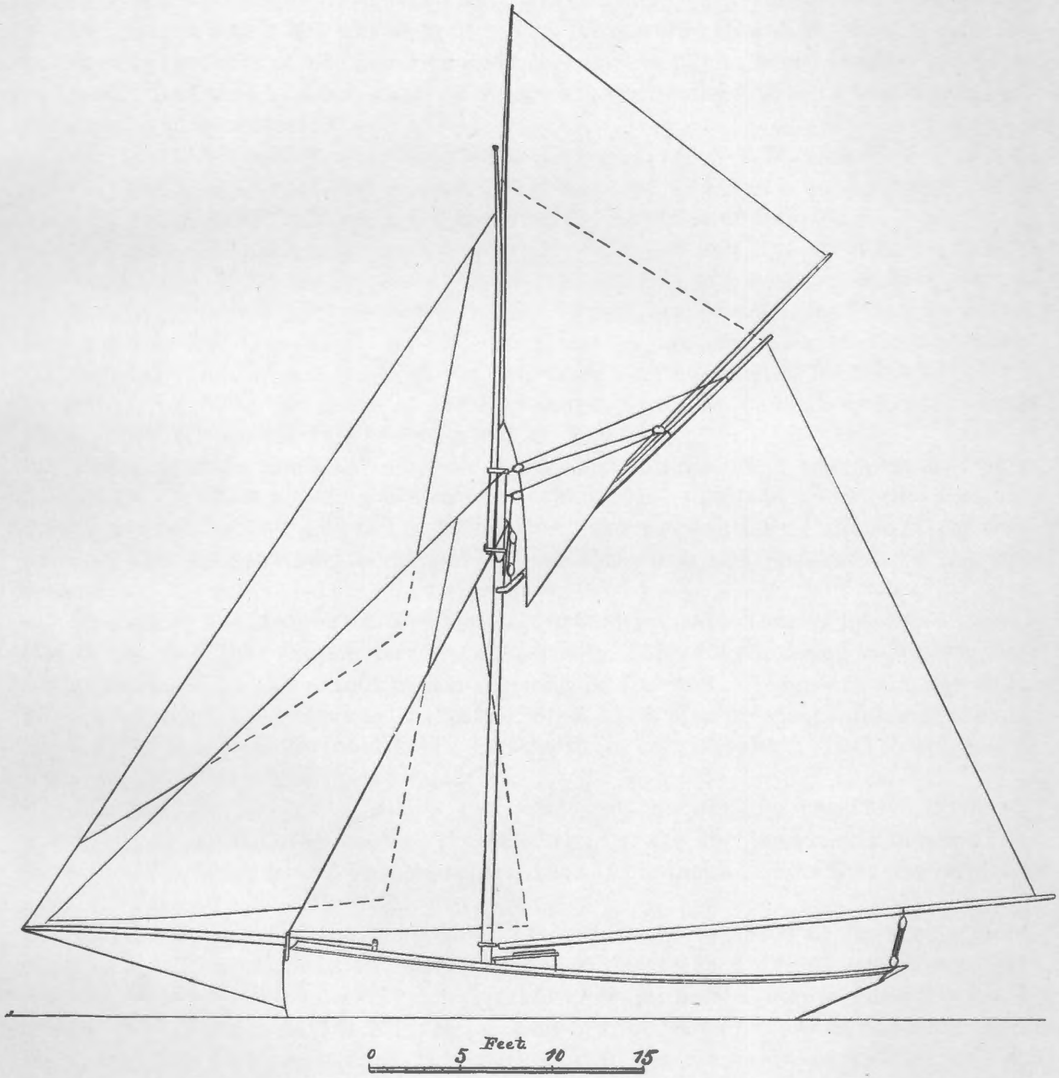


PLANS OF FISHING-CUTTER SHOWING FORM AND LOCATION OF WELL. (See page 180.)

Designed by J. W. Collins.

FIG. 1. Midship cross-section.

FIG. 2. Sheer plan.



SAIL PLAN OF FISHING-CUTTER. (See page 180.)

Dotted lines across club-topsail indicate size of working gaff-topsail.

Designed by J. W. Collins.

result is, of course, much to the disadvantage of the market fisherman, since any uncertainty about obtaining fish in good condition tends to decrease the demand, and thereby to make the price lower than it otherwise would be.

The demand in southern California will not at the present time warrant the employment of large fishing vessels or steamers to supply the ports with fresh fish, but it seems entirely feasible to improve the market fishery very materially by using small welled boats in which fish can be kept alive. This would insure, beyond all question, placing the products of the fisheries upon the market in the best possible condition, and would doubtless lead to a material increase in the demand, to the advantage of both fisherman and consumer.

Mr. A. B. Alexander, who has visited the region referred to, as fishery expert on board of the Fish Commission steamer *Albatross*, and who had a good opportunity to note the boats, and condition of the fisheries there, writes as follows:

"A smack would be the proper vessel to use in this locality, and it seems strange that that class of vessel has never been employed in the California fisheries. In summer there is but little demand for fish in the markets south of San Francisco, owing to the fact that nearly all fish which are exposed for sale are in a partially-decomposed state. Ice is too high for fishermen and fish-dealers to think of using it for preserving fish. By using smacks fresh fish could be constantly kept on hand. He who first engages in this business will do well."

Deeming this a matter of more than ordinary importance, I have prepared plans (Plates 16, 17, 18) of a sailing welled-boat, which can be built at a moderate cost, and I believe it will be well adapted to the market fishery of southern California, and may, perhaps, also be profitably employed at San Francisco and elsewhere on the west coast.[1]

In making the designs for this boat I have been influenced somewhat by consideration of the fact that she can carry comparatively little ballast, owing to her buoyancy being decreased to the extent of the capacity of the well. Therefore she has ample beam to give her the requisite stability. Since it is also necessary to have as much capacity in the well as practicable, her depth is considerable. This feature will, however, improve her sea-going qualities.

If a portion of the ballast can be put outside, in the form of a metal keel, it will add materially to the stability, and, at the same time, make the boat easier in a sea-way, since then the weights will be more central than if put inside, where they can be placed only forward and aft of the well.

The arrangement of the deck and interior must be adapted to the special needs of those who use the boat, and may vary considerably in different localities. I will suggest, however, that tolerably comfortable quarters for sleeping and cooking can be had forward of the well (Plate 17, fig. 2), and in that part of the boat the deck might be nearly flush with the rail, as indicated, to give the maximum of head-room. Aft of the cuddy the deck might be lower, as shown in the plan, and in the hold, abaft the well and on each side of it, can be stowed nets, lines, etc., also fish that die in the well, or otherwise.

[1] In most cases it will doubtless be most economical for those fishermen who have suitable boats to build wells in the boats they now own. This can be done at little cost. It will probably be necessary to use a live-car in connection with each boat, this to be moored at the market port for the storage of such fish as can not be immediately disposed of.

The cutter rig is the one best adapted to a boat of this kind when speed is a special requisite. Besides, a running bowsprit (which can be pulled in when the sea is rough) and a housing top-mast add materially to the power and efficiency of a boat in heavy weather. The sail plan, Plate 18, shows a large area of canvas, most noticeable, perhaps, in the club gaff-topsail. But the prevalence of light winds on the Pacific coast during a portion of the year seems to call for considerable light canvas, and, on a boat like this, it can be easily managed and will do most effective work.

The special feature of this boat is, however, the well. It is believed that the so-called "box well" (Plate 17, figs. 1 and 2), which is peculiar to the Key West "smackees," is the style best adapted to market fishing, and for this reason such an one has been shown on the plans. If greater capacity for living fish is required it can be obtained by making the well of the ordinary type with a deck, and building it with "primings-out." It is probable, though, that a box well will be found quite sufficient to accommodate the catch from day to day, and any surplus which can not be marketed can be transferred to live-cars, as previously mentioned.

The plans have been made for a boat of such size as is believed to be most suitable for the market fishery of the west coast. It is, however, entirely feasible to construct one smaller or larger from the plans, as will be understood by practical builders.[1]

The following are the principal dimensions:

	Feet.	Inches.
Length over all	34	3
Length, load water line	28	2
Beam, extreme	10	9
Beam, load water line	9	7½
Depth, deck to keel, amidships	6	0
Draught, extreme	5	½
Least freeboard	1	9
Length of well, extreme	8	0
Length of well at deck	3	0
Width of well, extreme	5	0
Width of well at deck	2	0
Mast, from fore side of stem at deck	10	9½
Mast, deck to hounds	22	9
Masthead	4	6
Topmast, fid to truck	22	0
Boom	30	6
Gaff	20	0
Bowsprit, outside stem	14	6
Topsail pole	23	0
Topsail club	16	6

F.—NOTES ON BRITISH FISHING STEAMERS.[2]

1. STEAM FISH-CARRIERS.

No vessels employed in the British fisheries play a more important part than those which are termed "carriers," the chief business of which is the transportation of fresh fish from the fleets of beam-trawlers in the North Sea to the principal markets.

[1] The lines have been drawn to show the form and dimensions of the boat to outside of planking instead of to outside of frames, as is commonly the case.

[2] These notes are extracted from a manuscript report, prepared by the writer, on the fishing vessels of foreign countries.

There are two distinct systems of fishing adopted by the trawling smacks. One is called "fleeting," and the other the "single-boating" system. When pursuing the former an arrangement is made between a number of vessels to fish in company, thus forming a fleet, one of the captains, an experienced fisherman, being appointed *pro tem.* as an "admiral," whose duty and privilege it is to decide upon what grounds the fleet he commands shall fish, and by a system of signals he controls and directs the movements and operations of all the smacks following his flag. The others put out their gear in response to a signal from the admiral, and they all head on the same tack, towing their trawls together in the same direction.

"In connection with each of the fleets there are several steam-vessels, called steam-cutters, which ply to and fro between the fleet and the port where the fish has to be discharged, generally London, Hull, or Grimsby. One of these cutters is generally arriving every day at the fleet, and the fish which have been caught by the smacks, and have on board of them been packed in boxes, are transferred or boarded in the smacks' boats to the steam-cutter, with which she then goes back to her port of discharge. The smacks engaged in fleeting remain at sea for periods varying from six to eight or ten weeks, when they return to their port to refit. From Yarmouth there are about six hundred and seventy smacks engaged in fleeting and thirty in single-boating all the winter and summer; from Hull one hundred and fifty or two hundred are engaged in fleeting, and from two hundred to two hundred and fifty in single-boating in the winter, and in the summer nearly all are engaged in fleeting; and from Grimsby there are about three hundred engaged in fleeting and 100 in single-boating in summer; but none of them go fleeting in winter."[1]

Messrs. Hewett & Co., of London, who own a large fleet of trawlers, have the reputation of being the first to introduce the system of fleeting. Their carriers at first were swift-sailing cutters like the trawlers now employed at Brixham.

"These carriers," writes Dunell, "would visit the North Sea fleet and bring in the fish in all weathers. Perhaps in the whole history of sea-faring life there has never been a better example of the courage and endurance of sailors than was shown by the skippers and crews of the old sailing carriers. No matter what the time of year, so long as the boat could stagger under her canvas she was driven hard through all weathers. So great was the desire of the men to get their fish in that nothing was thought of danger and little of personal discomfort. Hardships that can be but faintly imagined by those who have not known what it is to be continually forcing a passage in winter at sea, were cheerfully undergone month after month by these men, they caring nothing so long as their fish were in time for the market."[2]

The importance of this carrying trade, as indicated by the foregoing statements, naturally led to the introduction of steam-vessels to take the place of sailing carriers, for it was soon found that adverse winds or calms rendered uncertain the supply of fresh fish, notwithstanding the fact that every possible effort was put forth by the crews of the cutters. Steam-carriers were sent out to take the fish from Hewett's fleet as early as 1864, but they were not employed from Hull until 1880.

These steamers, as a rule, have been designed especially for the trade. They are built of iron, generally not extremely sharp; the most important qualifications in

[1] Report to the Board of Trade on the system of deep-sea trawl-fishing as conducted in the North Sea. London, 1883.

[2] George R. Dunell, in (London) "Engineering," August 10, 1884.

such vessels being good carrying capacity and sea-worthiness, with the ability to make headway against strong winds and heavy head seas. One who has sailed many months in a steam-carrier told the writer that he never had seen a time when that vessel would not keep on her course, and make good progress, when she was bound to market.

The London steamers are celebrated for having more than the usual amount of sheer—indeed, they are decidedly crooked, with their ends well up from the water even when they are deeply loaded. But, as a rule, vessels of this class are not remarkable for having a strong sheer, and some of them are rather straight on top.

The steam-carriers built and engined by Earle's Ship-building and Engineering Company (limited), of Hull, enjoy a very high reputation amongst those interested in the beam-trawl fisheries. The illustrations (Figs. 1 and 2, Plate 19) are a longitudinal section with sail plan and deck plan of the *Australia*, one of the latest built and best of the steam-carriers produced by the above-mentioned firm.

The form of this vessel is excellent, considering the purpose for which she is intended. She has a moderately sharp bow, rather strongly convex above the water, which gives her good lifting power, or buoyancy, forward, when plunging into a sea; her stem is straight and nearly vertical above the water-line, but curved below. She has a long, rather flat midship section, with low, rounding bilge, short but clean run, and a rather light and graceful stern.

The following are the under-deck arrangements: Abaft the forecastle, and separated from it by a bulkhead, is the ice-room, this being entered through a hatch which is located just aft of the forecastle companion. The ice-house is 9 feet long, fore and aft, and holds 25 to 35 tons of ice. Abaft this, and between it and that portion of the vessel where are placed the engine-room and coal bunkers, is the fish-room in which boxes or "trunks" of fish are stowed and iced, whether the vessel is fishing on her own account or acting only as a carrier.[1]

The coal-bunkers are forward of the boiler, and next to the after bulkhead of the fish-room, directly beneath the bridge. They extend from the deck to the keelson, and, when filled with coal, prevent the heat from the furnaces penetrating the bulkhead of the fish-room. Aft of the engine-room is the cabin, where the captain, engineer, and other officers sleep and eat.

The *Australia*, like other vessels of her class, is ketch-rigged, but has no bowsprit, the jib-stay setting up at the stem-head. The forecastle, which affords accommodations for the crew, is partly above the main deck forward; aft, the quarter-deck is flush with the main rail, and underneath this is the cabin.

"The length of the vessel is 135 feet, breadth 22 feet 6 inches, and depth to floors 11 feet. With about 50 tons of permanent ballast on board, the draught forward would be 4 feet 10 inches and aft 10 feet 6 inches, the freeboard being 4 feet 6 inches. The engines are compound surface-condensing, with cylinders 21 inches and 40 inches in diameter, and 27 inches stroke. The cooling surface in the condenser is 617 square feet, the indicated horse-power being 380. The boiler is of the ordinary return-tube type, 12 feet in diameter and 9 feet 6 inches long, having a total heating surface of 1,205

[1] Mr. Charles Hellyer, a smack owner of Hull, is my authority for stating that these vessels occasionally engage in trawling, particularly when, owing to calms or other interruptions, the sailing trawlers are detained somewhat from working, and therefore have not enough fish to load the carrier when she arrives at the fleet.

square feet and a grate surface of 38.5 square feet, the working pressure being 80 pounds. On the official trial of this vessel a speed of 10.8 knots was obtained, the consumption of coal per twenty-four hours being between eight and nine tons."[1]

These steam-carriers have a capacity for cargo of from 3,000 to 3,500 "trunks" of fish, each trunk or box holding from 80 to 90 pounds. The amount of ice carried to preserve these fish varies from 10 tons in winter to 25 or 35 tons in summer.

The crew, as a rule, numbers twelve men, all told, four of these being in the engine-room, and eight on deck and in the galley. The deck gang is composed of the captain, mate, boatswain, and four seamen, while the cooking is done by one of the men, who is usually called a steward.

2. ENGLISH STEAM-TRAWLERS.

The Grimsby Steam Trawling Company was established in 1881, and in the beginning of the following year (1882) it commenced practical operations with two steamers.

The pioneer vessel of this company, the *Zodiac*, was soon followed by the *Aries*, and so successful did these two vessels prove that in 1883 four other steamers had been added to the fleet.

These are all iron, ketch-rigged, screw steamers, and differ chiefly in length, the more recently built vessels being a few feet longer than the others—the beam and depth remaining the same—and having a high quarter-deck.

Description of the steam-trawler Zodiac.—The *Zodiac* has a flush deck, with a forecastle under deck forward, aft of which is the forward fish-room. Between the two fish-rooms is the ice-house, provided with air-tight doors, in which is stored the ice that is used for preserving the cargo, and of which the vessel carries 8 tons in winter and 15 tons in summer. This ice-house is just abaft the mainmast. It extends from side to side and is about 7 feet fore and aft. Just abaft the after fish-room is the forward coal-bunker, which extends from deck to keelson and from side to side. This is located a little aft of amidships, and between it and the cabin, at the stern, are the boiler and the engine-room. She has engines which are essentially the same as those supplied to other vessels of this class, the cylinders are compound surface-condensing, 17 inches and 32 inches in diameter by 18 inches stroke; cooling surface in condenser 350 square feet; boiler, return-tube pattern, 9 feet 8 inches diameter, and 8 feet 10 inches long; heating surface 653 square feet; grate surface, 19.25 square feet; working pressure, 75 pounds; indicated horse-power, 182. The speed on trial was nearly 9 knots; consumption of coal per twenty-four hours is about four tons.

The *Zodiac* is 98 feet over all, 92 feet between perpendiculars, 20 feet (molded) beam, and 10 feet 6 inches deep.

Details of construction of a steam-trawler.—The following are the details of dimensions, construction, etc., of one of the recent additions to the Grimsby Company's fleet of steam-trawlers: Length between perpendiculars, 95 feet; beam, 20 feet; depth of hold, 10 feet 6 inches. Spars: Pole foremast, 70 feet long, 26 feet from eyes of rigging to truck, diameter at deck, 15 inches; pole mizzen-mast, 57 feet long, 21 feet feet from rigging to truck, 13 inches diameter at deck; bowsprit, full length, 33 feet,

[1] "Engineering," August 10, 1883.

diameter at gammon-hole, 11 inches; main-boom, 40 feet long, diameter 10 inches; main-gaff, length, 32 feet; mizzen-boom, length, 25 feet; mizzen-gaff, length, 19 feet; two topsail-yards, the forward one 12 feet long and the after one 15 feet.

The sails are made of canvas of the following weights: The mainsail and foresail are made of No. 1, extra G; small (or "storm") jib, No. 0, extra G; second jib and mizzen, No. 1, ordinary; big jib, fore-topsail, and mizzen-staysail, No. 2; and mizzen-topsail of No. 3. The dimensions of the lower sails carried by the *Zodiac* are: Jib—luff, 49 feet; leach, 27 feet; foot, 27 feet. Stay-foresail—luff, 29 feet 3 inches; leach, 23 feet 6 inches; foot, 16 feet 6 inches. Mainsail—luff, 22 feet 6 inches; leach, 45 feet; foot, 32 feet 6 inches; head, 27 feet. Mizzen-staysail—luff (about), 22 feet 10 inches; leach, 20 feet; foot, 17 feet 3 inches. Mizzen—luff, 19 feet 6 inches; leach, 32 feet; foot, 21 feet; head, 20 feet.

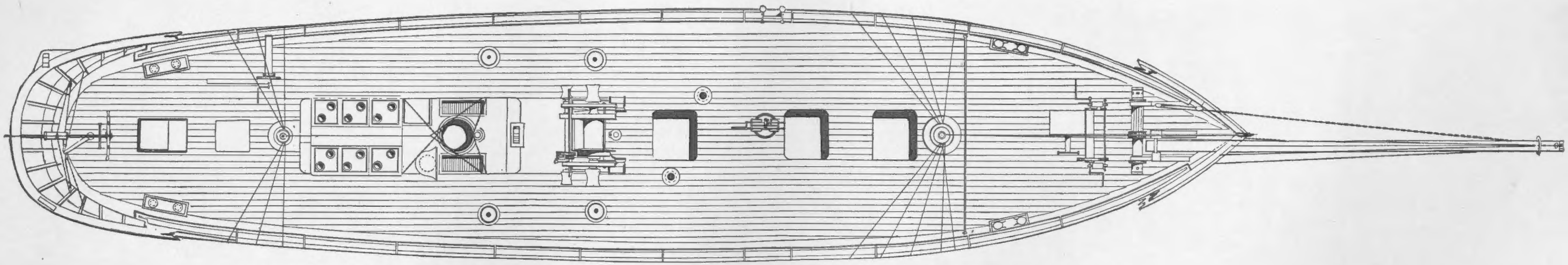
These vessels are built to class 100 A1 at Lloyd's. They are provided with accommodations for eight men, there being four berths aft in the cabin for the officers, and four berths forward. The cabin and forecastle are fitted in a comfortable and substantial manner, are provided with side and deck lights, and each has a cooking-stove of an approved pattern.

Nothing but the best material of its respective class is used in the construction of these trawlers. The butts of all plating, the stringers and keel, are planed and drawn hard together All butt strips are $\frac{1}{16}$ in. thicker than plates they connect, and all are double-riveted. The double lugs on the frames, for the attachment of stringers, are of the same scantlings as reverse bars, and fixed with at least three rivets.

The liners behind the frames, at alternate strakes of outside plating, and wherever required, are made in one piece, so that they accurately fill the space in length, breadth, and thickness. All stringers are continued fore and aft, the bulkheads and other obstructions being notched and made good up to them.

The keel and stem are made of bulb bar-iron $7\frac{1}{2}$ by $1\frac{1}{4}$ inches. The stern frame is $7\frac{1}{2}$ by $2\frac{1}{4}$ inches. The frames are angle-iron, 3 by $2\frac{1}{2}$ by $\frac{6}{16}$ inches. The reverse bars are of angle-iron, $2\frac{1}{2}$ by $2\frac{1}{2}$ by $\frac{4}{16}$ inches, every alternate one running up to the deck and above the bilge stringers. The floors are of plate-iron, 13 by $\frac{5}{16}$ inches. The keelson is made of two bars of angle-iron 4 by 3 by $\frac{8}{16}$ inches, running fore and aft, with a bulb bar 8 by $\frac{8}{16}$ inches, between, extending from fore bulkhead to 3 feet 6 inches abaft of the aft engine-room bulkhead. The stern frames for bulwark are 4 by 3 by $\frac{7}{16}$ angle-iron, with $\frac{5}{8}$ plate knees riveted on the top for rail. The bilge stringers are composed of two bars of angle-iron 3 by 3 by $\frac{6}{16}$ inches, riveted back to back, and to double reverse bars, being properly tied at each end by a plate hook and riveted. The stringer between bilge and deck is made of two bars of angle-iron, 3 by 3 by $\frac{6}{16}$ inches riveted back to back, and to reverse bar and lugs, and is continued fore and aft. It is properly connected forward and aft by plate hooks between the bars and riveted. The main deck stringer is of plate iron 24 by $\frac{6}{16}$ inches wide, tapering to twenty inches at ends, fitted to skin with a 3 by 3 by $\frac{6}{16}$ inches angle bar which is riveted to the skin, and stringer carried fore and aft the vessel. The deck ties on the beams are 8 by $\frac{3}{8}$ inches, and are carried fore and aft. The deck beams are made of angle-iron $5\frac{1}{2}$ by 3 by $\frac{6}{16}$ inches, with welded ends riveted to each end with not less than four rivets. The carlins and fore-and-afters are all of the same dimensions as the beams; double fore-and-afters are placed where the bitts go through the deck, and plates are riveted on the top before the deck is laid, not less than $\frac{5}{16}$-inch thick.

Fig. 1.



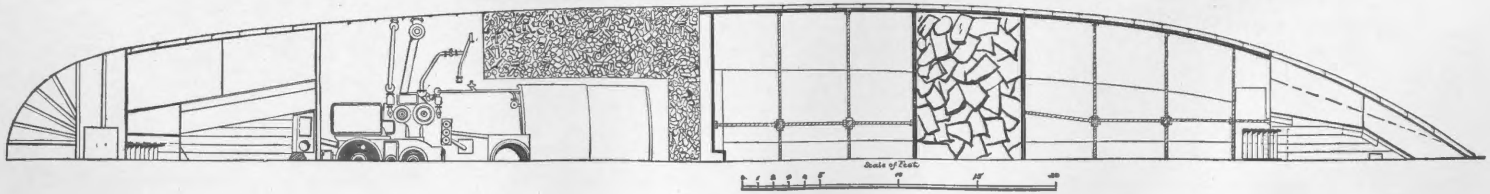


Fig. 2.

PLANS OF STEAM-TRAWLER ZODIAC.

FIG. 1. Deck plan.

FIG. 2. Half-breadth plan with deck removed, showing interior arrangement.

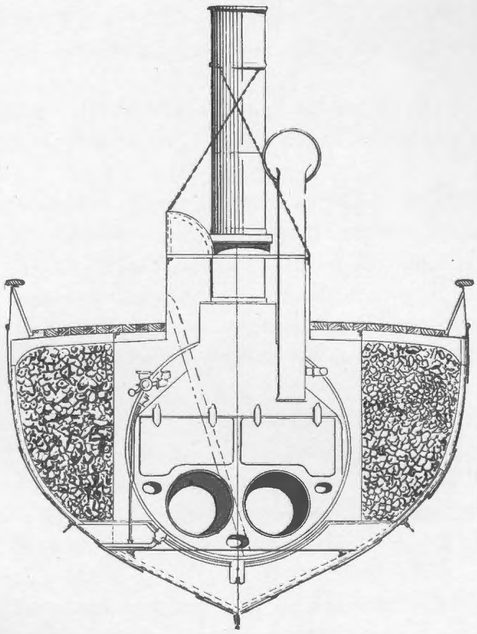


Fig. 1.

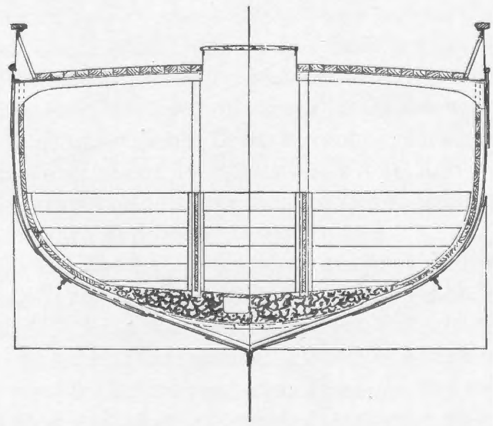


Fig. 2.

PLANS OF STEAM-TRAWLER ZODIAC.

FIG. 1. Cross-section in boiler-room, showing location of boiler, coal-bunkers, etc.
FIG. 2. Midship section, showing construction, ballast, etc.

Iron plates, from $\frac{5}{16}$ to $\frac{7}{16}$ inches, are riveted to the beams in the wake of all coamings, dandy winch, windlass, capstan, fore-winch drum, etc. All of the chocks under deck, between the beams, for properly securing the same, are made the depth of the beam in thickness.

There are three water-tight bulkheads, carried up to the deck, of $\frac{4}{16}$-inch plate-iron, stiffened with $2\frac{1}{2}$ by $2\frac{1}{2}$ by $\frac{4}{16}$ inches angle-iron, provided with valves to be worked from the deck.

The outside plating is as follows: The garboard strakes, two bilge strakes at each side, sheer strake, and boss-plates are $\frac{7}{16}$ of an inch thick, the remainder of the shell plating being $\frac{6}{16}$ of an inch thick. The bulwark plates are $\frac{4}{16}$, except the two fore-plates and the plates in the wake of the rigging, which are $\frac{6}{16}$ of an inch thick. The bulwarks are provided with two water-ports on each side. The rudder head is $3\frac{1}{2}$ inches diameter and $2\frac{1}{4}$ inches at the heel; it has a welded wrought-iron frame, and is plated with $\frac{4}{16}$-inch plates.

The boiler is made of steel. There are two side bunkers and one athwartship for coal (as shown in the plans, Plates 21, 22, and 23), the whole having sufficient capacity to hold fuel enough for fourteen days' consumption.

The knight-heads are oak, $5\frac{1}{2}$ inches thick, and extend 5 feet on each side of the stem; they are pierced with hawse pipes and bowsprit hole. The forward warping chocks are also of oak.

The deck is pitch pine, the planks being 6 by $3\frac{1}{2}$ inches. The space below deck, under the capstan, is filled in solid with American elm chocks, and oak planking 14 inches wide is laid next to the gunwale bar, fore and aft, and also for capstan, windlass bitts, alongside of the hatchways, etc.

Two-inch pitch pine is used for ceiling in the hold, carried from keelson to deck, and caulked so that it is perfectly tight above the ballast. The coal bunkers are sheathed with 2-inch American elm. The hatch coamings are iron, with round corners of plate-iron 12 by $\frac{6}{16}$ inches, with half-round iron bar $2\frac{1}{2}$ by $1\frac{1}{4}$ inches, round top edges, and they are $9\frac{1}{2}$ inches in height above deck. The bulwark stanchions are iron $1\frac{5}{8}$ inches in diameter. The beam stanchions in the hold are $2\frac{1}{2}$ inches round iron. The rail-bar is 4 by 3 by $\frac{5}{16}$ inches angle-iron; and the beading iron is half-round bar $2\frac{1}{2}$ by $\frac{3}{4}$ inches, this being fastened with $\frac{3}{4}$-inch rivets 12 inches apart.

The main rail is made of American elm, $7\frac{1}{2}$ by $3\frac{1}{2}$ inches, with a greenheart capping on top, $6\frac{1}{2}$ by $2\frac{1}{2}$ inches, extending about 40 feet on each side, and well rounded on top. There is also an iron bar fastened to the outer edge of the capping with a 6 by $2\frac{1}{2}$ inch sheave at each side of the forward end of the towing chock.

The windlass is the ordinary handspike form, and is provided with a lever-ratchet purchase on the spindle outside of the bitts. The forward winch, similar to those on sailing trawlers, is carried, and, by a peculiar arrangement, the winch and windlass can be combined on one set of bitts, if necessary. There is a steam drum for winding in wire warp. This is provided with reversing gear and separate action of main barrel and winch ends at end of drum, with brake power, separate pawls to main barrel, and ends fitted with hand gear to treble purchase. There is also a capstan similar to those on a sailing trawler, which acts as a fair-leader to the drum. The dandy winch, placed at the mizzen rigging on the port side, is the same as the improved forms used on other trawlers. The trawl-warp gangway is provided with both horizontal and vertical iron rollers. There are two bollards aft for towing, and one revolving bollard or sampson post on each side. At each side there is a rolling chock 30 feet long, made of bulb bar-iron $7\frac{8}{16}$ inches between two angle-bars 3 by $3\frac{1}{2}$ by $\frac{6}{16}$ inches, riveted to the ship's sides. The sheet of the stay-foresail works on an iron traveler, which extends from side to side of the bow. The chains are galvanized, and the anchors are of the ordinary short-shanked pattern carried by other trawlers. The side of the vessel is made flush, the chain plates being riveted to the bulwarks, so that boats may come alongside in a sea-way without being damaged by projections.

Provision is made to pump the vessel out by steam, but she is also supplied with a 6-inch hand pump. There are two iron water-tanks, having a total capacity of 500 gallons.

About 40 tons of ballast are carried, this being the best iron slag; it is grouted in with cement, and over the top of the ballast there is put a 3-inch face of Portland cement. The cement is rabbeted to take a wooden cover 2 inches thick, and a 9-inch gutter is left in the center for drainage purposes. In the ice-room a redwood floor, $2\frac{1}{2}$ inches thick, is laid on top of the ballast and firmly secured.

Description of one of the latest built steam-trawlers.—A fine model of one of the most recently built steam-trawlers of the Grimsby Company's fleet, which differs somewhat from the *Zodiac*, was exhibited at London, 1883. The lines of this vessel are excellent for sea-worthiness, carrying capacity, and for a reasonable amount of speed. She is moderately sharp forward, with straight stem and nearly square fore-foot; rounding bilge, with medium dead-rise; a long, finely shaped run, and round stern. She has more sheer than the average vessel of this class, which, with the high bow chock forward, and raised quarter-deck aft, gives gracefulness to her appearance, which is all the more pleasing because of its general absence in British steam fishing vessels.[1] The main deck extends from the bow to within about 25 feet of the stern, where the quarter-deck begins; the latter adds to the height of the after section, and gives more cabin room. The bridge extending from side to side, and elevated 7 to 8 feet above the main deck, is placed just forward of the quarter, and over the after part of the engine-room. It is protected by a metal railing, and is reached by steps, from the quarter-deck, on the starboard side. The cabin companion is on the quarter-deck, just forward of the mizzen-mast, and a little to starboard of the latter. A large sky-light abaft the mizzen-mast affords light and ventilation to the cabin. The entrance to the forecastle is aft of the windlass, while three hatches, one foreward of the main-mast and two aft of it, on the main deck, lead to the hold and fish-rooms. The trawl-warp roller is on the port side (about 5 feet aft of the main rigging), and a capstan stands abreast of the roller in the middle of the deck. On the main deck, a little forward of the smoke-stack, is a steam winch for winding in the trawl-warp, hoisting sails, etc., and the dandy winch, or "wink," is on the port forward end of the quarter. The boat is carried on the davits aft of the starboard main rigging. As previously stated, the rig differs in no essential particular from that of the *Zodiac*.

She is 70.63 tons; her length, breadth, and depth being the same as have already been given. She carries a 60-foot trawl-beam, and has a capacity for 1,700 "trunks" of fish. Her speed, under steam alone, is 10 knots, and, being so heavily rigged, she

[1] Many of the fishing steamers, probably most of them, judging by the models exhibited at London, are flush-decked, and some are so straight on top that their appearance is not pleasing to the eye. In some cases they looked almost as if they were "hogged." The vessel above described differs from the *Zodiac* chiefly in having a raised quarter-deck.

will often make 11 to 13 knots under sail and steam. Often, when vessels of this class have a favorable wind, they disconnect the screw and run under sail alone.

Cost and expense of running a steam-trawler.—A steam-trawler, such as has been described, would cost from £4,000 to £4,500 ($20,000 to $22,500), which is about three times as much as a first-class sailing trawler would cost. Then a steamer is more expensive to run. In the first place, she must have three more men, of the class, too, that receive high pay; then there are the repairs to machinery, coal, oil, etc., which together amount to quite a sum. As an offset to this, a steamer will stock from twice to three times as much as a sailing trawler.

Redway's steamer.—The smaller class of steamers designed alone for fishing are sometimes considerably sharper than those from Grimsby, not requiring so much carrying capacity The following details of dimensions, etc., are those of a design by W. E. Redway, of Milford Haven (Plates 23, 24, and 25), from which several steam-trawlers were built in 1883. This type of vessel is now in high favor, it is said, and it is claimed that they are very serviceable, swift, and sea-worthy.

The following are the principal details of a vessel of this type:

	Feet.	Inches.
Length by Lloyd's measurement	87	6
Breadth by Lloyd's measurement	20	0
Depth by Lloyd's measurement	12	4
Depth of hold	10	8
Load draught	10	6
Least height of freeboard	2	9

	Tons.
Tonnage gross register (approximately)	96
Tonnage net register (approximately)	50
Builder's measurement	155
Weight of hull	62
Weight of machinery	20
Weight of outfit	15
Weight of coal	20
Weight of water	10
Total dead weight capacity	48
Total displacement	175

Elements of design of hull:

Length of fore body	feet..	48
Length of after body	do...	40.5
Area of immersed midship section	square feet..	118
Ratio that area of immersed midship section bears to its circumscribing rectangle		.65
Area of load water plane	square feet..	1,218
Ratio that load water plane bears to its circumscribing rectangle		.688
Displacement per inch of immersion at load water line	tons..	2.9
Square feet of immersed surface		2,082
Square feet of augmented surface		3,836

Coefficient of fineness $= \frac{\text{displacement}}{\text{LXBXD}} = .390$

Area immersed vertical longitudinal section	square feet..	770
Center of lateral resistance from fore end of load water line	feet..	47.4
Center of buoyancy below load water line	do...	2.99
Metacenter of buoyancy	do...	4.68
Area of lower sails	square feet..	2,238
Center of effort above load water line	feet..	29.25
Center of effort abaft fore end of load water line	do...	46.25

The engines fitted to these vessels are of the ordinary inverted compound surface-condensing type with an intermediate receiver. The cylinders are 12 inches and 24 inches in diameter, the stroke being 24 inches. They are supplied with steam by an ordinary return-tube steel boiler.

The vessels are classed 90 A1 at Lloyd's, and as shown in the illustration are dandy-rigged. There is, however, no mizzen-mast proper, the funnel serving for hoisting the after-sail upon, a plan which has evoked most hearty expressions of contempt from some old-fashioned fishermen, but which according to some authorities has stood the test of practical experience and been found to answer well. In regard to the fault found about the funnel serving as a mast, I have heard many complaints from those competent to judge of its merits, and was credibly informed that it had so far proved a failure that many of the owners who have had their vessels provided with funnels of this kind are discarding them and are using the ordinary smoke-stack. There is no bowsprit. It is anticipated that the engines will give about 120 indicated horse-power, and with the fine water lines and beautiful models Mr. Redway has given these craft a good speed should be attained.

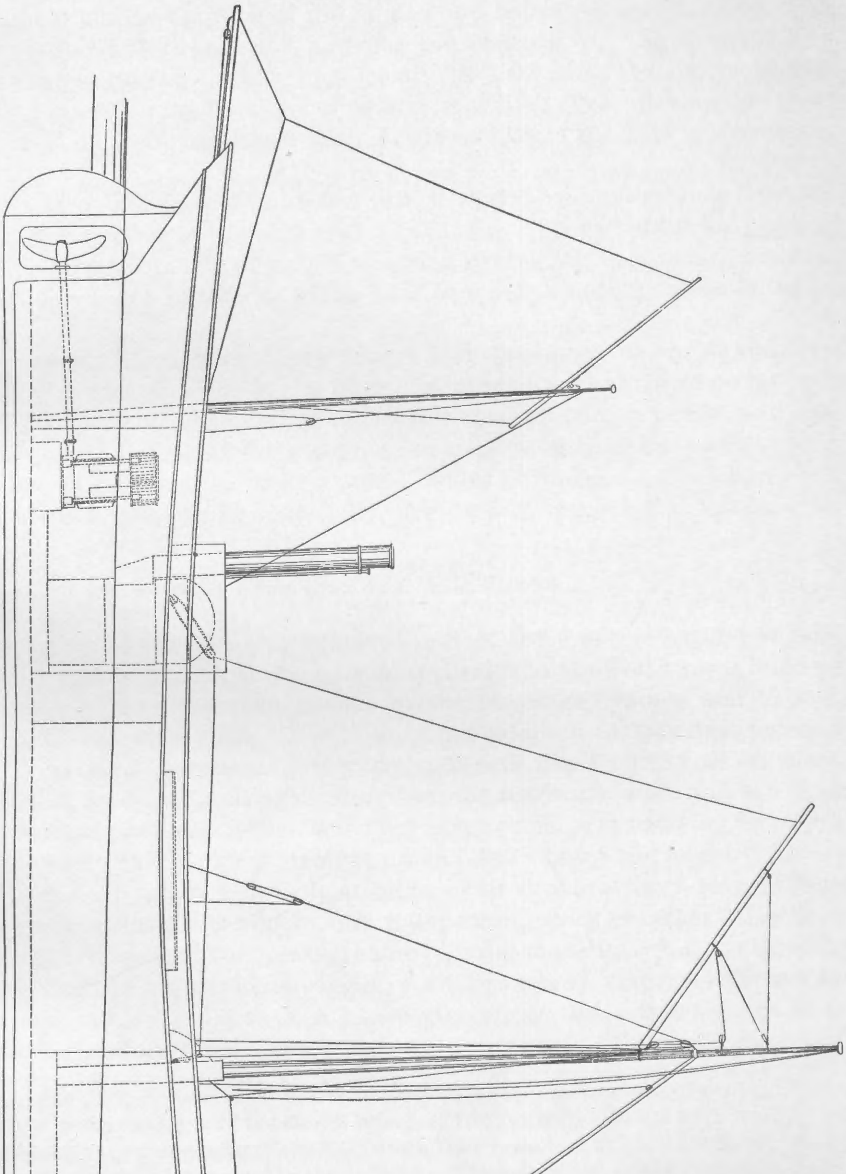
The vessels constructed on this design, though sharper than those built for the Grimsby Company, are well proportioned, both for speed and sea-worthiness, and when large carrying capacity is not specially required it is difficult to see where their form can be improved.

3. LONG-LINE STEAMER.

Steamers have recently been employed successfully in the long-line fisheries of the North Sea. The first vessel of this class was the *Albatross* (Plate 26), which was built in the summer of 1884 for Mr. T. F. Robertson-Carr, of Berwick (now, 1889, Tynemouth). Mr. Carr states that this was the eighth vessel of the kind which has been constructed with a view to arrive at the class of boat that is now wanted on the east coast; she is 10 feet longer than any of the rest. He adds: "What defects I have seen in those already built I have remedied."

In her leading characteristics this vessel is not very much unlike the Scotch steam-trawlers and steam-drifters, which are discussed at length elsewhere. As will appear by the following description, she is so designed that she is equally well adapted to either the drift-net or long-line fishery—though intended for the latter industry—and it is now deemed probable that this class of small steamers will supersede the Scotch fishing luggers, unless steam-tugs are to be extensively used to tow the sailing boats to and from the fishing grounds.

The *Albatross* is a wooden screw steamer, built under Lloyd's special survey. She has an elliptical stern, and a handsome model, the lines being specially fine under water. She is 75 feet long over all, 70 feet between perpendiculars, 17 feet extreme beam, and 8 feet 9 inches deep. The engines are of the compound surface-condensing type, specially designed for craft of this description, and fitted with patent air and circulating pumps. These engines occupy less space than any other; besides, they are simple and more effective than the ordinary form of compound marine engines, while the consumption of fuel is considerably less. The high-pressure cylinder is 8 inches in diameter, and the low-pressure 16 inches diameter, with a stroke of 12 inches. She has a working pressure of 100 pounds per square inch, and 45 indicated horse-power.



Fishing Steamer Albatross.

Scale of Feet.

SHEER AND SAIL PLAN OF STEAMER ALBATROSS.

The after bulkhead of the hold forms the front of the cross coal bunker. This arrangement of having a coal bunker forward of the engine and boilers, extending from side to side, has been found a desirable one, and has been extensively if not universally adopted on all fishing steamers, since by this means the heat from the boilers is prevented from penetrating into the hold and affecting the fish. The after bulkhead of the bunker, the side bunkers, and deck casings are of iron. There is a store-room abaft the engine.

The crew have large accommodations forward, with companion entrance from the deck. There is a sliding door in the bulkhead, so that the "wings" of the hold can be easily reached, this being requisite during the herring fishing, at least before the nets are sorted. There is a large hatchway to the hold which has nothing peculiar in its arrangement.

The vessel is ketch-rigged, with a lug mizzen and outrigger for sheet, and, like the average sailing drifter, she has her mainmast arranged so that it can be lowered when necessary. On account of steam being the principal propelling power, and also for the attainment of "handiness," the sail area is comparatively small, no light sails being carried. She is expected to make a speed, under steam alone, of 8½ knots per hour, and in fresh winds this can be materially increased by the aid of the sails.

4. SCOTCH STEAM SCREW TRAWLERS.

One of the best types of screw trawlers used in Scotland was represented at London by two rigged models exhibited by a Granton firm who are well-known builders of fishing steamers.[1] These were the models of the steamers *Granton* and *Gannet*, which apparently differ only in size. The vessels are adapted to trawling, net and line fishing, and carrying purposes. They are, however, used chiefly as trawlers. They are carvel-built, keel craft, have excellent lines for sea-worthiness, and are swift enough for all practical purposes, while their form gives them good carrying capacity. They have a moderately sharp, rather straight up-and-down bow—the forward frames being U-shaped—curved forefoot, low deep bilge, with a rather short turn at floor timber-heads, long floor, finely formed run, and round stern, which is rather fuller than the stern of average vessels of this class, thereby giving more buoyancy to this section. They have flush decks, are ketch-rigged, with two masts, and carry three sails (foresail, main, and mizzen). There is a house just aft of the mainmast, which is similar in form and function to the cabin house of an American fishing schooner, and

[1] This firm has built several steamers of about the same type for Spain, France, and the Canary Islands. The following, corroborative of the above, is clipped from an article in the Edinburgh Scotsman of July 2, 1881, describing the opening of the Edinburgh Dock: "A branch of this industry, which only came into existence a few years ago, is the building of wooden screw steam trawling vessels. Messrs. Allan & Co., who may be said to be the inventors of this class of vessel, have now removed from Leith to larger premises at Granton, and their ground has been taken by Messrs. Ramage & Ferguson. The first steam trawling vessel of the kind, the *Pioneer*, was launched in 1877, and since that date fourteen vessels of a similar construction have been launched. Others are in progress. While some of these vessels were for the home trade, others have gone to Spain, France, and the West Indies. These trawlers have quite revolutionized the fishing industry, and have financially proved most successful."

It may not be out of place to mention here that two special prizes were awarded the firm at the International Fisheries Exhibition, London, in addition to the gold medal, for the excellence of their models.

gives greater height to the cabin. The engine-room is aft of amidships. A steam-winch, for heaving in trawl or net warps, stands just abaft the foremast.

The dimensions of the *Granton* are: Length over all, 108 feet; between perpendiculars, 100 feet; beam, 19 feet; depth, 10 feet. She steams 11 knots, and makes 14 knots, with favorable circumstances, under sail and steam. The following additional particulars have been kindly furnished by the builders, who have also supplied the details of their other steamers, together with the plans: The *Granton's* gross register tonnage is 120 tons; net, 50 tons; cargo measurement, 100 tons; dead weight, 180 tons; draught of water, loaded, 10 feet; same, light, 8 feet. She is provided with compound surface-condensing engines, placed amidships; cylinders, 18 by 34 inches; length of stroke, 24 inches; number of revolutions, 120 per minute. Nominal horse-power is 45; effective horse-power, 225. She has a horizontal multitubular boiler, working pressure, 85 pounds; one steam-winch, and one donkey-engine. The consumption of coal is 3 tons per day; capacity of bunkers, 30 tons. There are three bulkheads and one hatchway.

The dimensions of the *Gannet* are: Length, 102 feet; beam, 18 feet; depth, 10 feet.

The same firm exhibited a builder's model of the screw-boat *Onward*, which was built in 1877, and is 60 feet long between perpendiculars, 16 feet wide, and 7½ feet deep. Her gross register tonnage is 40 tons; net, 20 tons; nominal horse-power, 20; effective horse-power, 100; speed, 8 knots. She had a long, rather full body, hollow floor near the keel, bow full above water (for a steamer), very concave below, short run, and round stern. The shape of this vessel is not so good as that of the others, though it must be borne in mind that the smaller size of the *Onward* did not, perhaps, admit of the fine lines which are noticeable in the *Granton*.

The following interesting history of the attempts to successfully use steam fishing vessels is from the pen of Mr. David Allan, senior partner of the firm of D. Allan & Co. Under date of September 13, 1883, he writes:

"You will observe in the extract from the Scotsman of 25th July, 1881, it is there mentioned that the *Pioneer* was the first steam trawler launched by us in 1877. This is a slight mistake, as the *Pioneer* was simply a fishing boat, built by us with steam-engines of 10 horse-power (driving the vessel about 6 knots an hour in a calm), solely for net and line purposes, in the Shetland Islands. She answers the purpose well for which she was intended; but the people on board were unable to work the machinery, and hence, like many pioneers, she proved unremunerative to the owner.

"The *Onward*, we might say, was the first steamer designed and built especially for fishing purposes. We, however, put small high-pressure engines on board, which were very imperfectly made, and consequently were continually breaking down, and being unable to get any skilled fishermen to go on board, owing to their prejudice to steamers, she also proved unremunerative.

"The *Mamelena 1st*, built from the same lines as the *Onward*, and engined with compound surface-condensing engines, and sold to Messrs. Mercader & Sons, San Sebastian, Spain, was really the first successful screw fishing vessel; and I might say she combines all our experience to that date. The machinery has given every satisfaction, and she happening to fall into the hands of men such as Mr. Mercader and Mr. Goristidi, who was associated with him in the enterprise, both being men of great intelligence and perseverance, they have the credit of being the first to make screw fishing steamers a commercial success, which you can easily see from the fact that they have

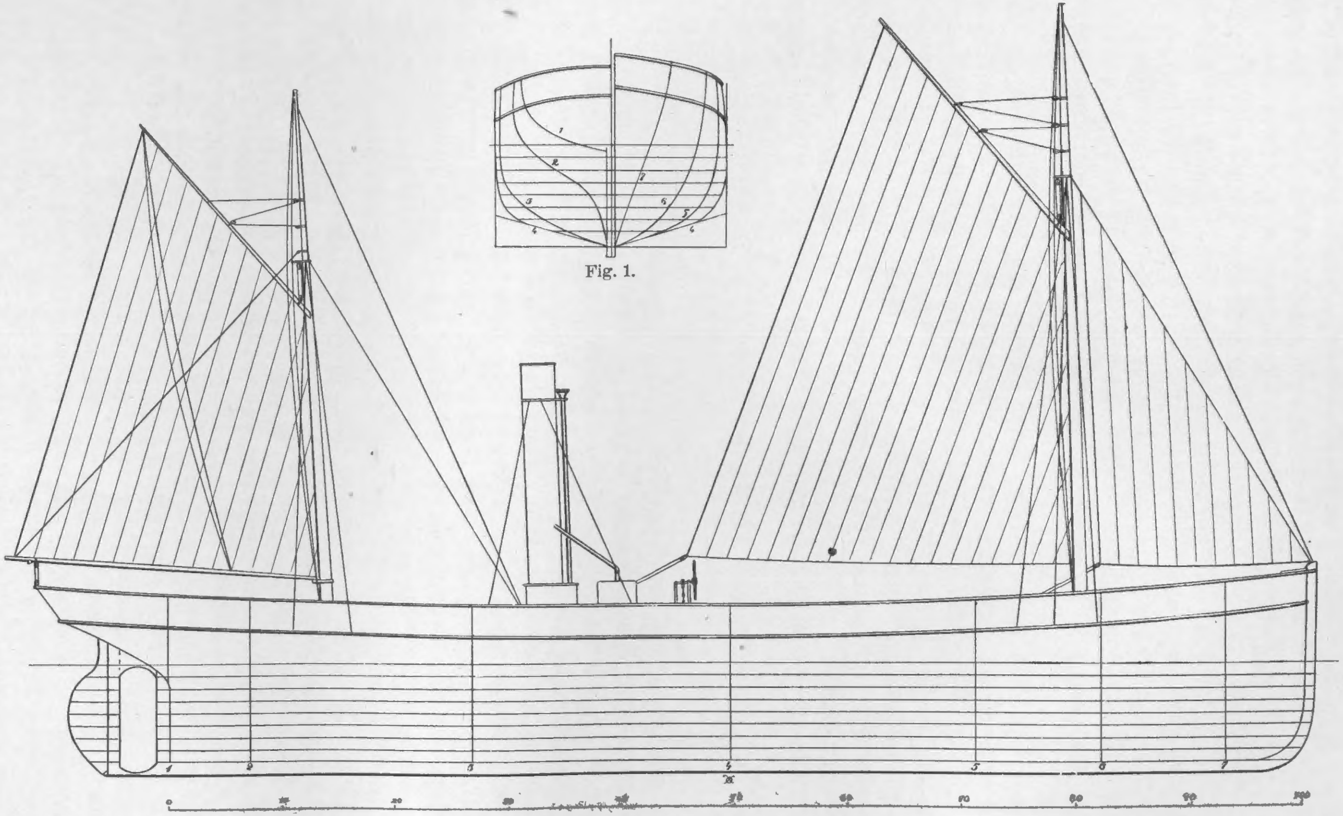


Fig. 1.

Fig. 2.

PLANS OF STEAM-TRAWLER GRANTON.

FIG. 1. Body plan.

FIG. 2. Sheer and sail plan.

Drawn by D. Allan.

since bought two other vessels, viz, *Mamelena 2d* and *3d*, and they are also connected with a fishing company at Canary Islands for which we built three vessels."

The excellent sea-going qualities of these are shown by the following extract from a letter written by the captain of the *Sea Queen*, a vessel similar to the largest fishing steamers. The *Sea Queen*, which is engaged in trading about the West Indies and vicinity, left Leith, Scotland, January 2, 1881, and arrived at Kingston, Jamaica, on February 9, encountering very heavy southwest gales on her passage. A little more than a month later the captain wrote as follows:

"BERMUDA, S. S. SEA QUEEN, *11th March*, 1881.—I just finished delivering the cargo at St. Anne's Bay, and was leaving, when I got a telegram to come full speed back to Kingston to carry Government dispatches. I arrived there at 6.30 a. m. next morning, and after a detention of two and a half hours, taking coal, water, and stores, was sent off to this place, Bermuda, with news of Colley's death, and the Cape Despatch, with orders to stop the troop ship *Orontes*, with the Ninety-ninth Regiment, and send them to the Cape. H. M. S. *Phœnix* had been dispatched from a place 86 miles nearer Bermuda, twenty-eight hours previously. I had strong head winds the first two days; when I met a heavy northwest gale. Knowing the importance of the mission intrusted to me, and the capabilities of the vessel, I kept on, although it blew with hurricane force at times, and the crew complained that I was trying to drown them. I arrived safely the morning of the fifth day, the distance being 1,130 miles. I got here just in time to stop the *Orontes*, as she was to have left two hours after I arrived. The admiral said he would be doing nothing but his duty in writing the home Government, and the government of Jamaica, of the valuable services I had rendered them in delivering the dispatches. H. M. S. *Phœnix* did not arrive until twenty-four hours after I did, she being hove to thirty-six hours."

5. SCOTCH STEAM-DRIFTERS.

There were four steam-drifters employed in the Scottish herring fisheries in 1883, of which the *Kingfisher* is the type. These were modeled and rigged like the steam-trawlers built at Granton, and which have already been described. The following are the details of dimensions, etc., of the *Kingfisher:* Length over all, 92 feet; between perpendiculars, 85 feet; beam, 18 feet; depth of hold, $9\frac{1}{2}$ feet; tonnage, 80 tons gross; 25 nominal horse-power; speed, 10 knots under steam alone; 12 to 14 knots with steam and sail. The consumption of coal is 2 tons per day when fishing, and $2\frac{1}{2}$ tons when running. She carries 20 tons of permanent stone ballast, and has capacity for 100 tons of cargo.

William Jarvis (ship and boat builder), of Anstruther, Scotland, also exhibited at London a model of a screw steamer intended for the drift-net and long-line fisheries of Scotland. This boat had a sharp bow, concave below water-line, straight stem with square forefoot, hollow floor near keel, but rather flat as it extended outwards, with short turn on bilge, giving good sail-carrying power. The floor merged into a long, fine run, which was thinner than the run of the average British fishing vessel. The stern was round. The screw had only two blades. The model was yawl-rigged, the mizzen being a lug-sail, and the mainsail of the ordinary fore-and-aft type, with gaff, but having no boom. The mainmast, as in nearly all drift-net boats, worked on a hinge and could be lowered when the nets were out,[1] while she had a running bowsprit. There were two large oblong hatchways just abaft the foremast, the after one of which extended athwartships, and both were provided with rollers on their sides to lessen the friction when the nets were being transferred to and from the hold, which was divided into pens or bins, for the reception of gear and fish. There was a small forecastle at the bow, entered by a companion placed alongside of the mainmast. There were two small hatches on either side of the deck, just forward of the smoke-stack. Aft of the net and fish rooms was the engine-room, while at the extreme after part of the vessel was the cabin, entered by a small companion which stood athwartships close abaft the mizzen-mast. The vessel steered with a tiller. On each side of the bow was a warp-chock with three sheaves. These sheaves were for the purpose of lessening the friction when the net is being hauled in. The dimensions of the vessel represented by this model are as follows: Length over all, 63 feet; on keel, 58½ feet; extreme beam, 16½ feet; draught aft, 7½ feet; height of mainmast above deck, including pole topmast of 13 feet—the whole spar is one piece—is 52 feet; bowsprit, outside stem, 24 feet; main gaff, 24 feet; mizzen-mast above deck, 36 feet; spanker-boom, 24 feet; spanker-yard, 18 feet.

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[1] The steamers built by Allan & Co. have no provision for lowering their mast, and, indeed, there seems little use for it, since a steamer can, if necessary, always turn ahead slowly and take any heavy strain off the net.

4.—NOTES ON FISHES COLLECTED AT COZUMEL, YUCATAN, BY THE U. S. FISH COMMISSION, WITH DESCRIPTIONS OF NEW SPECIES.

BY TARLETON H. BEAN, ICHTHYOLOGIST, U. S. FISH COMMISSION.

The U. S. Fish Commission steamer *Albatross* was sent by the Commissioner, Prof. Spencer F. Baird, late in January, 1885, to the Island of Cozumel for the purpose of investigating its natural history, with special reference to the fishes and their associates.

The vessel was in command of Lieutenant-Commander Z. L. Tanner, U. S. Navy. The naturalists on board were Mr. James E. Benedict, naturalist in charge, Capt. J. W. Collins, Mr. Thomas Lee, and the writer, who was detailed more especially for the investigation of the fishes.

On the 22d of January the *Albatross* arrived off the north shore of the island and anchored at the only anchorage laid down upon the present charts, in the extensive shallow bight towards which the bottom very gradually falls for a long distance off shore, making it very difficult to reach the land for the purpose of daily exploration. Hand-lines were immediately put into requisition here, and in a short time several species of fishes were captured. These were *Ocyurus chrysurus*, one or two species of *Hæmulon*, and one species of shark, *Carcharias cœruleus*. *Ocyurus* and *Hæmulon* accepted our bait of salt mackerel very freely.

On the following day the vessel steamed around to the northwest side of the island and anchored off the village of San Miguel, the principal settlement of Cozumel. There is no harbor here, but a very good lee during easterly winds. Here the vessel remained, with but one interruption, caused by a sudden norther, until the 29th of January, when our position was changed to the south end of the island for a few hours before our departure to the northward. Seining parties were sent out from the *Albatross* in a seining-boat when the distance to be traveled was short, and the boat was towed by a steam-launch when distant points were to be explored. Collections were made near the village of San Miguel, in and near a lagoon about 4 miles below San Miguel, and along the beaches at the southern end of the island. Seining was everywhere made difficult by the presence of sharp rocks, the prevalence of submerged vegetation, and the abundant *Porites*. Hook-fishing was essentially a failure. The water is everywhere clear, so that multitudes of fishes may be seen darting here and there, but none of them would take the hook freely. Certain species, which one would not expect to capture with the hook, were caught by angling. These were, *Balistes vetula* and *Ostracion bicaudalis*. A gill-net was used on one occasion, and took only two species, *Scarus guacamaia* and *Scarus cuzamilæ*.

The great majority of our fishes were taken in a capelin seine 25 fathoms in length.

The total number of species collected is sixty. Two-thirds of these species have already been recorded from Key West, Fla. The fish fauna is essentially West Indian.

The shore line of Cozumel abounds in tide-pools formed by the beating of the surf upon the exposed rock. These pools are usually small and deep, and in them may be obtained an abundance of fishes of the genera *Gobius*, *Chætodon*, *Glyphidodon*, *Hæmulon*, *Lutjanus*, *Pomacanthus*, *Harengula*, and many others belonging to the shore fauna.

One might easily empty the majority of these pools by pumping out the water, and the results obtained would amply repay the trouble. Besides fishes the collector would secure sea-urchins, brittle-stars, crabs, shrimps, squillas, sea-anemones, chitons, annelids, and other invertebrates in abundance.

Among the characteristic shore fishes are *Atherina*, *Stolephorus*, *Harengula*, *Sparisoma*, *Gerres*, *Hæmulon*, *Lutjanus*, *Tylosurus*, and *Dussumieria;* most of these can be taken among the algæ along shore even with a small Baird seine. The absence of cyprinodonts is rather remarkable.

The fish best known to the people of Cozumel for food purposes, apparently, is the barracuda, *Sphyræna picuda*, which we found to be an excellent table-fish. The *Trachurops crumenophthalmus* proved to be a most palatable fish, and *Harengula sardina* is a fish of great delicacy. The species of *Hæmulon*, *Lutjanus*, and *Ocyurus* are also very acceptable as food.

A very large species of ray was seen groping around the bottom in the vicinity of our steamer, which was not obtained, and consequently could not be identified, but, judging from its size, it may have been a species of *Manta*.

There was no fishing by natives during our stay. Casting-nets were seen on the island, but not in use.

Unless otherwise indicated the species about to be mentioned were taken in the seines. The management of the fishing apparatus by Captain Collins was perfect, and the results obtained were due principally to his skill.

1. Diodon liturosus Shaw.

The length of the single individual obtained is 106 millimeters; it was taken in the seine. Museum No. 37110.

2. Orbidus spengleri Bloch.

Two examples, catalogue No. 37065, were secured in the seine. These measure 110 and 125 millimeters, respectively. Both specimens have scattered, slender filaments on the back and sides, and from twelve to thirteen roundish dark blotches close to the ventral outline.

3. Ostracion triqueter L.

Two specimens, catalogue No. 37117, were caught with the hook, January 28, in the lagoon harbor. One of these measures $6\frac{7}{10}$ and the other $7\frac{3}{10}$ inches in length.

The carapace is three-ridged, spineless, and forms a continuous bridge across the back behind the dorsal fin. The body and tail are profusely covered with white spots, none of which are as large as the pupil. Lips, roots of the fins, and margin of the caudal dark brown.

4. Ostracion bicaudalis L. *Pesce Toro;* Bull-fish. (Pl. 28, Figs. 1–3.)

A fine example, catalogue No. 37130, was seined January 29, at the southern end of the island. This is $10\frac{1}{5}$ inches long. The species is known at Cozumel as *Pesce Toro* (the Bull-fish).

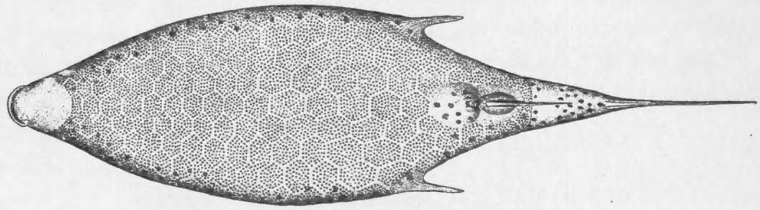


FIG. 1. *Ostracion bicaudale.* (Page 194.)

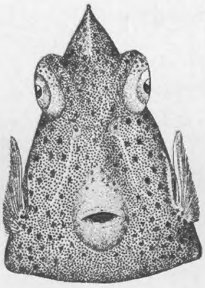


FIG. 2. *Ostracion bicaudale.* (Page 194.)

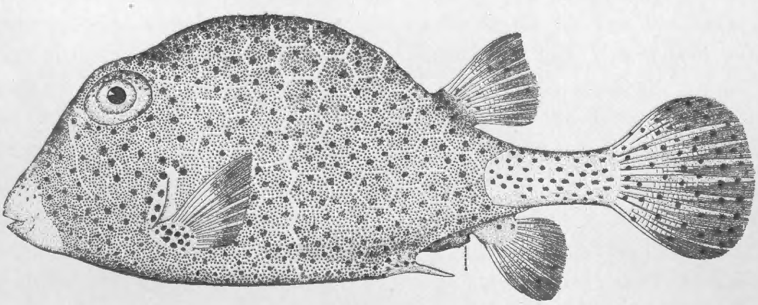


FIG. 3. *Ostracion bicaudale.* (Page 194.)

The carapace is three-ridged, with a flat spine on each ventral ridge. The ventral spine is vertically beneath the base of the dorsal fin; the spine of the left side is as long as the eye. The carapace forms a continuous bridge across the back behind the dorsal fin. All parts except the pectoral, dorsal, and anal profusely covered with roundish-brown spots, the largest of which are one-half as long as the pupil. Dorsal, pectoral, and anal with several brown spots. Each hexagonal plate bears from four to seven brown spots.

5. Ostracion quadricorne L.

A single specimen, catalogue No. 37138, measuring 10 inches in length, was seined January 29, at the southern end of the island.

The carapace is three-ridged, with a flat spine on each ventral ridge under dorsal base. A pair of supraorbital spines pointing straight forward, projecting from the forehead a distance about equal to one-half diameter of eye.

6. Ostracion trigonum L.

Two specimens were seined January 29 at the south end of Cozumel. One of these, catalogue No. 37116, is $6\frac{1}{2}$ inches long and the other, No. 37140, measures $13\frac{3}{10}$ inches.

The carapace is three-ridged, with a spine on each ventral ridge.

7. Monacanthus hispidus (L.).

Three specimens, catalogue No. 37071, were obtained January 29 in the seine. One of these, about 3 inches long, has D. 33; A. 33.

8. Balistes vetula L.

This species was caught occasionally with a hook. Example No. 37139 was so taken by Mr. Schroeder, and another one was captured in the same way by Mr. Baker. The fish could be seen in large numbers around the steamer, but they generally refused the bait, unless it became detached from the hook. Floating fragments of vegetables and meat were eagerly followed by the *Balistes*, whose brilliant colors flashing at the surface made it a conspicuous and attractive object. A small purse seine might be used successfully in the capture of this species and the large scaroids with similar feeding-habits.

9. Siphostoma mackayi Swain & Meek.

One male and one female of this species were seined along shore. The catalogue No. is 37122. The female is 180, and the male 151 millimeters long. The marsupium of the male contains eggs in two somewhat imperfect series on each side. The dorsal covers 2 + 5 rings, and contains 30 rays. The number of body rings is 17; caudal rings 35. The opercle is not keeled. The greatest depth of the female equals the width of $3\frac{1}{2}$ body rings; while in the male the depth equals the width of $2\frac{1}{2}$ body rings. The snout of the female is 17 millimeters long and its head 29.

The species was originally found by Professor Jordan at Key West, and is described in Proceedings U. S. National Museum, Vol. VII, page 239.

10. Malthe vespertilio var. longirostris C. & V.

A single specimen, No. 37123, was caught in the seine. It is 205 millimeters long. The length of the snout is 26 millimeters, or nearly one-sixth of the total length without the caudal. The lips and the outer third of the pectoral, anal, and caudal are very dark. The length of the supraoral cavity equals twice its width. The anal rays are one and two-thirds times as long as the dorsal rays. The general color in spirits is light gray.

11. Platophrys lunatus (L.).

One specimen, catalogue No. 37074, is 105 millimeters long; it was seined January 29. D. 93; A. 76; tubes in lateral line, 82; scales 93. Many of the blue spots are larger than the eye. Three dark blotches along the lateral line, the middle one darkest, the third almost obsolete.

12. Gobius soporator C. & V.

Seven examples were caught with a dip-net in tide-pools; their agility both in and out of water is astonishing. We had great difficulty in keeping this species unless we killed the fish at once in alcohol.

13. Scorpæna plumieri Bloch.

One young example, catalogue No. 37103, was seined January 27. D. XI, I, 10; A. III, 5; tubes in l. lat. 26.

14. Scarus cuzamilæ, new species. (Pl. 29, fig. 4.)

The type of the present species, catalogue No. 37128, was taken in a gill-net at Cozumel, on the 28th of January, 1885. It is 330 millimeters long to the end of the middle caudal rays; 294 to the end of the lateral line.

The species is evidently related to *Scarus superbus* and *Scarus acutus* of Poey. I have compared it with a specimen of *Scarus superbus* which was sent to the National Museum by Professor Poey. In this species the external caudal rays are produced more than twice as much as in the species about to be described. The coloration, also, is very different, the under surface of the head of my species being uniform whitish. *Scarus acutus* is said to have a broad, whitish band from the base of the pectoral to the caudal. The snout of *acutus* has two deep blue bands and there are two bands of carmine on the chin. Poey makes no reference to lateral canines in the upper jaw. The coloration and dentition of the Cozumel species are so different from Poey's description that I can not identify the species with *S. acutus*.

The body is somewhat fusiform in shape. The jaws are whitish at the margin and olivaceous over the rest of their surface. There are three canines directed outward and slightly backward on the lower posterior edge of the upper jaw. The upper lip covers rather less than one-half of the surface of the upper jaw. The snout is attenuated. There is a considerable depression above the nostrils. The distance from tip of the upper jaw to the iris, measured obliquely, equals one-third of the length of the entire dorsal base and nearly one-half the length of the head. The length of the eye is contained seven and one-half times in the total length of the head; it is situated rather less than one of its diameters from the upper profile of the head and nearly three of its diameters from the lower profile. There are four rows of scales on the cheeks besides a row of scales upon the suboperculum and interoperculum. The lower series on the cheek contains five scales and the other series contain from six to seven. There are seven series of scales on the median line of the back before the dorsal.

The greatest height of the body is contained about three and one-third times in the length to end of scales; it is not equal to the length of the head. The least height of the tail equals the length of the postorbital part of the head, and is not quite one-half the greatest height of the body. The origin of the dorsal is about over that of the pectoral. The base of the dorsal is exactly twice as long as that of the anal. The dorsal spines are about equal in size, the fourth spine equals one-third the greatest height of the body, and is contained three times in the distance from the tip of the upper lip to the origin of the dorsal. The length of the pectoral is about one-fifth of the total length to the end of the middle caudal rays. The ventral is a little more than one-half as long as the head.

D. IX, 10; A. III, 9; P. 14; V. I, 5. Scales 2–25–7. The lateral line interrupted under the end of the soft dorsal, eighteen scales being pierced before the interruption.

Colors of the alcoholic specimen: Spinous dorsal with a narrow, dark margin; soft dorsal with a broad, dusky margin, the rest of the fin lighter. Anal light at base, a faint, dusky band covering about the outer two-thirds of the fin. Pectoral and ventral pale. Caudal, light at base, and with several broad, light areas, extending out on the rays, the major portion of the fin, however, is very dark. General color dusky olivaceous, many of the scales having a rosy blotch at the base. Operculum with a few irregular blotches of blue. Iris yellowish. Sclerotic very dark.

The species is called *cuzamilæ* in allusion to the ancient name of the island from which it came.

Scarus acutus Poey. Poey, Mem., II, 216, 217. Common name *Loro.*

The individual which I describe is 310 millimeters long. The tip of the muzzle is rounded, but the head is prolonged and attenuated towards its anterior extremity, the superior line of its profile being nearly straight, a little depressed above the nostrils; the curve of the throat, as far as the mandible, is, on the contrary, well pronounced. The cleft of the mouth is horizontal; the mandible is slightly included, and the teeth are naked, regularly arranged in quincunx order, on a smooth and polished surface; the cutting-edge has no inequalities. The nostrils have two orifices, very small and very close together, distant from the eye one of its diameters. The pores of the head are not numerous. The height of the body is contained three and one-half times in its total length; it equals the length of the head, which contains the eye seven times; the eye is situated in the middle of the length of the head at the first quarter of its height. The fins are situated as usual; the unarticulated rays are not sharp; their extremities bend to form fringes on the margin of the dorsal and the anal; the caudal is straight in the middle, but its angles are slightly produced.

D. 9, 10; A. 2, 9; P. 15. The scales are large, much higher than long on the cheek; there are none on the head in front of the eye; there is a series supporting the base of the dorsal. The lateral line is interrupted; the scales which form it have only a longitudinal tube, which sends two branches upward. There are twenty-four scales from the shoulder to the caudal; they are not ciliated.

The head is olivaceous above, violaceous on the sides, rosy below and on the throat. A small oblique space in front of the eyes is clearer without forming a broken band. There are two deep blue bands above the upper teeth and two of carmine under the lower teeth. The iris is reddish-brown. The back is violaceous, the belly also, but paler. A large whitish band traverses the sides from the base of the pectoral to the tail. The dorsal is obscurely violaceous; the caudal deep reddish-brown; the other fins are rosy. — 373.

This translation of Poey's description is introduced here for comparison with the preceding species.

15. Scarus guacamaia Cuvier. "*Loro.*"

A single specimen, No. 37126, was taken in a gill-net January 28, in the harbor lagoon; this example is 14 inches long. The following color-notes were taken in the fresh condition: Scales bluish, with a brown margin. Sides of head, except cheeks, blue. A blue band around the snout; another across the snout in front of the eyes; between these two bands there is a brown one. A dark blotch above the eye. Teeth blue, with a white margin. Iris golden. Dorsal, anal, and ventrals with a narrow blue margin. Most of dorsal, anal, and ventral dark brown. The pectoral is dark brown.

16. Scarus croicensis Bloch.

A single individual, catalogue No. 37052, was taken in seine January 24. It is 3 inches long.

17. Sparisoma cyanolene Jor. & Swain.

Numerous specimens were obtained by seining on the 24th, 27th, and 29th of January. Catalogue Nos. 37058, 37091, and 37101. Length 2 to 3¼ inches.

18. Sparisoma flavescens (Bl. Schn.).

Numerous examples, catalogue Nos. 37056 and 37100, were caught January 24 and 27 in seine. Length 2 to 6½ inches.

19. Sparisoma xystrodon Jor. & Swain.

Three specimens, catalogue No. 37073, were seined January 29. Length 2¾ to 3 inches.

20. Thalassoma nitidum (Gthr.).

One specimen, seined January 29. D. VIII, 13; A. II, 11; scales 2-28-9.

21. Platyglossus bivittatus (Bloch).

A single individual, catalogue No. 37109, was caught in the seine January 29. Length 3 inches. D. IX, 11; A. III, 12.

22. Xyrichthys ventralis, n. s. (Pl. 29, fig. 1.)

The type of the present species is No. 37077 of the National Museum Catalogue. It was the only authentic example secured. The species belongs to the subgenus *Novacula* of Bleeker. It has some points of resemblance to *Xyrichthys modestus* Poey, but differs from this species in form, in the structure of the spinous dorsal, the shape of the caudal, and in the size and location of the eye.

The body is compressed and of moderate height. The upper profile of the head does not form a very sharp edge. The profile descends in a very regular curve from the beginning of the dorsal to the tip of the snout. The snout is comparatively short and blunt and the preorbital is low, its width at the angle of the mouth equaling the length of the eye. The maxillary scarcely reaches the vertical from the front of the orbit and equals two-sevenths of the length of the head. There are two strong canines in the front of each jaw, those of the mandible being received within the maxillary canines. Both sets of canines have a lateral and backward curve. No posterior canines.

The eye is distant from the upper profile only about one-third of its diameter, which is contained one and one-half times in its distance from the tip of the snout, and four and one-half times in the length of the head to the end of the opercular flap.

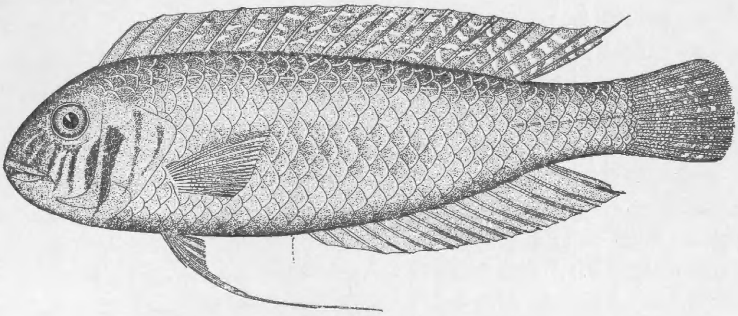


FIG. 1. *Xyrichthys ventralis.* (Page 198.)

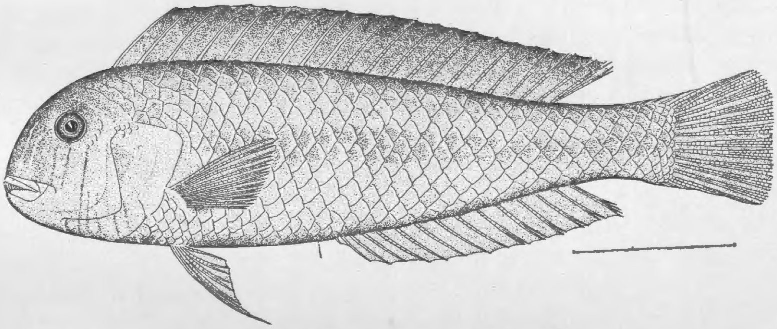


FIG. 2. *Xyrichthys infirmus.* (Page 199.)

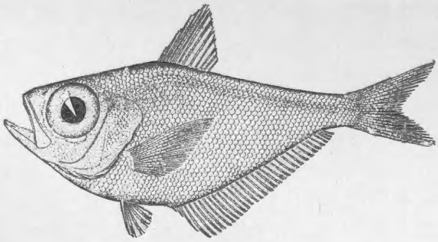


FIG. 3. *Pempheris mülleri.* (Page 204.)

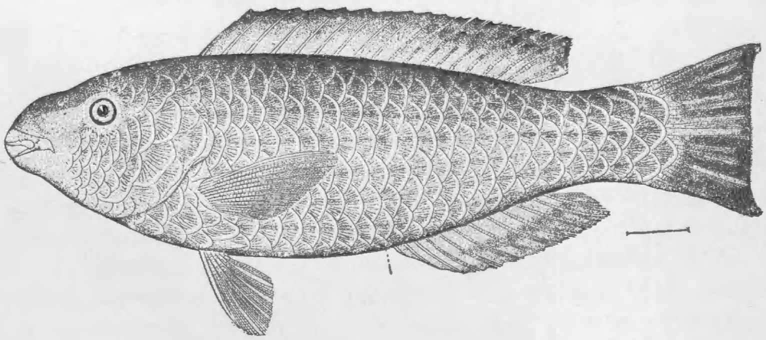


FIG. 4. *Scarus cuzamilæ.* (Page 196.)

There are a few faint rudiments of scales behind and below the orbit. The interorbital width equals the short diameter of the eye. The distance from the snout to the eye is one-third of the length of the head.

The length of the head is contained three and two-thirds times in the total length to caudal base. The greatest height of the body, a little behind the origin of the ventral, is contained three and one-half times in the standard length.

The first two dorsal spines are flexible, slenderer and longer than the others; still they are not evidently differentiated from the rest of the fin, as in *X. rosipes* and some other species. The length of the first spine is almost one-half that of the head. The second spine is slightly shorter than the first. The third spine is one-third as long as the head. The ninth spine is slightly longer than the third. The first soft ray is three-sevenths as long as the head, while the last ray is one and two-thirds times as long as the first spine, its length being about one-fifth of the total without caudal.

The anal spines are moderately strong. The first spine is about two-thirds as long as the eye. The third spine is as long as the third spine of the dorsal, and nearly one and one-half times as long as the eye. The last anal ray is one-half as long as the head.

The caudal is slightly rounded. Its middle rays, from the end of the scales, are contained six times in the total to caudal base.

The ventral spine is one fourth as long as the head. The first ray is produced, extending, when laid backward, to the base of the fourth anal ray. The length of the ventral is one-third of the total with caudal.

The pectoral is as long as the head without the snout.

D. IX, 12; A. III, 12; V. I, 5; P. 11; scales 2–26–8. The lateral line pierces twenty scales before the interruption, which occurs under the tenth ray of the dorsal.

In spirits the general color is purplish-gray. There is a broad streak of solferino in the middle of the sides, beginning near the head and extending back to above the middle of the anal fin. The width of this stripe is uncertain now, but it was probably twice that of the eye. The iris is solferino with the exception of a narrow light circle around the pupil. Several narrow stripes a little darker than the body color extend from the eye over the preorbital and cheeks, a similar stripe running almost vertically on the operculum. The dorsal is mottled with dusky. The other fins are pearly, except the caudal, which is slightly dark with a light margin, and the anal, which shows some faint mottlings in alcohol.

I refer, with some doubt, another young specimen of a *Xyrichthys* to the foregoing species. It is only 57 millimeters long. The first two dorsal spines are flexible and the others stiff. The ventral scarcely reaches to the anal origin. Across the top of the head and back are nine or ten light blotches, some of these being continued down the sides, forming about six indistinct bands.

23. Xyrichthys infirmus, n. s. (Pl. 29, fig. 2.)

There are four specimens of the present species, catalogue No. 37076. The length of the types is from 107 to 123 millimeters. This species also belongs to the subgenus *Novacula* of Bleeker, and is remarkable in having all of the dorsal spines flexible. The shape of the body is similar to that of *X. ventralis*, but the descent of the profile is more abrupt; the species in this respect bears more resemblance to *X. psittacus*. The upper profile of the head does not form a very sharp edge. The snout is comparatively short and blunt, but the preorbital is very much higher than in *X. ventralis*, the shortest distance from the angle of the mouth to the eye equaling nearly twice the length of the eye. The maxillary does not reach to the vertical from the front of the orbit; its length equals one-fourth that of the head. The canines are as in *X. ventralis*. No posterior canines.

The eye is distant from the upper profile nearly one-half of its own diameter, which is contained about six times in the length of the head and more than twice in the distance of the eye from the tip of the snout. The interorbital width equals the length of the eye.

There are a few scales below the orbit. The distance from the snout to the eye is two-fifths of the length of the head.

The length of the head is contained about three and one-half times in the total length to caudal base. The greatest height of the body, which is about at the origin of the ventral, equals the length of the head.

All of the dorsal spines are flexible, and of about equal length. The third spine is one-third as long as the head. The last soft ray is very slightly produced, and is about two-fifths as long as the head.

The anal spines are very weak. The third spine is about two-sevenths as long as the head. The last anal ray is a little more than one-third as long as the head.

The caudal is usually nearly truncate; in some specimens the middle rays are very slightly longer than the external rays. The middle rays, from the end of the scales, are one-seventh of the total length to base of caudal.

The ventral spine is slender and weak, and about twice as long as the eye. The first ray reaches about to the vent when extended. The fin is about two-thirds as long as the head, and one-fifth of the total length without caudal.

The pectoral is nearly as long as the ventral.

D. IX, 12; A. III, 12; V. I, 5; P. 11; scales 2–27–11. The lateral line pierces twenty scales before the interruption, the twentieth pierced scale being under the tenth ray of the dorsal. The scales of the breast and abdomen are much smaller than any of the others. The posterior angle of most of the scales is acutely produced.

The color in spirits is light olive-gray, the dorsal and anal fins being darker except along their basal portions. The axil of the pectoral is very dark and the dark blotch is sometimes bordered behind by several bluish streaks on the scales. Three narrow bluish stripes extend from the eye over the preorbital and cheek, and the interoperculum has six or seven short, nearly vertical, lines of bluish. Iris solferino. The dark color of the dorsal is more pronounced on the spinous portion.

24. Xyrichthys venustus Poey.

Xyrichthys lineatus, C. & V., Hist. Nat. Poiss., XIV, 1839, p. 50; not *Coryphæna lineata* Gmelin, Linné, Syst. Nat., p. 1195.

The species to which I refer under the above name is perhaps the best known upon our coasts. It has a large pearl-colored blotch in the pectoral region connected with its fellow of the opposite side by numerous narrow bands extending around the belly. It may be identical with *X. psittacus*, but I am disposed for the present to consider it a distinct species and present herewith a complete description.

The collection made at Cozumel contains sixteen specimens, catalogue No. 37075, these ranging from 92 to 105 millimeters in length. All these examples have the pearly blotches and the connecting lines well developed. The dorsal spines of these specimens are flexible and the species bears a close resemblance to *X. infirmus*, but the coloration is quite different and the caudal is more nearly truncate in *X. venustus* than in *X. infirmus*. Other points of distinction will appear as we proceed with the description.

The descent of the profile of the head is not abrupt, and the edge of the profile does not form a very sharp edge. The snout is short; the preorbital is rather low, the shortest distance from the angle of the mouth to the eye scarcely exceeding the length of the eye. The maxillary does not reach to the vertical from the front of the orbit; its length equals one-fourth the length of the head to the end of the opercular flap.

The canines are weak. No posterior canines. The eye is distant from the upper profile nearly one-half of its own diameter, which is contained five times in the length of the head and nearly twice in the distance of the eye from the tip of the snout. The interorbital width is about equal to the length of the eye. In some examples there are several scales below the orbit. The distance from the snout to the eye is contained about two and two-thirds times in the length of the head.

The length of the head is contained nearly four times in the total length to caudal base. The greatest height of the body, which is a little behind the ventrals, exceeds the length of the head and is contained about three and one-half times in the total without caudal.

All of the dorsal spines are flexible, and of nearly equal length; the third spine is a little more than one-third as long as the head. The last soft ray is scarcely produced; its length equals less than two-fifths the length of the head. The anal spines are very feeble; the third spine is less than one-fourth as long as the head. The last anal ray is contained nearly three and one-half times in the length of the head.

The caudal is usually truncate or very slightly rounded. The middle rays from the end of the scales are contained about seven and one-third times in the total to caudal base.

The ventral spine is slender and weak, and about twice as long as the eye. The longest ventral ray does not quite reach to the vent when extended; it is about two-thirds as long as the head. The length of the ventral is contained five and one-third times in the total without caudal. The pectoral is about as long as the ventral.

D. IX, 12; A. III, 12; V. I, 5; P. 11; scales 2–27–11. The lateral line pierces twenty scales before the interruption, the twentieth pierced scale being under the tenth ray of the second dorsal. The scales of the breast and abdomen are somewhat smaller than those of the rest of the body. The posterior angle of some of the scales on the hinder portion of the body is somewhat acute.

The color in spirits is as follows: The ground color of most of the examples is olive-gray, sometimes with a faint orange tinge. The spinous dorsal is somewhat dusky; otherwise the fins are usually pale. A pearly blotch on the side behind the pectoral, and about as long as the pectoral, connected with its fellow of the opposite side by numerous, sometimes about seventeen, narrow whitish bands. A conspicuous dark blotch covering most of the operculum and suboperculum in marked contrast with milky-white marking in front of the head, the one behind the head occupying the whole of the opercular flap. There are at present no traces of bluish lines upon the head. Iris dusky.

I am somewhat in doubt concerning the relationship of this species to *X. infirmus*, which it resembles in many respects, but the coloration is always different, and there are other points of distinction which may be observed in the descriptions of the two. There is no doubt that this is the species which we have long known as *Xyrichthys lineatus* C. & V., but, as Poey has noticed, it is probably not the same as *Coryphæna lineata* of Gmelin.

Xyrichthys psittacus (L.).

The only large example of this species available for comparison with the type of *X. vermiculatus* Poey is No. 31915 of the Museum catalogue. It was taken by Silas Stearns at Pensacola, Fla. The length of the example is 207 millimeters. The shape of the body is similar to that of *X. vermiculatus*, and the profile of the head is about the same. The width of the preorbital at the angle of the mouth is nearly one-half the length of the head and contains the length of the eye only about two and one-third times. The eye in *X. psittacus*, if we may depend upon the material at hand, is always larger than in *X. vermiculatus*. The maxillary scarcely reaches the vertical from the front of the eye, its length is about two-sevenths of the greatest length of the head measured somewhat obliquely over the tip of the snout to the tip of the opercular flap.

The canines show nothing different from those of the species already mentioned. There are no posterior canines.

The eye is distant from the upper profile of the head about one-half of its own diameter, which is contained less than five times in the length of the head, even less than five times in the greatest length of the head from the tip of the snout to the tip of the opercular flap.

Scales below the orbit in two series, the lower series containing two scales. The interorbital width equals the short diameter of the eye. The distance from the snout to the eye is one-sixth of the total length to caudal base, and about three-fifths of the greatest length of the head.

The length of the head, measured on the axis of the body, is contained three and two-thirds in the total without caudal.

The greatest height of the body at or a little behind the ventral origin equals one-third of the total length without caudal.

The first two dorsal spines are flexible. The length of the first is less than one-third of the length of the head. Length of the ninth spine is more than a third of the length of the head. Length of the first soft ray is more than two-fifths of the length of the head, and the last ray is more than one-half the length of the head and equals the least height of the caudal peduncle.

The anal spines are short and rather blunt, the third being scarcely longer than the eye. The first soft ray is about three-sevenths as long as the head, and the last ray is equal to the last ray of the dorsal. The caudal is very slightly rounded; its middle rays from the end of the scales is contained five and two-thirds times in the total to caudal base.

The ventral spine is one-fourth as long as the head, the first ray reaches to the vent. The length of the fin is contained five and two-thirds times in the total length without caudal.

The pectoral is contained about four and three-fourths times in the total length without caudal.

D. IX, 12; A. III, 12; scales 2–10–27. The lateral line pierces nineteen scales, the nineteenth scale being under the interspace between the eighth and ninth ray of the dorsal.

In spirits the general color is light yellowish-brown, most pronounced on the cheek. The well-defined bluish lines which are usually so noticeable in *X. vermiculatus* are replaced in this example by numerous irregular and crooked very narrow brownish streaks. The dorsal fin at present is uniform pale in color, without mottlings of any kind. The anal is pale, except along its margin, which has numerous very narrow dark streaks nearly at right angles with the direction of the rays, besides some vague pearly mottlings. The caudal has seven or eight very narrow dark bands.

It is proper to state that another example, which should probably be referred to *X. psittacus*, catalogue No. 29972, 200 millimeters in length, taken at Charleston, S. C., by Mr. C. C. Leslie, is intermediate between the Pensacola example and Poey's type of *X. vermiculatus*. The length of the eye in this example is contained nearly three times in the least height of the preorbital, and there is only one series of scales below the orbit. The lateral line also pierces scales to the twentieth, and is under the tenth ray of the dorsal.

25. **Pomacentrus leucostictus** Müll. & Trosch.

Three specimens, catalogue No. 37061, were taken in a tide-pool January 28. Length 1 to 2¼ inches.

26. **Glyphidodon saxatilis** (L.).

Numerous individuals, catalogue Nos. 37063, 37069, and 37084 were obtained by seining.

27. **Gerres harengulus** (Goode & Bean).

37067.	(2 specimens.)	January 24, 1885.	Seine.
37068.	(10 specimens.)	January 29, 1885.	Seine.
37085.	(5 specimens.)	January 27, 1885.	Seine.

The smallest of the above examples is 1¾ inches long, and the largest 6 inches. The species is abundant, and was found wherever we hauled the seine.

I have compared *harengulus* with *gracilis* of the Pacific coast, and can not at present believe that the two are identical.

28. **Gerres lefroyi** Goode.

This species was found only at San Miguel, January 24. Two individuals, No. 37066, were seined. These are 6 inches and 7¾ inches long, respectively.

29. **Gerres zebra** Müll. & Trosch.

Only two specimens of *G. zebra* were obtained. The larger one, No. 37131, was seined January 27, near the harbor lagoon. It is 11½ inches long. The other, No. 37118, was caught with a hook, in the same lagoon, January 28. It is 8 inches long. Both of these examples still show the dark bands, seven or eight in number, on the sides.

30. **Pomacanthus aureus** (Bloch).

One very young individual, catalogue No. 37064, one-half inch long, was taken in a tide-pool January 28.

31. Teuthis hepatus (L.).

A single individual, measuring $5\frac{1}{10}$ inches, catalogue No. 37120, was seined January 29.

32. Chætodon striatus L.

A single specimen of this beautiful species, measuring $1\frac{1}{4}$ inches, catalogue No. 37062, was taken in a tide-pool January 28.

33. Trachurops crumenophthalmus (Bloch).

A small number of this species, catalogue No. 37081, was seined on the 24th of January. These varied in length from 9 to $10\frac{1}{2}$ inches.

34. Caranx ruber (Bloch).

Numerous young specimens, catalogue Nos. 37107 and 37108, were seined on the 27th and 29th of January. D. —, 1, 28; A. 1, 22; scutes 29.

35. Trachynotus glaucus (Bloch).

A single example, 12 inches long, was taken in the seine, January 27, near the harbor lagoon. This specimen has four evident bands on the sides and a faint trace of a fifth. D. VI, I, 20; A. II, I, 16; P. 16.

The height of the body is one-half of the length to the end of the scales. The least height of the caudal peduncle equals the distance from the tip of the snout to the middle of the eye, and is slightly more than one-third of the length of the head. The length of the maxilla is contained two and two-thirds times in the length of the head, and eleven times in the distance from the snout to the end of the middle caudal rays. The eye is about three-elevenths as long as the head. The anterior rays of the dorsal and anal reach somewhat beyond the middle of the caudal.

36. Trachynotus goreënsis C. & V.

Three young individuals, No. 37102, were seined, January 27, near the harbor lagoon. The smallest is $1\frac{3}{8}$ inches and the largest $3\frac{3}{8}$ inches long. D. VI, I, 19; A. II, I, 17.

37. Pempheris mülleri Poey. (Pl. 29, fig. 3.)

Numerous examples taken in seine January 27, catalogue No. 37111. These varied in length from 1 to $1\frac{3}{4}$ inches. D. V, 8–9; A. III, 31; V. I, 5; scales 52.

38. Hypeneus maculatus (Bloch).

A single specimen, catalogue No. 37104, was seined January 27. Length $4\frac{1}{2}$ inches. D. VIII, I, 8; A. I, 6; scales 2–30–5.

39. Ocyurus chrysurus (Bloch).

Four specimens were caught January 22 with hooks from the vessel; only one of these, No. 37113, was preserved. This species is excellent for food. In our seining at Cozumel we found no young examples, but at Key West, earlier in the same month, they were very common.

40. Hæmulon arcuatum C. & V.

Eight specimens, catalogue No. 37088, were seined January 27. They varied in length from 5 to 6 inches, and some of them were infested with an Æga-like parasite.

41. Hæmulon flavolineatum (Desm.).

Large numbers, catalogue Nos. 37086, 37087, were seined on the 27th and 29th of January. These vary in length from 2½ to 4½ inches.

42. Hæmulon melanurum (L.).

A large number of this species, catalogue No. 37078, was seined on the 29th of January. The largest specimen measures 7 inches and the smallest about 4½ inches.

43. Hæmulon sciurus (Shaw).

One example taken in the seine January 27; catalogue No. 37089. Length of specimen 5¾ inches.

44. Lutjanus caxis (Bl. Schn.).

Young individuals, No. 37119, measuring 2⅛ to 2¾ inches in length, were seined, January 29, at the south end of the island. One specimen, 3½ inches long, No. 37060, was caught in a tide-pool, January 28, in company with *Gobius soporator*, *Pomacentrus leucostictus*, *Glyphidodon saxatilis*, *Pomacanthus aureus*, and *Chætodon striatus*. All of these young examples of *L. caxis* have whitish bars on the sides.

45. Lutjanus griseus (L.).

Lutjanus griseus, Jordan & Swain, Proc. Nat. Mus., 1884, 431, 439.

This species was taken in the seine, January 27. The specimens preserved are No. 37129. *L. griseus* was much less common than the other species, *caxis* and *synagris*. The young were not seen; our examples vary from 14 to 16 inches in length.

46. Lutjanus synagris (L.).

Specimens were taken in the seine, January 27, near the harbor lagoon; these, No. 37083, range from 4 inches to 6½ inches in length. Others were obtained by seining, January 29, at the south end of Cozumel; these, No. 37070, were also small, one of them being only 2½ inches long.

47. Centropomus undecimalis (Bloch).

A large example, 23 inches long, No. 37137, was seined, January 27, near the deep lagoon which serves as a harbor for small vessels. The species was not seen by us at any other time around the island.

D. VIII, I, 10; A. III, 6; scales, 70, to the end of the black portion of the lateral line.

48. Sphyræna picuda Bl. Schn.

On the 24th of January we took several individuals, No. 37135, in the seine at San Miguel. On the 29th of the same month the species was seined again at the south end of the island, and one specimen, No. 37134, was kept. *S. picuda* is very abundant here and very destructive to weaker fishes. In company with *Tylosurus caribbæus* and *T. notatus* it scourges the shoals of *Harengula* and *Stolephorus*, driving the panic-stricken masses upon the shoals, where the gluttonous pelicans continue the rush of devastation.

As already mentioned, this species of barracuda is a fair food-fish.

49. Atherina aræa Jor. & Gilb.

Catalogue Nos. 37094 and 37097. Very plentiful, caught in the seine January 29. Length, 2¼ to 2¾ inches. D. VI, I, 10; A. I, 12; scales, 42.

50. Atherina velieana Goode & Bean.

Eight individuals, catalogue No. 37054, were taken in the seine January 24. These measure from $1\frac{3}{10}$ to $2\frac{3}{4}$ inches in length. D. V, I, 10; A. I, 13; scales, 38.

51. Atherina stipes Müll. & Trosch.

Many specimens, catalogue Nos. 37059, 37096, 37098, 37099, and 37112, were caught in the seine on January 24 and 29. Length, $2\frac{1}{4}$ to $2\frac{3}{4}$ inches. D. V, I, 11; A. I, 13; l. lat. 39; transv. 6.

52. Tylosurus notatus (Poey).

Numerous examples, catalogue No. 37093, were seined January 29.

53. Tylosurus caribbæus (LeS.).

A single specimen, catalogue No. 37124, was obtained by seining January 29. This was 11 inches long.

54. Albula vulpes (L.).

The lady-fish was not uncommon at Cozumel. No very young specimens were taken, the smallest being $5\frac{1}{2}$ inches long. Our specimens, No. 37132, were seined January 27, near the harbor lagoon and Nos. 37121 and 37133 were obtained in the seine January 29 at the south end of the island.

55. Harengula sardina (Poey).

Numerous examples, catalogue Nos. 37079, 37092, and 37115, were seined on the 24th, 27th, and 29th of January. These varied in length from $2\frac{1}{10}$ to $6\frac{1}{2}$ inches.

56. Harengula pensacolæ Goode & Bean.

Five specimens, catalogue Nos. 37080 and 37114, were caught in the seine January 24 and 27.

57. Stolephorus mitchilli (C. & V.).

A large number of this species, catalogue Nos. 37053 and 37105, were seined January 24 and 27. Length, $3\frac{1}{4}$ to $3\frac{1}{2}$ inches. D. I, 11; A. I, 25; scales, 39.

58. Dussumieria stolifera Jor. & Gilb.

Abundant. Catalogue Nos. 37055 and 37106. A large number of these were seined January 24 and 29. Length, 1 to 2 inches.

59. Narcine brasiliensis (Olfers).

A single specimen, catalogue No. 37125, was seined January 29.

60. Carcharias cœruleus DeKay.

One example, No. 37141, was taken with a hook baited with salt mackerel. The species was abundant on the north side of the island at our first anchorage and soon destroyed the fishing for *Ocyurus* and *Hæmulon*. During all of our efforts with hooks from the steamer while we were lying off San Miguel no species of shark was captured

5.—THE MOST RECENT METHODS OF HATCHING FISH EGGS.

BY WILLIAM F. PAGE.

The purpose of this article is to attempt to establish a proper basis for the work of hatching fish eggs. The writer believes that a larger measure of success can be achieved by the use of the McDonald universal automatic hatching jar for developing not only semi-buoyant but heavy fish eggs. The results of my experience and observation during the past seven years are herein embodied.

At the Central Station of the U. S. Fish Commission and at other hatcheries the following species of fish eggs have been successfully hatched in this apparatus: Shad, Whitefish, Brook trout, California trout, Rangeley trout, Lake trout, Atlantic salmon, California salmon, and Land-locked salmon.

THE WATER.

So much has been written on the subject of water, the kinds best adapted to the purpose, and the kinds that can be made to answer; the highest and lowest temperatures allowable; the absolute clearness desirable; and the best means of aerating, filtrating, etc., that a delicacy is felt in entering on this branch of the subject. Undoubtedly temperature has an important bearing upon fish-culture. Nature's laws of heat and cold when rudely violated will work injury to fish as well as man.

It is unquestionable that clear water offers many advantages; the condition of the eggs and fry can be better ascertained, and the labor of removing the sediment is obviated. Ordinary river-water, such as is furnished for household purposes in most of the larger cities on the Atlantic slope, is capable of doing excellent hatching work for nearly all the kinds of fish spawning in fresh water, though scarcely any of it south of Maine is capable of rearing any of the species of Salmonidæ. No better water for hatching can be found than that in the cities bordering on the Great Lakes. It may be stated, as a general rule, that water suitable for drinking purposes is available for hatching fish. Though the water be very muddy, filtration is not absolutely necessary for hatching, and any one who has been compelled to work with the "wire screens for coarse trash," "bagging for small trash," and "flannel trays for fine mud," can testify how arduous and totally unavailing such efforts have been. Filters for hatching are not the necessity now that they once were, because the hatching apparatus is changed. In the autumn of 1888, while at the centennial exposition of the Ohio Valley and Central States, held in Cincinnati, Ohio, I had charge of the hatching of 45,000 California salmon eggs. At the time of their arrival the temperature of the water was 78° Fahr. and it was quite muddy even for Ohio River water.

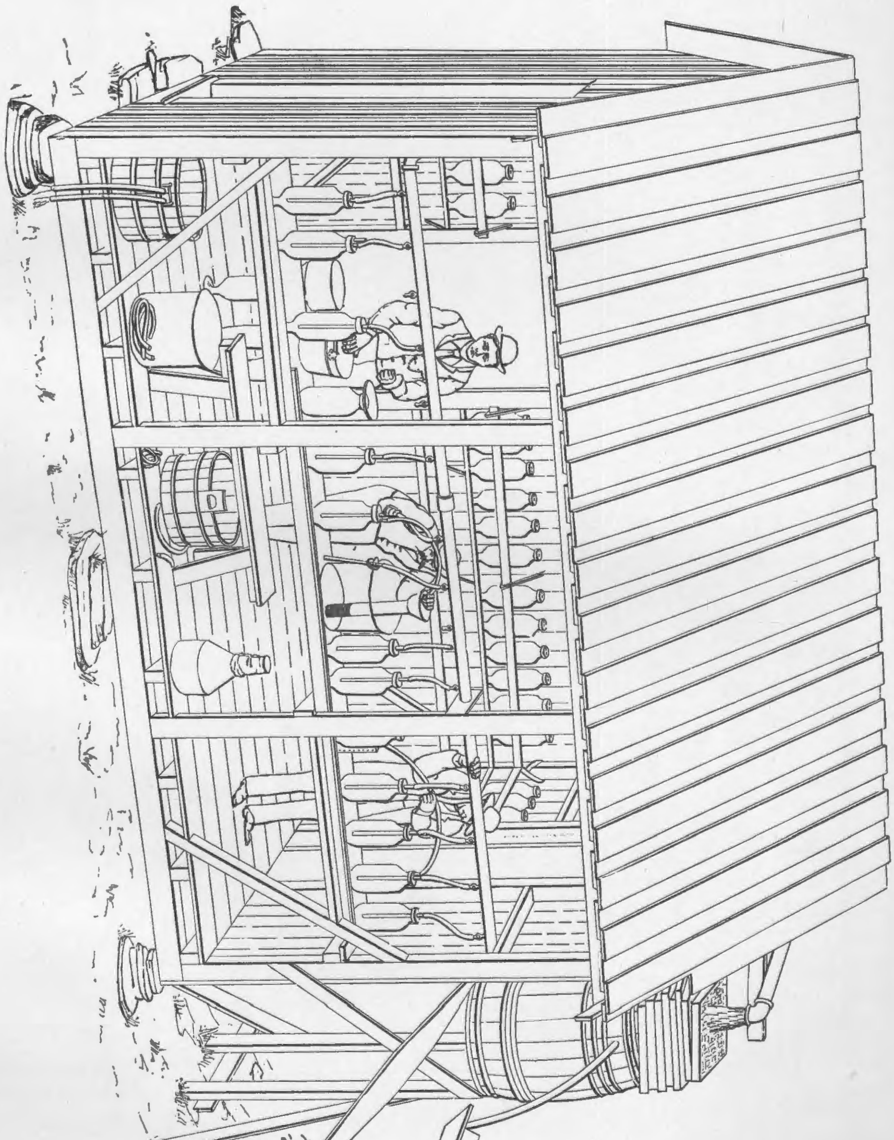
These eggs were hatched in two McDonald jars with gratifying success. I would not be understood as advocating muddy water in preference to that naturally clear, but to prove that clear water is not absolutely necessary to successfully hatch the eggs of fishes spawning in fresh water.

The prime requisite is an unfailing water supply of a pressure as nearly constant as is attainable. For hatching semi-buoyant eggs the pressure should not be less than 6 pounds per square inch at the point where the water is to be drawn from the pipe; a variation of 2 pounds will not materially affect the results, as it can, to a large measure, be corrected by raising or lowering the central tube of the jar. For eggs of the Salmonidæ less pressure will answer; three or even two pounds per square inch can be used. If the water is taken from a spring, race, or other abundant or cheap source, and carried into a supply tank by means of a flume, the tank may be kept always full and an overflow maintained. (Plate 30.)

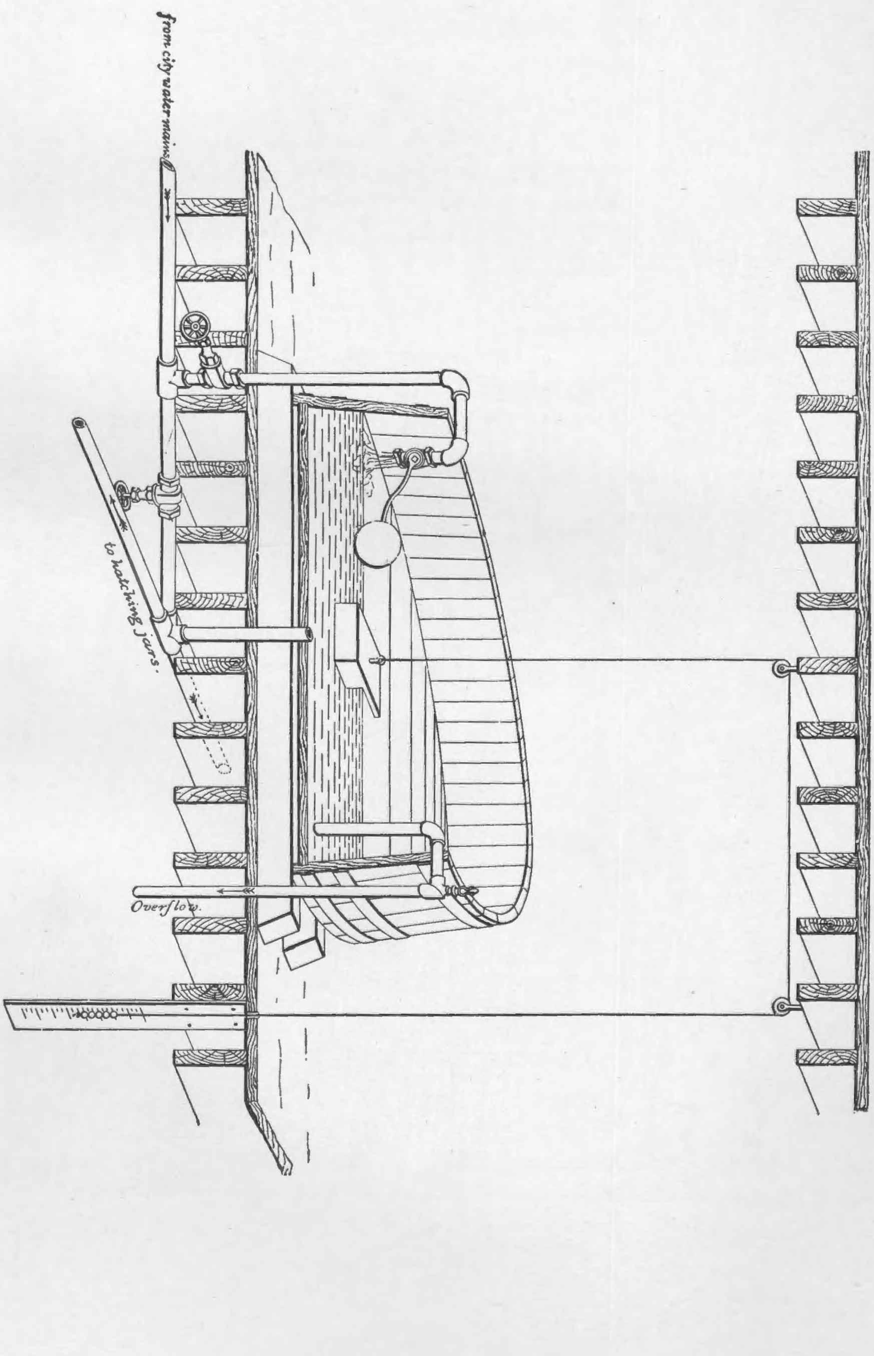
When the water is taken from the main of a city water-works it should be discharged into an open tank through a ball-cock, which, working automatically, will preserve a nearly uniform level or pressure. (Plate 31.) The bottom of the tank for semi-buoyant eggs should be not less than 6 feet above the top of the hatching-table. The water is taken by iron pipes from the bottom of the tank and distributed to the hatching-tables. (Plate 32.)

A point especially to be guarded against is the presence of bubbles of air in the pipe. If the regulating tank is of sufficient dimensions the bubbles coming in with the supply will rise and escape from the surface. But if the level of the water is allowed to get low in the tank the water will drag air down with it into the supply pipe. To guard against the possibility of this I have devised the following apparatus: A float is placed in the tank from which a line, passing over pulleys, extends down into the hatching-room. On the lower end of the line is a weighted rod, carrying a metallic index sliding in a groove; to either side of the groove are affixed contact points of an electric circuit. Two contacts are placed where the index would mark 8 inches, which amount is regarded as extreme low water in the tank. If desirable, other contacts may be arranged to indicate high water. As the metal index passes up and down, consequent upon the fluctuation of the water in the tank, it meets a contact, closes the electric circuit and thereby rings a vibrating alarm bell. (Plate 33.) This bell can be placed at any convenient point. As the greatest degree of fluctuation of pressure occurs in city water mains during the night, it has been found desirable, in hatcheries where no night watchman is maintained, to run an auxiliary alarm to the sleeping quarters. The ringing of the alarm bell calls attention to the fact that more or less water is needed, which can be easily remedied if a proper system of valves has been provided.

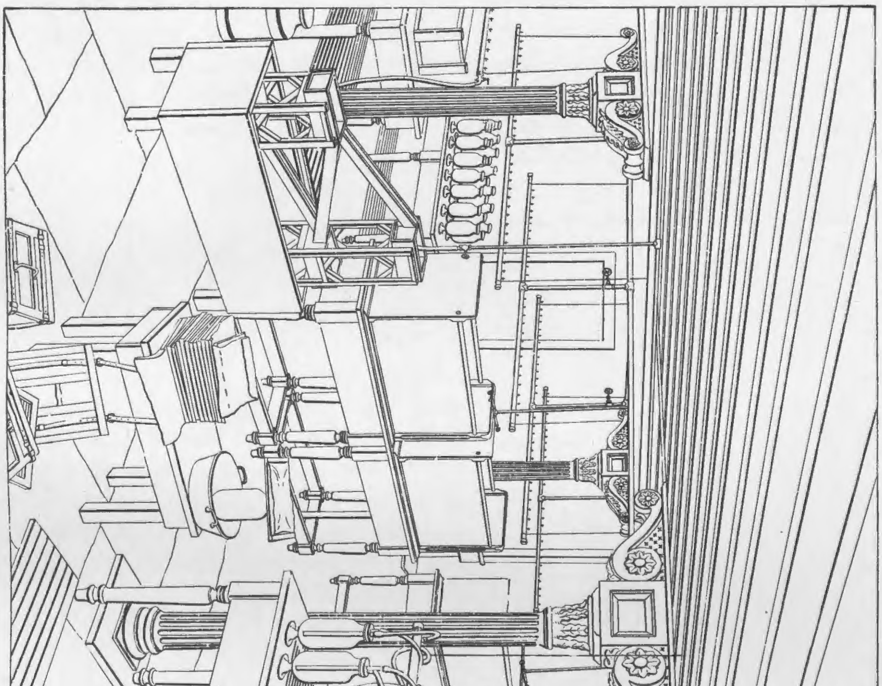
The quantity of water necessary for hatching a given number of eggs must necessarily vary, not only with the supporting quality of the water, that is the relative amount of oxygen it contains, but to a considerable extent it depends upon its muddiness. In hatching semi-buoyant eggs it will be found necessary to employ considerably more water if it be very muddy; a part to support the eggs and an additional quantity to wash away the mud. Allowing for air vents and other wastes it will be safe to estimate for 7,000 gallons of water each twenty-four hours for every million eggs of shad, and 4,000 gallons per twenty-four hours for each million whitefish eggs. Thirty gallons an hour through one jar will easily hatch 25,000 eggs of any of the Salmonidæ.



METHOD OF REGULATING WATER SUPPLY FROM A SPRING. (See page 208.)



TANK FOR REGULATING SUPPLY FROM WATER-MAINS.



MANNER OF DISTRIBUTING WATER TO THE HATCHING TABLES. (See page 206.)

DESCRIPTION OF THE McDONALD UNIVERSAL HATCHING-JAR.

The jar consists essentially of a cylindrical glass vessel with hemispherical bottom. These are not blown, but pressed, in order to secure regularity of the interior surface, upon which depends to some extent the perfect working of the jar. The jar is supported upon a tripod of three glass lugs, which form of attachment was adopted to prevent the distortion of the bottom of the jar—a defect frequently found in jars resting upon a single foot. The top of the jar is made with threads to receive a screw cap, and both the bottom and top surfaces are ground so that the plane of each shall be at right angles to the axis of the jar, and so that when the jar is resting upon its feet its axis shall be perfectly vertical. These are all-important considerations to secure good results in hatching eggs.

The top of the jar is closed by a metallic disk, perforated with two holes five-eighths of an inch in diameter; one central, which admits the glass tube that introduces the water into the jar; the other, equally distant from the central hole and the edge of the metal plate, admits the glass tube which carries off the waste water. The central tube is connected by a half-inch rubber pipe with the jet cock which should furnish a supply of water under a constant head. A groove in the inner surface of the metallic plate carries a rubber collar, and when the plate is in place the tightening of the metallic screw cap seals the opening hermetically. It will sometimes be found that a slight defect will cause a small leak even after the metal screw cap is down tight. This can nearly always be corrected by the employment of two rubber collars or washers. Both the inlet and outlet tubes pass through stuffing boxes provided with gum washers and binding screws. The central or feed tube is provided with stuffing boxes, one on top of the disk and one on the bottom, the better to hold it in a true center. The outlet tube is provided with only one stuffing box, and moreover the binding ring is beveled, the purpose of which will be explained later. In fitting the jar for work it will be found advantageous to fit in the side tube first. The glass tubes should be wet, the gum washer slipped on the tube about 1 inch from the end, and introduced into the opening; holding the tube perpendicular to the face of the plate, press fairly on the tube, and the washer, rolling on itself, will fall into the seat provided for it. Screw on the binding ring, and test by seeing that the tube slides freely back and forth in the stuffing box. If not, it should be refitted with a heavier or lighter washer, as may be required. The glass tubes can not be procured of absolute uniformity in size, and the gum washers, being hand made, also vary; therefore in order to secure a neat fit use large washers with small tubes and *vice versa.* Water is the only lubricant that should be used about the jar fitting.

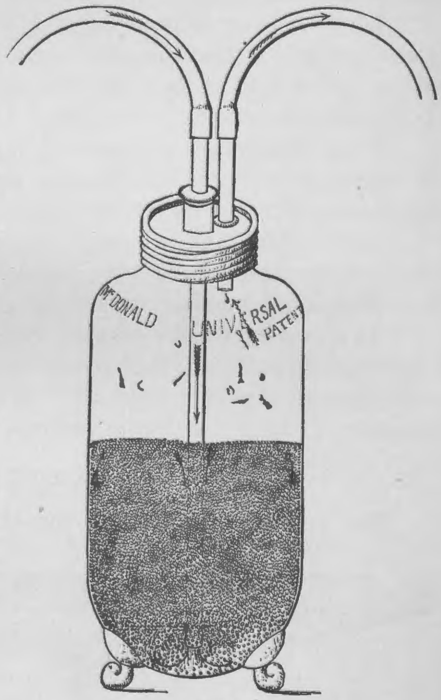


Fig. 1.

With a proper quantity of semi-buoyant eggs in the jar and the water turned on and regulated, the movement of the current establishes a regular boiling motion in the mass of eggs, which brings each in succession to the surface. The intensity of the boiling motion may be regulated at will without altering the quantity of water employed. By loosening the upper binding screw of the central stuffing box and pushing the feed tube down until it almost comes in contact with the bottom of the jar, the motion of the eggs is increased. If the jar is working properly the dead eggs when brought to the surface do not go down to mix again with the live eggs, but remain on top, forming a distinct layer. By pushing down the outlet tube a suitable distance the dead eggs are lifted up by the escaping current and taken out, leaving a mass of clean, live eggs in the jar. The beveled edge of the binding screw permits the swinging of the outlet tube over a large portion of the surface of the eggs. By careful manipulation in this way it is possible to remove every dead egg without the loss of one live egg.

The hatching is done on tables arranged for the work. The dimensions and arrangement of the tables are capable of indefinite modification. Working drawings of the tables used at the Central Station of the U. S. Fish Commission at Washington, D. C., are here given. (Plate 34.)

When the period of hatching has arrived among the semi-buoyant eggs, instead of allowing the water from the hatching-jars to pass directly into the sink, it is necessary to conduct it into a receiving tank.

In the shad and whitefish hatching at Central Station, large rectangular glass aquaria are used as receiving tanks, six or eight and sometimes ten jars discharging their fish into a common receiver. (Plate 35.)

As receiving the fry of semi-buoyant eggs is practically the same with all forms of hatching apparatus, it will not be further described. The handling of the heavy eggs and their fry by this apparatus being entirely different from all others, it will be mentioned under a separate paragraph.

MANIPULATING THE JAR WITH SEMI-BUOYANT EGGS.

The eggs are introduced into the jar by means of a shallow funnel (Fig. 2), as shown in the cut. The funnel is made of tin and is provided with a rim of perforated tin or wire gauze. The jar, thoroughly clean, is filled with fresh water (never stale) and placed in a sink or pan to catch the overflow. The funnel is inserted in the jar so that the water will stand as high in the funnel throat as possible, and the eggs poured in from a pan or washed in from the transportation trays by means of a jet of water. In this operation care must be used to have the eggs fall but a short distance and drop into the water. On no account suffer any fish scales or other

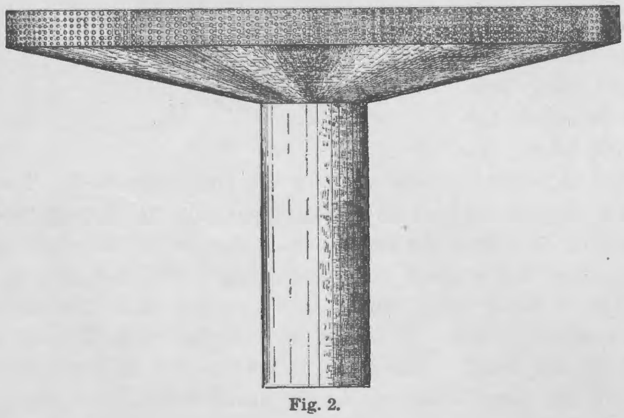
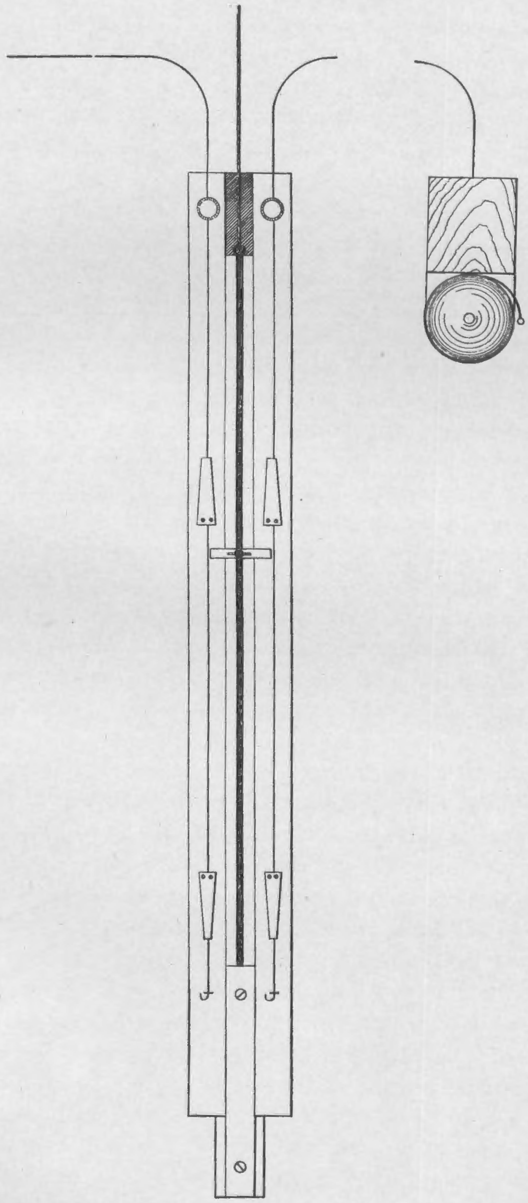


Fig. 2.



ELECTRIC INDEX AND ALARM-BELL TO WATER-TANK. (See page 208.)

foreign matter to enter the jar. The presence in the jar of anything but water and eggs renders a proper motion of the mass impossible, and generally results in the loss of a large proportion of the eggs. No absolutely definite law can be established as to the correct number of eggs for each jar, because the conditions are never the same in any two hatcheries, and vary from day to day in any particular hatchery. With shad eggs it will not generally be found advisable to put more than three quarts, or about 85,000 eggs, in a jar. If the water is very clear, or temperature low, an additional pint of eggs can be safely added; or if the eggs are known to be very bad the quantity can be increased to a gallon (about 115,000 eggs), provided the boiling motion, at first, be very slow. After thirty minutes, the dead eggs being partially separated, may be drawn off and a faster motion given to the remaining live eggs. Whitefish eggs when first taken are somewhat glutinous, and, if not properly managed, liable to become "lumpy" and require breaking up or separating. When the whitefish are new they should be worked quite rapidly under a full current. (This also applies to a limited extent to shad eggs.) Care should be exercised at this point that the end of the inlet tube reaches nearly to the bottom of the jar for the double purpose, first, that the eggs may not be caught under the inlet and pounded on the bottom of the jar; and, second, that the boiling motion may be increased without any unnecessary waste of water. An experienced workman can easily tell when the eggs are entirely "free" and reduce the motion accordingly. I am aware that the fish-culturists of the lake region claim that it is absolutely necessary to have an open jar in which to hatch whitefish, to more conveniently "feather" or separate the lumps; but actual practice has determined that the McDonald jar is capable of satisfactorily incubating whitefish eggs in all stages of hatching. When the whitefish eggs are new, three quarts (about 108,000 eggs) is a sufficient quantity for a jar. As they advance to the eye-spot period the quantity of eggs may be doubled, so that each jar will have between 4 and 5 quarts (from 145,000 to 180,000 eggs). This will not only leave fewer jars for attention, but economize water.

The requisite number of eggs being in the jar, it is put in its proper position on the hatching-table and closed. Before closing, be sure that both the inlet and outlet tubes slide freely in their stuffing boxes, and that the rubber washer as well as the screw-cap is in its proper position. If the tubes should have become gummed so as not to slide freely, this can often be remedied by allowing water to trickle down around the binding screws. To close the jar, turn on the water, place the feed-tube in the jar, turning off the water immediately after the feed-tube has passed beneath the surface of the water in the jar. The object of this is to expel all the air from the feed-tube, else it would rise in bubbles, throwing a portion of the eggs out through the outlet-tube. After expelling the air from the feed-tube place the washer and metal plate in position and screw down the screw-cap. When the water is turned on semi-buoyant eggs for the first time the action is often peculiar, and the jar should be watched closely until a regular motion has been established. When eggs from any cause have stood fifteen or twenty minutes in the jar before the water is turned on, they do not readily yield themselves to the boiling motion, but seem to have become packed so that they tend to rise in a solid mass to the top of the jar. By quickly starting and stopping the current the mass is readily disintegrated. A jar should never be left till the attendant is thoroughly satisfied that the regular boiling motion has been established. The degree or intensity of motion the egg should have will be found to vary not only with the age and condition of the eggs, but also with the condition of the water. If the water is muddy, the motion should be quite rapid, rapid enough, in fact, to prevent mud settling either on the eggs or in the bottom of the jar. Under ordinary conditions of clearness (and absence of glutinous coating) the best motion will be found to be that which readily brings the dead eggs to the surface. After the hatching has progressed far enough to dispose of a portion of the eggs, there is, of course, less resistance to the current and it should be reduced by shutting off a part of the supply or by slightly lifting the central tube. In fact the motion should be reduced somewhat when the hatching-out begins. If the motion is not reduced from time to time as the hatching-out progresses it will be found that the shells will be carried over into the receiving tank with the fish, and being very light, will be drawn against the outlet-screen, soon causing an overflow. The motion should be so gentle at the time of the greatest hatching as barely to induce the fish to swim out of the jar and leave their cast-off shells behind. Under the combined conditions of very healthy eggs, bathed in bright direct sunshine, the hatching is so rapid that the combined effort of the swarming mass of young fish will establish sufficient current to draw some shells over into the receiving tank. This can not be entirely prevented, but may be modified by placing a screen between the jar and the light. The shells under normal conditions remain and form a cloud-like layer above the mass of working eggs. As they accumulate in quantities they should be removed by shoving down the outlet-tube until they are drawn up with the escaping water. A good plan is to draw several jars in succession, catching the "draw-off" in a large pan, from whence any fish coming over with the shells may be ladled into the receiving tank. Towards the latter part of the incubation it will be noticed that a remnant of eggs will be very long in hatching. These eggs should be poured into a large pan and exposed to bright sunlight. The pan should be clean and bright. It is not recommended to put over 5,000 eggs in one 3-gallon pan. After a lapse of five or ten minutes, depending upon the stage of the eggs and intensity of the sunlight, the eggs will all be hatched out and the fish may be ladled into the receiving tank.

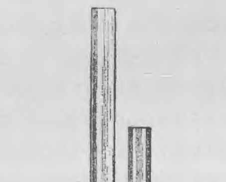
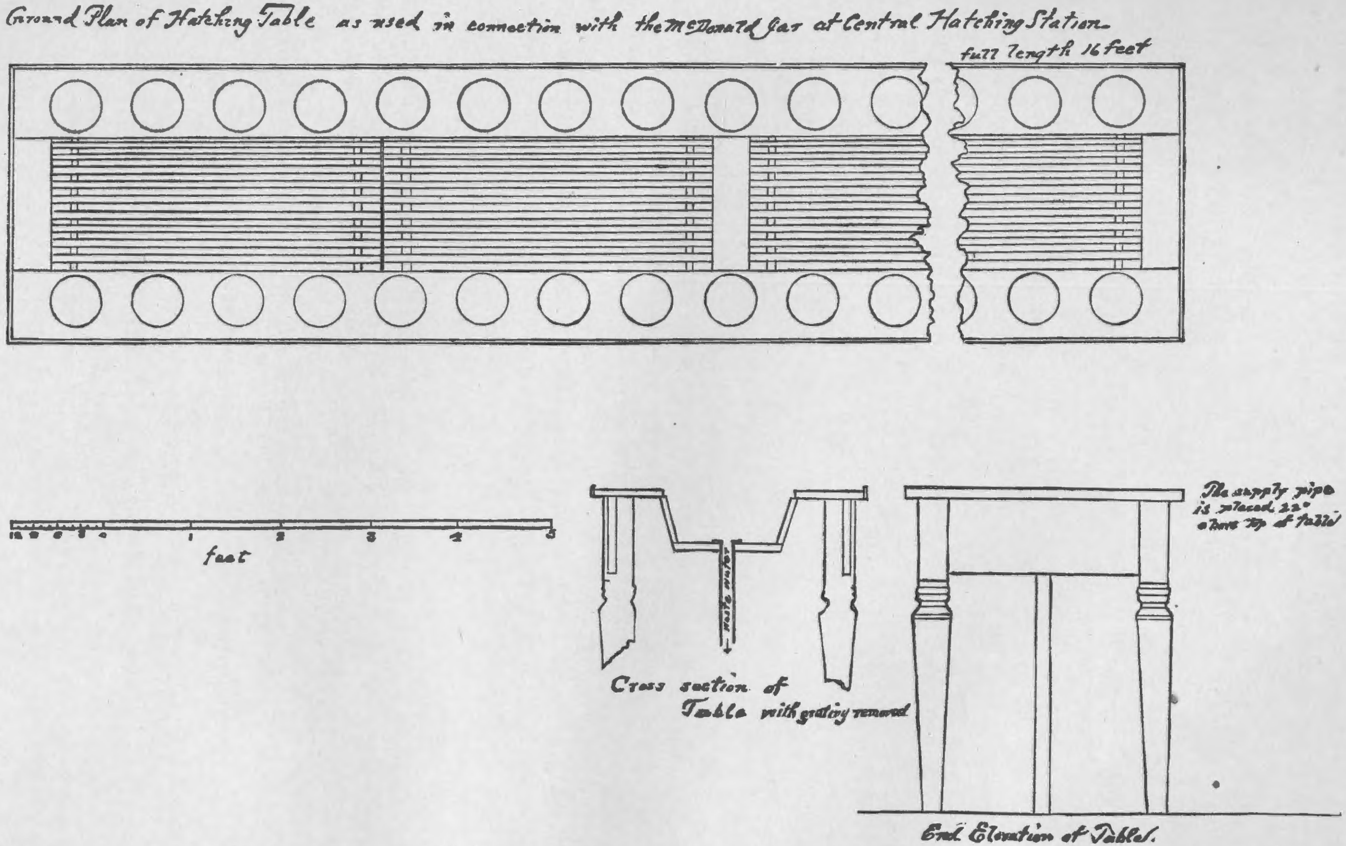


Fig. 3.

Sometimes in the course of hatching it may be found necessary or convenient to break the connection between the rubber tube and the jet cock. The handle of the jet cock may wear loose, so that the current of water drags in bubbles of air, mud, trash, iron rust; or small fish will occasionally clog the jet cock, stopping off the supply; or it may be desired to move the jar to another part of the hatchery. Any of these conditions would necessitate breaking the connection between the feed-tube and the jet cock, filling the former with air. When the connection is broken, be careful that the rubber tubing attached to the glass feed-tube does not drop down and siphon the eggs from the jar. In reconnecting it will be necessary to again expel the air from the feed-tube before turning on the water. To do this without unscrewing the jar top, draw the feed and outlet tubes up high in the jar until the ends are



WORKING DRAWINGS OF HATCHING TABLE. (See page 210.)

nearly to the metal plate (Fig. 3), turn on a full head of water, and the air in the feed-tube will pass in bubbles above the eggs, leaving the jar by the outlet-tube. The eggs will not be disturbed. After the air is all out, close off the supply, shove down the central tube to its proper position, and turn on the water again.

A scaff-net, small enough to easily enter the mouth of the jar, fixed to a handle several inches longer than the height of the jar, will be found a convenient tool for removing particles of foreign matter that will occasionally, in spite of every precaution, find its way among the eggs.

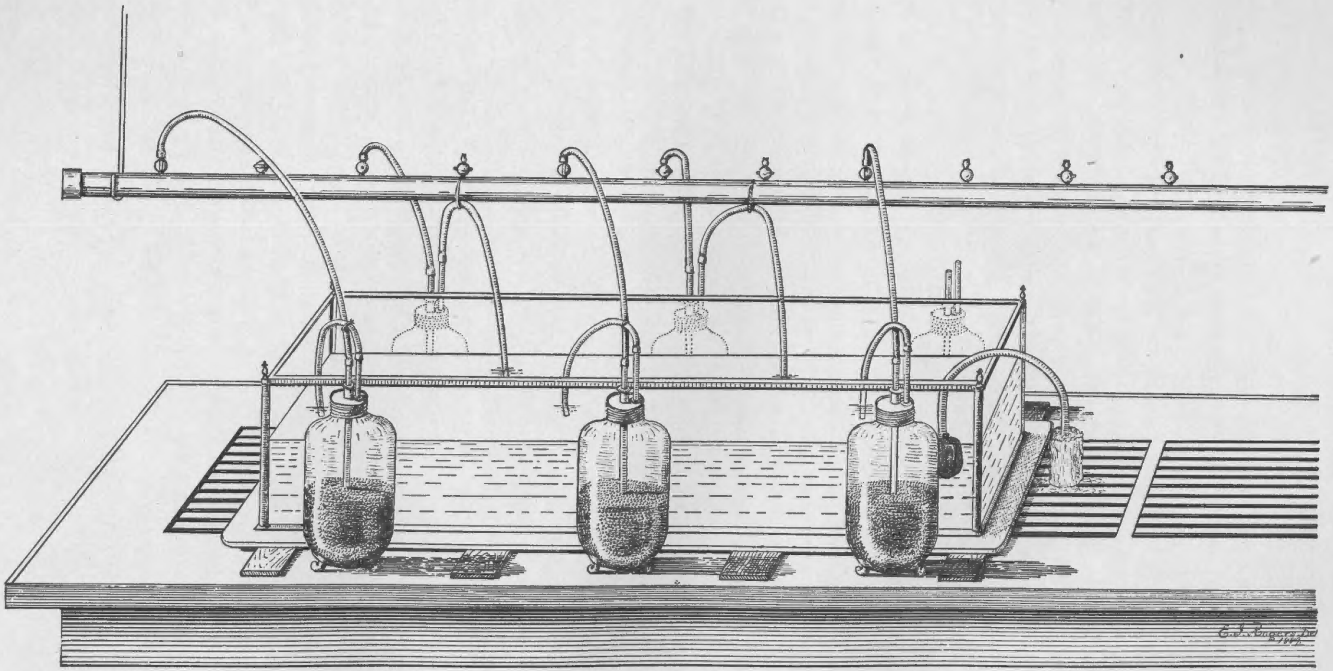
MANIPULATING THE JAR WITH HEAVY EGGS.

Practically there is little difference in handling any of the varieties of salmon and trout eggs, so little that no difference will be recognized in treating of their management. Such small differences of treatment of the eggs and fry as may be necessary will readily suggest themselves to the veriest tyro, and it is safe to assume them known to the expert. The term "heavy eggs" will be used as a general term to designate all species of salmon and trout eggs.

When the eggs are received at the hatchery the first step is to ascertain their temperature. It is supposed of course that the hatchery has a fairly accurate thermometer. Remove the outer case and carefully introduce the thermometer into the egg package, allowing it to remain about twenty minutes, carefully withdraw it and observe the temperature. If there is a variation of more than four or five degrees between the temperature of the eggs and the water in which they are to be hatched; the package should be allowed to stand in the hatchery until the temperatures are equalized, or nearly so. If the packing material is frozen, frequent drenching with cold water, or even submerged in cold water 33° to 35°, is recommended. If the precaution is taken to gradually equalize the temperature, it will prevent the shock which would otherwise result to the eggs by a too sudden change of temperature. If the eggs are packed in shallow cotton or flannel bottom trays, covered with mosquito-netting and moss, they are easily washed into a pan by a jet of water. Should they be packed in alternate layers of moss between netting, pick off the moss, take up the lower netting by the four corners, and pour the eggs into a pan of water. Any bits of moss or other foreign matter may be picked out with tweezers and the eggs thoroughly rinsed. The dead eggs are now picked out. This operation is one demanding some amount of skill. Dead eggs are white, but it is not safe to assume that every white egg is dead. In all cases give the egg the advantage of any doubt and remove none that are not known to be dead. If an egg be really dead, a few hours more will definitely settle the question.

The apparatus used in connection with the McDonald jar for picking over heavy eggs are a shallow square or oblong tin pan, filled nearly to the top with water, in which floats a tray with a wire-cloth bottom, a pair of ordinary tweezers, a small scaff-net, and several feathers from a turkey's wing. The tray should be of some light wood, one inch less in length and breadth than the pan. A wire-cloth bottom of oblong mesh (one-sixth of an inch by 1 inch) should be generally used for trout-hatching. Tweezers of wood are generally recommended above those of metal. The scaff-net is conveniently made by bending a piece of copper wire for the frame and twisting the ends to form a handle. A good size is 4 by 2½ inches. Over this frame sew a piece of mosquito netting.

With the scaff-net transfer a portion of the eggs from the pan to the floating tray. A slight sifting motion of the tray will cause any remaining trash to fall through the meshes, and, at the same time, level off the eggs. The dead are picked out with the tweezers and the living are put in a jar. By counting the number of trays or layers the proportion of the entire lot can be ascertained for each tray or layer. Knowing this, it can approximately be determined what quantity each jar is to receive. With heavy eggs it is not advisable to fill the jar more than one-third full, though excellent results have been obtained with the jar three-fourths filled with Atlantic salmon eggs. With heavy eggs the boiling motion is neither necessary nor desirable. The amount of water for each jar is about the same as that required for shad, possibly a little less, and it can be used under much less pressure than that needed for semi-buoyant eggs. No motion being given to the heavy eggs, there is of course no automatic separation and picking of the dead eggs. To remove the dead eggs the jars have to be unsealed, the eggs poured into a pan and picked with tweezers in the same manner as when they arrived. This slight trouble, however, is abundantly compensated for, because in this apparatus the heavy eggs do not require picking for several days. So perfectly is every egg supplied with the constantly-changing envelope of fresh water that they remain healthy for a much longer period than in the forms of apparatus employing horizontal currents. In the jar there are no dead angles for stale and eddy water. Should the water become muddy, as it does at times in nearly all hatcheries, eggs exposed under horizontal currents are in constant danger of asphyxiation from deposits of sediment. In the McDonald jar, the water coming from below and passing upwards, all sediment deposited is on the upper side of the egg. Gravity prevents any accumulation on the under side, which always presents a clean surface to the incoming current. The time elapsing between the " pickings," even with a uniform temperature, will vary; and here again the attendant must be guided by close observation and judgment. Mr. Charles G. Atkins says that in water of 40° Fahr. the eggs should be picked once in every three days. This rule was established with the old trough-and-tray system employing horizontal currents, and was undoubtedly correct for that system. During the season of 1883-'84, at Central Station, in Washington, D. C., a jar containing 30,000 Lake trout eggs remained closed from January 6 to January 21, when it was opened more for the purpose of washing than picking, but no unusual mortality could be detected. The temperature of the Potomac River water during that time varied from 41° to 38° Fahr., and averaged 39.5° Fahr. It may be interesting to note that during this period the water was unusually muddy. As often as is thought desirable the sediment may be washed from the eggs without opening the jar. Grasp the jar firmly at the bottom and top, lift clear of the table, and turn it rapidly so that the sides may generate a double cone, the center of the jar forming a common apex. In this operation care should be taken that the turning of the jar is not so violent as to throw the eggs up to a height that they will pass off through the outlet-tube. The eggs rolling upon themselves cut off the sediment, which readily passes off with the waste water. This operation will cleanse the eggs thoroughly, and, if judiciously repeated, will obviate all danger of asphyxiation by deposit of sediment. During the time when the fry are breaking from the shells the jar should be opened somewhat oftener, the dead picked out, shells removed, and the fry transferred to proper rearing quarters. The eggs should now be handled with more care than formerly, for while a salmon or trout egg is quite tough and will stand a good deal of rough handling at certain periods, as the



ARRANGEMENT OF JARS AND AQUARIA FOR FRY OF SHAD AND WHITE FISH. (See page 210.)

time of hatching-out approaches it has become tender and there is danger of prematurely bursting the shell. Pour the eggs carefully into a pan nearly full of water. With the scaff-net slightly disturb the water, and as the shells rise skim them off. After all the shells are removed, put a part of the eggs on the picking-tray and remove any dead. By gently sifting the tray and turning the eggs over with a feather, the fry can be made to drop through the meshes into the pan below, from whence they are easily transferred to the rearing quarters prepared for their reception.

MEASURING THE EGGS.

The question of measuring the eggs is a most important one to the fish-culturist, and yet, to judge from the various ways of measuring eggs, it is one that has received little attention. Every branch of trade has a standard measure, but fish-culture has remained without standard or rational unit; each workman establishing for himself a system of determination, and varying that system from year to year as the exigencies of the season demanded. There has not only been a want of harmony in the various so-called measures used, but the "measures" themselves have lacked the elements of reliability, being in many cases the most arbitrary and irrational. The records of results of work in the earlier days of fish-culture were but wild guessing, and, sad to say, many records are yet made in the same manner.

The practice of arriving at the number of any given lot of eggs by estimating each parent fish to contain an unvarying quantity of eggs, and multiplying this quantity by the number of females spawned has justly gone out of use. How various and how far wide of the mark such estimates were is shown by the following: Seth Green estimates a shad to contain from 20,000 to 28,000 eggs;[1] C. C. Smith, of Connecticut, puts it at 50,000;[1] Dr. H. C. Yarrow estimates a shad to contain from 100,000 to 150,000 eggs;[2] and Prof. J. A. Ryder, embryologist of the U. S. Fish Commission, says a shad may have 250,000 ova in process of maturation at one time in her roes.[3] These statements are made to show the absurdity of the old method of determination. There is no desire to attach odium to any one; but the wish is earnest to call to the attention of all interested the necessity of some recognized standard of measurement to be known and used by all fish-culturists. Not unfrequently has it happened that a consignment of eggs when estimated by the recipient has fallen short of the invoiced number. Sometimes these occurrences have led to accusations of fraud. In a former article in a Bulletin of the U. S. Fish Commission, I have shown that the discrepancy may often result in part from other causes, and instead of being actual is to some extent but apparent. Whitefish and shad eggs, and possibly others, after several hours in the packing-crates, undergo a shrinkage, amounting to nearly 12 per cent. of their bulk. After being several hours in the jars the eggs reabsorb the water and resume their normal size. But the main reason for the discrepancy in the measurements at the receiving and shipping points will be found in the want of harmony in the methods of measuring.

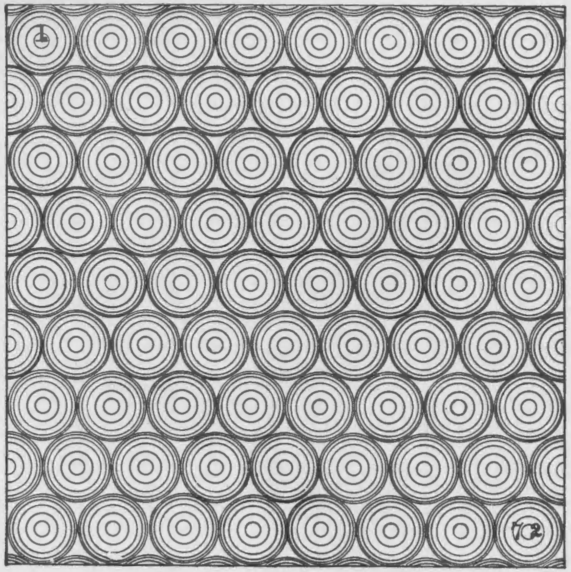
In many hatcheries, especially those hatching heavy eggs, the system of determination is based on the diameter of the egg. It will be found very difficult to estab-

[1] U. S. Fish Commission Report, Part II, p. 427.
[2] Ibid., p. 455.
[3] U. S. Fish Commission Bulletin, Vol. III, p. 196.

lish by calculation, based on the diameter, a standard for measuring eggs on trays; and the difficulty amounts to almost impossibility when it is attempted in like manner to determine the number of eggs in a given bulk. This at once becomes apparent by reference to the accompanying diagram. To determine the number of eggs on a tray, the general practice has been to count the number of eggs on two of its adjacent sides and multiply them together; it being assumed that the product was the number of eggs on the tray. This would be true if the eggs arranged themselves as shown in Fig. 2, Plate 36. As a matter of fact the eggs really group themselves in a different manner (see Fig. 1, Plate 36), nearly obliterating the void space between the eggs. Theoretically but sixty-four eggs, one-eighth of an inch in diameter, will occupy 1 square inch; practically we get over seventy-five. When we come in like manner to estimate eggs in bulk occupying a known cubic space, the error becomes greater by reason of the obliteration of the void. The eggs on the second layer do not occupy a position directly above those on the first layer; that is to say, the nadir of an egg on the second layer does not coincide with the zenith of an egg on the first layer, but falls in the center of a void formed by three contiguous eggs. From this it follows that the altitude of two layers is less than two diameters of an egg. It is a legitimate conclusion that a bulk 1 inch deep of eggs one-eighth of an inch in diameter will have more than eight layers of eggs. It will require a higher knowledge of applied mathematics to solve this problem than is generally possessed by fish-culturists.

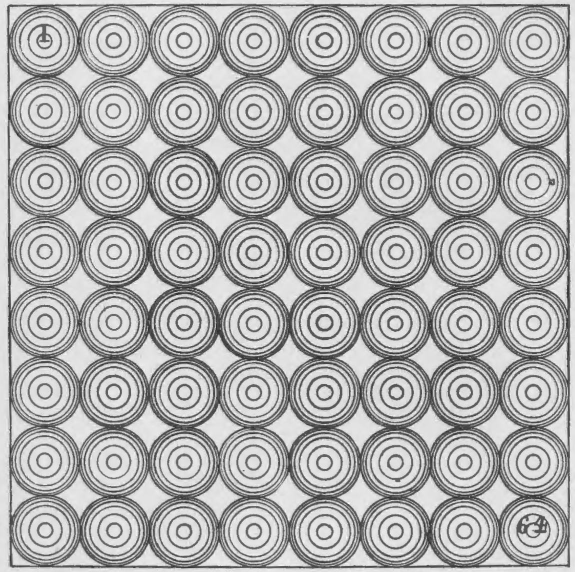
While employed at the Central Station of the U. S. Fish Commission, at Washington, D. C., in charge of hatching, from 1882 to 1888, I devised a system of measuring fish eggs and fry. It is applicable to all classes of semi-buoyant and heavy eggs, and is, I believe, based upon rational principles. No one recognizes better than I that it still possesses inaccuracies, which only time, close observation, and determined practice can obliterate. The basis of this system is the number of eggs in a standard quart of the United States (57.75 cubic inches) determined by actual count of each egg. In the table here given some of the varieties of eggs were not obtainable for counting; these have been computed from their known diameter, due allowance being made from absorption of the voids. In all cases stated to be counted, the count has been made of each egg in the measure.

Fig 1.



ACTUAL.

Fig. 2.



THEORETICAL.

DIAGRAMS ILLUSTRATING THE ARRANGEMENTS OF FISH EGGS IN A SQUARE INCH. (See page 216.)

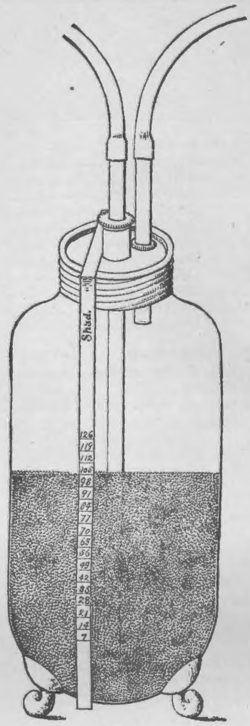
Species.	Number of eggs to a standard quart, 57.75 cu. in.	Authority.	How determined.	Reference.
Spanish mackerel[1]	1,267,728	R. E. Earll	From diameter	F. C. Report, 1880, p. 450.
Codfish[2]	335,000	H. C. Chester	......do	
Wall-eyed pike[3]	120,000	James Nevens		July 7, '87, Forest and Stream.
Whitefish[4]	36,800	F. N. Clark	Count part of quart	F. C. Report, 1880, p. 575.
Do	34,800	W. F. Page	Count of 1 quart	Central Station, season 1884-'85.
Do	33,450	....do	......do	Central Station, Feb., 1887.
Shad[5]	28,239	do	......do	Central Station, season of 1886.
Do	28,800	W. P. Sauerhoff	Count of 1 gill	Battery Station, May, 1886.
Do	22,750	....do	......do	Do.
Rockfish[6]	24,363	S. G. Worth	From diameter	
Rainbow trout[7]	12,800	F. N. Clark	Count, 1 fluid ounce	F. C. Report, 1882, p. 820.
Do	9,485	G. A. Seagle	Count, 4 cubic inches	Personal letter, Wytheville Station.
Rainbow trout, three and four years old fish, domesticated.	7,625	E. M. Robinson	Count, 8 cubic inches	Do.
Rainbow trout from Baird, Cal.	6,875	....do	......do	Do.
Do	6,624	W. F. Page	Count of 1 quart	Central Station, 1884.
Do	6,536	....do	Count, 1 pint	Central Station, Feb., 1887.
Von Behr trout[8]	9,935	....do	Count, 15 ounces	Central Station, Mar., 1887.
Do	8,301	E. M. Robinson	Count, 8 cubic inches	Personal letter, Wytheville Station.
Brook trout[9]	11,092	William Buller	Count of 1 quart	Personal letter, Corry, Pa., hatchery.
Do	13,998	W. F. Page	Count, 13 ounces	Central Station, Feb., 1887.
Brook trout, eggs from Michigan.	13,590	E. M. Robinson	Count, 36 cubic inches	Personal letter, Wytheville Station.
Brook trout, eggs from Connecticut.	12,063	....do	......do	Do.
Lake trout[10]	5,720	W. F. Page	Count of 1 quart	Central Station.
Do	5,780	....do	......do	Central Station, Dec., 1887.
California salmon[11]	3,696	....do	From diameter	
Atlantic salmon[12]	4,272	....do	Count of 1 quart	Central Station.
Land-locked salmon[13]	3,300	....do	......do	Do.

[1] Scomberomorus maculatus.
[2] Gadus morrhua.
[3] Stizostedion vitreum.
[4] Coregonus clupeiformis.
[5] Clupea sapidissima.
[6] Roccus lineatus.
[7] Salmo irideus.
[8] Salmo fario.
[9] Salvelinus fontinalis.
[10] Salvelinus namaycush.
[11] Oncorhynchus chouicha.
[12] Salmo salar.
[13] Salmo salar, var. sebago.

An examination of the table will show certain apparent discrepancies between the counts made from year to year. It is undoubtedly true that in some kinds of eggs there is a slight variation from season to season. Where the count is made of a full quart, and of eggs matured under like conditions, the discrepancy in number will be but trifling. We can not expect an equality in size between the eggs from wild and domesticated fish, between "scrub" and "improved" stock.

The McDonald jar presents an easy, quick, and safe means of applying the knowledge contained in the table. The measurements in all cases are made while the eggs are in the jar, and with the cap screwed down. To ascertain how many eggs have been lost or hatched or are on hand are questions constantly arising. It would be cumbersome and tedious were we obliged to open the jar and measure the eggs in a graduate every time such information was needed. Moreover, we have to know the quantity of eggs in each jar at a period in their development when such procedure would be exceedingly hazardous.

The measuring scale is a light square made of wood, not so liable to break the jar as metal. The long leg of the square is 15 inches long, half an inch wide, and quarter of an inch thick. The short leg is of the same breadth and thickness and half the length. (Fig. 4.) The long leg is graduated to read from the bottom upwards. The first grade is at a height corresponding to the level attained in the jar by a measured half pint of water; the succeeding grades are determined by the introduction of additional half pints of water. When constructing a scale the feed-tube should be stopped at the lower end, so it may displace an amount of water equal to the amount of eggs it will displace in practice. It is desirable to have a separate scale for each variety of eggs hatched. All measurements are made with the feed-tube in place, the water shut off, and the eggs allowed to thoroughly settle. All semi-buoyant eggs should be in the jar several hours before measuring, so that they may swell to their normal size. The short leg of the square is placed over the top of the jar, the long leg hanging down, and the scale read from the point where the top layer of eggs shows in the jar. Reference has been made to measuring the fish. It is possible to obtain by measurement an almost correct estimate of the number of fish produced by a jar of semi-buoyant eggs. Just before the time of hatching all dead eggs should be carefully drawn off, and when the first fish is seen swimming in the jar the eggs should be again measured. It is an ascertained fact that scarcely any semi-buoyant eggs die, under proper conditions, after hatching out has commenced, so that the last measure furnishes us a close approximation to the number of fish.



No. 4.

6.—A REPORT UPON THE FISHES OF KALAMAZOO, CALHOUN, AND ANTRIM COUNTIES, MICHIGAN.

BY CHARLES H. BOLLMAN.

In 1885 the Fish Commissioners of Michigan began a systematic survey of the lakes and rivers of that State with a view to ascertaining the results of the early efforts at stocking those waters, and also their adaptability to different kinds of fish. This information was only to be obtained by a careful examination of each body of water as to its quality, temperature, depth, inhabitants, and food-resources. Field parties were organized from among the employés of the State Commission, and their work has been continued during each summer down to the present time. An account of their investigations will be found in the seventh and eighth biennial reports of the State Board of Fish Commissioners, published at Lansing, Mich., in 1887 and 1888.

No professional naturalist was attached to these parties previous to 1888, and their researches regarding the inhabitants of the lakes and rivers were chiefly limited to the commoner species of fish. For the purpose of obtaining a more comprehensive knowledge of the fauna, the writer was employed by the U. S. Fish Commissioner to accompany the Michigan party in 1888, as naturalist, under an arrangement with the State Commissioners. The present paper contains a brief outline of the explorations made during that season, and a list of the fishes taken, together with such notes upon them as seem to have some permanent value. On account of its northern position the State of Michigan has comparatively few kinds of fishes. The number of species enumerated in the following list is proportionally still smaller, for the reason that the bodies of water examined in 1888 have all essentially the same characters with respect to temperature and nature of bottom (usually fine mud or pulverent vegetable matter), as well as to the flora and fauna. A set of the fishes collected has been placed in the U. S. National Museum at Washington. The invertebrates have not yet been studied.

The places visited may be divided according to the river basins into three principal groups, as follows:

I.—THE ST. JOSEPH SYSTEM.

1. *Long Lake*, Kalamazoo County, situated about 7 miles south of Kalamazoo. Length, 2 miles; width, three-quarters of a mile; greatest depth, 42 feet; surface temperature, 73° to 74°; bottom temperature, 52° to 53°; date of examination, July 8 to 11. The southern parts of this lake have gravelly and sandy shores, while those of the northern parts are marshy, and the lake is diversified by patches of bulrushes, *Potamogeton*, and other aquatic plants.

2. *Austin Lake*, Kalamazoo County, about a quarter of a mile from Long Lake and

connected with it by a small stream. This lake has been ruined by being drained, and now has a depth of only from 12 to 15 feet, while formerly it was nearly twice as deep. Its size is somewhat larger than that of Long Lake. Date of examination, July 12 and 13.

3. *Indian Lake*, Kalamazoo County. This lake lies several miles to the southeast of Long Lake. Its length is 2½ miles; width, 1 mile; greatest depth, 76 feet; temperature at surface, 72° to 73°; at bottom, 54°. Date of examination, July 11 and 12.

4. *Gourd-neck Lake*, Kalamazoo County, lies several miles to the southwest of Long Lake. Length, 1¼ miles; width, one-half mile; greatest depth, 50 feet; temperature at surface, 73° to 75°; at bottom, 49° to 50°. Date of examination, July 12 to 14. Eastern shores somewhat gravelly, the remainder marshy, with a steep offset. Outlet wide at southern end.

5. *Rawson Lake*, Kalamazoo County, lies about 2½ miles southwest of Vicksburgh. Length, 1¼ miles; width, one-half mile; greatest depth, 30 feet; temperature at bottom, 51° to 53°; at surface, 72° to 74°. The lake is without gravelly shores, its central parts being rather shallow and filled with species of *Potamogeton*. The northern parts, especially around the inlet, contain water-lilies and *Utricularia* in large quantities. There are two inlets, the northern one from the preceding lakes, the southern from the following.

6. *Howard Lake*, Kalamazoo County, is situated just south of Rawson Lake, and is connected with it by a wide outlet and several small lakes. Length, three-fourths mile; width, one-fourth mile; greatest depth, 46 feet; temperature at surface, 72° to 73°; at bottom, 44°. Date of examination of Rawson and Howard Lakes, July 16 to 20. Characters the same as those of Rawson Lake.

II.—THE KALAMAZOO SYSTEM.

1. *Goguac Lake*, Calhoun County, is located 1 mile south of Battle Creek. Length, 1¾ miles; width, one-half mile; greatest depth, 65 feet; temperature at surface, 73° to 75°; at bottom, 43° to 51°. Date of examination, July 20 to 25. This is a very irregular lake, with sandy and gravelly shores and marshy places at the heads of the coves. It has no outlets or inlets.

2. *St. Mary's Lake*, Calhoun County, is located 4 miles north of Battle Creek. Length, 1 mile; width, one-fourth mile; greatest depth, 24 feet; temperature at bottom, 53° to 54°; at surface, 74°. Date of examination, July 24 and 25. Characters the same as those of Goguac Lake.

3. *Barnum* and *Payne's Lakes*, Calhoun County. These are two unimportant lakes lying about 5 miles south of Battle Creek, each having a length of about 1 mile, and a width of one-fourth to one-third of a mile; greatest depth, 30 to 40 feet; temperature at surface, 73°; at bottom, 49°. Date of examination, July 22 to 24. Shores muddy.

4. *Upper* and *Lower Brace Lakes*, Calhoun County. These lakes lie about 2½ miles southeast of Marshall, and have the same characters as the two preceding ones, but with higher temperatures and less depth. Shores very muddy. Date of examination, July 30 to August 1. These two lakes are connected and flow into Wilder Creek.

5. *Lyon Lake*, Calhoun County, is situated about 3 miles south of the preceding lakes. Length, one-half mile; width, one-third mile; greatest depth, 30 feet; temperature at surface, 73° to 76°; at bottom, 67°. Date of examination, August 1 and 2. It has very clear water and sandy shores. There is neither outlet nor inlet.

6. The *Kalamazoo River* was examined at two points, namely, at Battle Creek and Marshall. It is a rapid stream with gravelly bottom. The quiet places are choked up with mud and débris. At Marshall the gill-nets were used and set above the dams.

III.—ELK RIVER SYSTEM.

1. *Torch Lake*, Antrim County. Length, 18 miles; width, 2¼ miles; depth, about 320 feet; temperature at surface, 67° to 69°; at bottom, 32½° to 48°. The water is very clear and partakes of the character of that of the Great Lakes. Shores sandy and gravelly; vegetation scarce. It flows into Elk River by way of Torch River, Round Lake, and Elk Lake.

2. *Clam Lake*, Antrim County. This is a small lake flowing into Torch Lake by Clam River. Its waters are dark and its fauna is more southern in character than that of Torch Lake.

3. *Rapid River*, Antrim County. A small, rapid trout stream flowing into Torch River; temperature, 50° to 55°.

4. *Spencer Creek*, Antrim County, has the same character as Rapid River. There are two dams near the mouth, and above them two kinds of fish only are found, namely, *Salvelinus fontinalis* and *Cottus bairdi*. The rest of the species mentioned as found in Spencer Creek may be considered as also occurring in Torch Lake. These places were examined between August 8 and 18.

Following is a list of the species of fishes observed at the above localities:

1. **Petromyzon concolor** (Kirtland). *Lamprey-eel.*[1]

One specimen found in Wilder Creek clinging to a dead *Catostomus teres*. This individual differs from any of the known specimens of *P. concolor* in having on each side of the mouth four teeth of the first concentric series bicuspid.

2. **Lepisosteus platystomus** (Rafinesque). *Gar.*

Long and Austin Lakes.

3. **Amia calva** Linnæus. *Lawyer, Dog-fish, Mudfish.*

Not common; Long Lake and Austin Lake.

4. **Ameiurus nebulosus** (Le Sueur). *Bull-head.*

Very common; Long, Austin, Indian, Gourd-neck, Rawson, Goguac, Barnum, St. Mary's, Upper and Lower Brace, and Lyon Lakes; Kalamazoo River, at Battle Creek and Marshall.

5. **Noturus flavus** (Rafinesque).

Kalamazoo River, at Battle Creek.

One individual found guarding its progeny under a stone.

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[1] The common names given are those used by Michigan fishermen.

6. **Catostomus teres** (Mitchill). *White Sucker.*

Common or abundant; Indian, Rawson, Goguac, St. Mary's, Barnum, Payne's, Upper and Lower Brace, and Torch Lakes; Kalamazoo River, at Battle Creek and Marshall.

7. **Catostomus nigricans** Le Sueur. *Stone-roller, Nigger-head, Hammer-head.*

Common; Kalamazoo, at Battle Creek and Marshall.

8. **Erimyzon sucetta var oblongus** (Mitchill). *"Pin Minnow"* (young).

Common; Long, Austin, Rawson, Howard, Barnum, and St. Mary's Lakes.

9. **Moxostoma duquesnei** (Le Sueur). *Golden Red-horse.*

Common; Lower Brace Lake; Kalamazoo River, at Battle Creek and Marshall.

10. **Pimephales notatus** (Rafinesque).

Abundant at all places.

11. **Notropis hudsonius** (De Witt Clinton).

Long, Austin, Indian, Gourd-neck, Rawson, Howard, and Clam Lakes. Common in the southern lakes, but not so in Clam Lake.

12. **Notropis megalops** (Rafinesque).

Abundant; Kalamazoo River, at Battle Creek and Marshall.

13. **Notropis atherinoides** (Rafinesque).

Not common; Kalamazoo River, at Battle Creek, Torch Lake, and Spencer Creek.

14. **Rhinichthys atronasus lunatus** (Cope).

Common; Austin Creek, Torch and Clam Lakes and Spencer Creek.

Body much mottled, spots confluent above, gradually fading out towards belly; lateral band indistinct; fins plain. D. midway between C. and nostril; snout rather long; head 4–4½ in body; eye, 5–5½ in head; lat. l. 62–65.

In this paper I have considered the Michigan specimens as forming a variety of *atronasus*, on account of the pattern of coloration. *Lunatus* is separated from *obtusus* by having the scales along lateral line less (62–65 instead of 70).

15. **Hybopsis kentuckiensis** (Rafinesque).

Common; Kalamazoo River, at Battle Creek and Marshall.

16. **Semotilus atromaculatus** (Mitchill).

Common; Howard Lake, Austin Creek, Kalamazoo River, at Battle Creek and Marshall.

17. **Notemigonus chrysoleucus** (Mitchill). *Golden Shiner.*

Not common; Long and Lyon Lakes.

18. **Coregonus clupeiformis** (Mitchill). *Common Whitefish.*

Torch Lake.

19. **Coregonus artedi** (Le Sueur). *Herring.*

Abundant; Torch Lake, Traverse Bay.

20. **Coregonus artedi sisco** (Jordan). *Sisco.*

Not common; Indian and Rawson Lakes.

21. Coregonus tullibee bisselli, subsp. nov.

Related to *Coregonus tullibee*, but presenting the following differences: Maxillary reaching to middle of eye; end of supplementary bone rounded; lower jaw longer when closed; supraorbital bone elongate pear-shaped; eye $4\frac{1}{2}$–$4\frac{2}{3}$ in head; scales anteriorly scarcely larger in diameter than those on caudal peduncle; lat. l. 80–82; head $4\frac{1}{3}$–$4\frac{1}{2}$; depth $3\frac{1}{2}$.

One specimen was caught in Rawson Lake and thirteen were taken in Howard Lake. The above description is based upon two specimens—one from each lake. I take great pleasure in dedicating this new variety to Mr. John H. Bissell, president of the Michigan Fish Commission.

22. Salvelinus namaycush (Walbaum). *Lake Trout, Mackinaw Trout.*

Common in Torch Lake.

23. Salvelinus fontinalis (Mitchill). *Brook Trout, Speckled Trout.*

Abundant; Torch Lake, Rapid River, Spencer and Austin Creeks

24. Fundulus diaphanus menona Jordan & Copeland.

Abundant; Goguac, St. Mary's, Upper and Lower Brace, and Lyon Lakes.

25. Zygonectes notatus (Rafinesque).

Rare; Rawson and Howard Lakes.

26. Umbra limi (Kirtland).

A few were taken in a small brook which flows into Howard Lake; one in Goguac Lake, and three in Rapid River.

27. Lucius lucius (Linnæus). *Grass Pike, Pickerel.*

Common; Indian, Gourd-neck, Rawson, Goguac, Lower Brace, and Clam Lakes; Spencer Creek.

28. Lucius vermiculatus Le Sueur.

Common; Rawson and Goguac Lakes; Wilder Creek.

29. Anguilla anguilla chrysypa (Rafinesque). *Eel.*

Gourd-neck and Rawson Lakes.

30. Pygosteus pungitius (Linnæus).

Common in Rapid River; not seen elsewhere.

31. Eucalia inconstans (Kirtland).

Not common; seen in Rapid River.

32. Labidesthes sicculus (Cope).

Common; Long, Austin, Gourd-neck, Rawson, Howard, Goguac, St. Mary's, and Lyon Lakes.

33. Aphredoderus sayanus Gilliams.

Two specimens taken in a small brook which flows into Howard Lake.

Scales in lateral line about 60.

34. Pomoxis sparoides (Lacépède). *Calico Bass, Strawberry Bass, Speckled Bass.*

Very common; Long, Indian, Austin, Gourd-neck, Rawson, Howard, Goguac, St. Mary's, Upper Brace, and Lyon Lakes.

35. **Ambloplites rupestris** (Rafinesque). *Rock Bass.*

Common; Long, Gourd-neck, Rawson, Goguac, Lower Brace, Torch, and Clam Lakes.

36. **Chænobryttus gulosus** (C. and V.). *Buffalo Bass.*

Common; Rawson and Lower Brace Lakes.

37. **Lepomis cyanellus** Rafinesque. *Buffalo Sun-fish.*

Common; Rawson, Goguac, and St. Mary's Lakes.

38. **Lepomis pallidus** (Mitchill). *Blue-gill, Bream.*

Abundant in all the lakes examined, with the exception of Torch Lake, where none were found; also taken in the Kalamazoo River.

39. **Lepomis megalotis** (Rafinesque).

Not common or rare; Rawson, Payne's, and Clam Lakes; Kalamazoo River.

40. **Lepomis gibbosus** (Linnæus). *Pumpkin-seed.*

Has the same distribution as *Lepomis pallidus.*

41. **Micropterus dolomieu** (Lacépède). *Small-mouthed Black Bass.*

Common in Torch Lake and the Kalamazoo River. Two young were taken in Goguac Lake.

42. **Micropterus salmoides** (Lacépède). *Large-mouthed Black Bass, Green Bass, Gray Bass, Oswego Bass.*

Abundant; Long, Austin, Indian, Gourd-neck, Rawson, Howard, Goguac, Payne's, Barnum, St. Mary's, Upper and Lower Brace, Lyon, Torch, and Clam Lakes; Kalamazoo River, at Marshall and Battle Creek; Spencer Creek.

43. **Etheostoma nigrum** (Rafinesque).

Common; Long, Goguac, Torch, and Clam Lakes; Kalamazoo River, at Battle Creek and Marshall; Spencer Creek.

44. **Etheostoma caprodes zebra** (Agassiz).

Common; Goguac and Torch Lakes; Spencer Creek.

45. **Etheostoma aspro** (Cope & Jordan).

One specimen found in a fish-box at Long Lake. It was said to have been caught in the Kalamazoo River, at Kalamazoo.

46. **Etheostoma cœruleum** Storer.

Common in the Kalamazoo River, at Battle Creek and Marshall.

47. **Etheostoma fusiforme eos** (Jordan & Copeland).

Rawson, Goguac, St Mary's, and Thayer's Lakes. D IX, 11; A 11, 7; lateral line 58–60, tubes 15–22. Cheeks scaly.

None of the specimens observed in Rawson, Gognac, and St. Mary's Lakes were over 45^{mm} in length, while all from Thayer's Lake were 55^{mm} long.

48. **Etheostoma exilis** (Girard).

Clam Lake. D. VII, 10; A. 11, 7; lateral line extending to end of anal, scales 55; tubes interrupted, 37–40. Cheeks naked. This is probably also a variety of *E. fusiforme.*

49. **Perca flavescens** (Mitchill). *Yellow Perch.*

Abundant in all the lakes examined.

50. **Stizostedion vitreum** (Mitchill). *Wall-eyed Pike.*

Two specimens caught in Gourd-neck Lake.

51. **Cottus bairdi** Girard. *Miller's Thumb.*

Common; Rice Creek, Spencer Creek, and Rapid River; Torch Lake.

52. **Triglopsis thompsoni** Girard.

Fifteen specimens taken from the stomach of a *Salvelinus namaycush*, which was caught in Torch Lake.

53. **Lota lota** (Linnæus). *Ling, Lawyer.*

Common in Torch Lake.

INDIANA UNIVERSITY, *February* 18, 1889.

7.—NOTES ON FISHES FROM THE LOWLANDS OF GEORGIA, WITH A DESCRIPTION OF A NEW SPECIES (OPSOPŒODUS BOLLMANI).

BY CHAS. H. GILBERT.

During the latter part of June, 1889, Mr. Charles H. Bollman, assisted by Mr. Bert Fesler, undertook the exploration of the lowland streams of the Southern United States in the interests of the U. S. Fish Commission. The work was but fairly begun, when Mr. Bollman was prostrated by an attack of fever, which proved fatal. The following notes are on the material collected by him. The streams examined are thus described by Mr. Bollman:

(*a*) *Brier Creek at Waynesborough, Ga.*—A cold, sluggish stream, with steep banks, and apparently hard, sandy bottom; about 10 feet deep, and 40 to 50 feet wide, and without shallow spots. The specimens were chiefly obtained in a very small lagoon, with muddy shores, a short distance from the main stream.

(*b*) *A small stream in the southern suburbs of Savannah.*—This is a small, sluggish stream, about a mile long. At the place seined it was 6 to 10 feet wide and 2 to 4 feet deep, with a very muddy bottom.

(*c*) *The Ogeechee River at Millen, Ga.*—At this point the river is deep and sluggish, and overhung with dense vegetation. Greatest width, 40 to 50 feet; depth, 4 to 10 feet. On account of the depth and the character of the shores, seining was done in a small running lagoon, a few miles southwest of Millen. Here the water was very muddy, the bottom being of mud in the shallower parts near shore, and of compact sand in the deeper portions. Fishes were most abundant in the shallower water near shore, none except minnows being found in the deeper running part.

(*d*) *Buckhead Creek, a tributary of the Ogeechee River at Millen.*—The stream was seined at the railroad bridge, 1 mile southwest of Millen. At this point the creek is 40 to 50 feet wide, and 8 feet deep in midstream, with a bottom of hard sand. Most of the collecting was done in a small arm just above the bridge, with a bottom of mixed sand and mud.

(*e*) *The Satilla River at Waycross.*—This is a moderately swift swamp-water stream, with a bottom of white sand. The depth was 8 to 10 feet in the channel; the width 50 to 70 feet. Temperature 76° on July 2. The sand-bars were the only places that could be examined, and they yielded almost nothing. The fishes were principally obtained in a small lagoon 3 to 5 feet deep.

1. **Noturus leptacanthus** Jordan.

One specimen obtained in the Ogeechee River.

2. **Ameiurus platycephalus** (Girard).

A few obtained at Millen. A. 21 to 23.

3. **Ameiurus albidus** (LeSueur).

Several specimens obtained at Savannah. I know of no characters distinguishing Southern specimens (*niveiventris*) from Northern (*albidus*, *lophius*) or from Southwestern (*lupus*), and unite them therefore under the oldest name.

4. **Erimyzon sucetta** (Lacépède.)

Three specimens from the Ogeechee River, at Millen, have the scales in 36 to 38 transverse series.

5. **Notropis roseus** (Jordan.)

This species, hitherto known only from a few specimens taken in the Tangipahoa (Notalbany) River in Louisiana, seems to be the most abundant minnow in the lowland streams of Georgia. It was obtained in every stream examined, Brier Creek, the Ogeechee River, and Satilla River, and was everywhere common. It much resembles *N. chalybæus*, with which it is found associated, but may be distinguished at once by the broader head, blunter snout, and less oblique but somewhat larger mouth, the black lateral band less intense, and not including the lower jaw; the anal is quite constantly I, 7, instead of I, 8 as in *chalybæus*. The head is shorter than indicated in the original description, averaging 4⅓ in length, and the depth is somewhat greater.

6. **Notropis chalybæus** (Cope).

Abundant in the Ogeechee River at Millen.

7. **Opsopœodus emiliæ** Hay.

Two specimens taken in a lagoon of the Ogeechee River at Millen. Agreeing with the original description in having the lat. l. complete. All northern specimens examined have it incomplete, and may belong to a distinct geographical variety (*megalops* Forbes).

8. **Opsopœodus bollmani** sp. nov.

Differing from *O. emiliæ* in the nearly horizontal mouth with lateral cleft, and in the conspicuous round black spot at base of caudal.

Head small, snout compressed, slender, somewhat rounded at tip, resembling *Hybopsis labrosus*. Mouth small, subterminal, usually slightly overhung by the snout, the cleft slightly oblique; maxillary reaching vertical from posterior nostril, shorter than snout, 4½ in head. Eye equaling snout, 3⅗ in head, less than interorbital width.

Pharyngeal teeth 5–5 or 4–5, with well-developed grinding surface, one edge of which is conspicuously serrated, though less strongly so than in *emiliæ*. The pharyngeal bones are, as in the latter, very small and weak, scarcely half the size usual in *Notropis;* the base of the bone is abruptly dilated at outer third, as in *emiliæ.*

Origin of dorsal behind insertion of ventrals, slightly nearer base of caudal than tip of snout; anterior dorsal and anal rays longest, the outer margins of these fins concave. Caudal strongly forked, the lobes acute. Pectorals not reaching ventrals, the latter to, or nearly to, vent.

Lateral line incomplete, present on 7 or 8 of the anterior scales only.

Head $4\frac{1}{3}$ to $4\frac{1}{2}$ in length; depth $4\frac{2}{3}$ to 5. D. I, 8; A. I, 8. Scales $37\frac{5}{4}$; the breast scaled.

Color in spirits: Dusky olive, lighter below, the scales conspicuously margined with dusky, giving a checkered appearance to sides. A dusky lateral band passing through eye, and downwards to mouth, including tip of lower jaw; above this a conspicuous V-shaped light area on snout. A round, black blotch on base of caudal, nearly as large as eye. A dark dorsal streak, and one backwards from anal. Fins dusky; in males, a black blotch on first two dorsal rays, the marginal third of fin dusky; anal and ventrals broadly margined with blackish.

Five specimens, the longest 2 inches long, were obtained in a lagoon of Buckhead Creek, at Millen, Ga.

9. **Notemigonus chrysoleucus bosci** (Cuv. & Val.).

Brier Creek and the Ogeechee River; abundant. A. 14 to 17.

10. **Chologaster cornutus** Agassiz.

Chologaster avitus Jordan and Jenkins, Proc. U. S. Nat. Mus., 1888, p. 356.

A single specimen less than one inch long, from Millen, Ga. Agreeing wholly with Dr. Jordan's specimens from Dismal Swamp, except that the caudal fin is more largely dusky, the sub-basal white band being represented only by a translucent area on upper and lower rays near base. There can be little doubt that this is identical with the *cornutus* of Agassiz, differing from the original description only in being more slender.

11. **Fundulus heteroclitus** (Linn.)

Not abundant; taken in a small stream in the suburbs of Savannah, Ga.

12. **Zygonectes nottii** Agassiz. "*Star-headed minnow.*"

Fundulus zonatus Cuv. & Val., XVIII, 196. *Haplochilus zonatus*, Günther, VI, 316; not *Esox zonatus* Mitchill.

Zygonectes lineolatus, Agassiz, Amer. Journ. Sci. Arts, 1854, 353.

Zygonectes craticula, Goode & Bean, Proc. U. S. Nat Mus., V, 433.

Zygonectes zonifer, Jordan & Meek, Proc. U. S. Nat. Mus., VII, 482.

Abundant in lagoons connected with the Ogeechee River, and its tributary Buckhead Creek, at Millen. A few also taken at Savannah.

I agree with Prof. O. P. Hay in identifying *craticula* with *nottii*. The "fainter interrupted lines" are in females visible only towards the back, in males more conspicuous, and present also on middle of sides.

Zygonectes zonifer was based on males of this species. The vertical bars vary in width and also in number, ranging from eight to fourteen.

Zygonectes guttatus Agassiz (l. c.) seems to be identical with *Zygonectes escambiæ* Bollman (Proc. U. S. Nat. Mus. 1886, 463), and must supersede the latter.

13. **Gambusia patruelis** Baird & Girard.

Brier Creek at Waynesborough; Savannah; lagoons of the Ogeechee River at Millen; Satilla River at Waycross; everywhere abundant.

14. **Mollienesia latipinna** Le Sueur.

Abundant at Savannah.

15. **Lucius americanus** (Gmelin.)

Brier Creek, Ogeechee River.

16. **Lucius reticulatus** (Le Sueur.)

Brier Creek, Ogeechee River, Satilla River.

17. **Anguilla anguilla chrysipa** (Rafinesque.)

Abundant at Savannah.

18. **Labidesthes sicculus** Cope.

Ogeechee and Satilla Rivers; abundant.

19. **Aphredoderus sayanus** (Gilliams.)

Several specimens taken in the Ogeechee River at Millen, and the Satilla at Waycross. In the smallest (½ inch long) the vent is midway between base of ventrals and front of anal

20. **Elassoma evergladei** Jordan.

A single specimen from the Satilla River at Waycross, answering well the original description, but with the anal III, 7, instead of III, 5. D. IV, 9. Lat. l. 27. Fins all high, the ventrals reaching slightly beyond origin of anal, the longest dorsal ray 1⅓ in head. In spirits, faint traces of 6 or 7 dusky cross-bars; a white area on base of caudal. In life, "a blue band under eye and a number on sides. D. spines with blue."

21. **Centrarchus macropterus** (Lacépède.)

Found very abundant in a lagoon at Millen.

22. **Enneacanthus gloriosus** (Holbrook.) (=*E. simulans* Cope.)

A single specimen from Millen, Ga.

23. **Enneacanthus obesus** (Baird.)

One specimen from Millen.

24. **Lepomis punctatus** (Cuv. & Val.)

Many specimens from Millen and Waycross.

25. **Lepomis auritus** (Linnæus.)

Millen.

26. **Lepomis megalotis** (Rafinesque.)

Abundant at Waynesborough and Millen.

27. **Lepomis pallidus** (Mitchill.)

Waynesborough, Millen, and Waycross.

28. **Etheostoma nigrum olmstedi** (Storer.)

Many small specimens were taken in Buckhead Creek at Millen, Ga. D. IX or X, 13 to 15; A. I, 7 to 9. Lat. l. 47 to 52. Cheeks naked or partly scaled, breast naked; nape with few scales or none.

29. Etheostoma nigrofasciatum (Agassiz.)

One specimen from Millen.

30 Etheostoma fusiforme (Girard.)

Many specimens from Millen and Waycross. These differ from the western and southwestern form (*gracile*), in the scaly breast, the absence of the conspicuous black bar near base of spinous dorsal, and the dull coloration of the sides.

D. IX or X—10 or 11; A. II, 7 or 8. Lat. l. 47 to 55, pores present on 20 to 30 scales.

31. Etheostoma squamiceps Jordan.

A single specimen from the Ogeechee River at Millen. This species varies excessively in squamation of head, and in size of fins. The specimen before me has cheeks and opercles scaly, the nape, breast, and top of head naked. D. X—11; A. II, 9. Lat. l. 45, the pores wanting on 6 scales. Branchiostegal membranes rather broadly joined across the throat, the width on median line equaling three-fourths diameter of eye. Color as usual; caudal with three conspicuous black spots at base.

UNIVERSITY OF INDIANA, *October* 24, 1889.

8.—THE STURGEONS AND STURGEON INDUSTRIES OF THE EASTERN COAST OF THE UNITED STATES, WITH AN ACCOUNT OF EXPERIMENTS BEARING UPON STURGEON CULTURE.

BY JOHN A. RYDER.

(Plates XXXVII to LIX.)

1. INTRODUCTION.

The following studies upon the sturgeons and sturgeon fisheries of the Eastern rivers of the United States were undertaken in the spring of 1888 at the suggestion of the U. S. Commissioner of Fish and Fisheries, Prof. Marshall McDonald.

Pursuant of these purposes, I repaired to Delaware City, Delaware, a very important center of the sturgeon fishery, in order to collect data respecting the fishing; also to study the variations presented by the individuals of the common sturgeon; to determine the number of species taken in the Delaware River; their food, relative abundance, and value; and to find out, if possible, if artificial propagation might be successfully carried on. The latter part of the month of May and nearly the whole of June, 1888, were devoted to these objects.

The results which were obtained were to some extent unsatisfactory, owing to the difficulty of obtaining an abundance of living ova, and the difficulties attending their fertilization by artificial means, as well as rearing the embryos. Notwithstanding these untoward conditions, a number of novel facts were collected and experiments were carried out which must be of great significance in any further attempts at the artificial propagation of these immense fishes. Amongst the most important of my results, the observation which I regard as of the greatest practical value, is the determination, by experiment, that it is possible to quickly obtain both living ova and spermatozoa from recently-captured fishes by Cæsarean section. The only ova which I succeeded in fertilizing were obtained from females of the common sturgeon by cutting open the abdomen of the still living fish. Forcing out the ova by pressure, as practiced with the shad and salmon, is not feasible in the case of the sturgeon, and the removal of the ripe ova from the abdominal cavity of the parent fish may be far more expeditiously effected by slitting open the body cavity, in the manner usually practiced in dressing the carcass for market.

The milt is most readily obtained in a similar way from the recently captured and living ripe males, only that in this case pieces of the enormous testes are cut out and the milt pressed from the fragments. The success which followed the usual methods of fertilization proves conclusively that vast numbers of embryos could be hatched annually from eggs thus obtained and treated. The number of millions which could be reared in this way would depend entirely upon the number of trained spawntakers promptly on duty when spawning fish are taken by the fishermen, and the extent of the facilities for hatching them and protecting them against the attacks of *Achlya* and *Saprolegnia*, forms of fungi which were found to be most seriously destructive to the life of the ova of the sturgeon in moderately quiet waters.

Other practical information which was obtained related entirely to the manner in which the eggs must be treated in the work of artificial propagation. The extent and value of the caviare industry was also investigated, as well as the determination of the number of species which frequent the Delaware and other Eastern rivers in which sturgeons are taken. The important fact was also determined that the common sturgeon (*Acipenser sturio*) is the only species which is at the present time of any commercial value in the fishery of the Delaware. It was my good fortune also to secure no less than five specimens of the *A. brevirostris* of Le Sueur, which has, so far as I can learn, not been certainly recognized since that naturalist's time; recent writers have in fact almost uniformly confounded it with the common and far more abundant species. This species was originally discovered in the Delaware, and there have been, so far as I can discover, no trustworthy identifications of the species from any other waters. That it has a wider distribution is probable; it may be that its principal center of distribution is other than the river in which it was first taken. The comparative rarity with which it is taken speaks much in favor of this view.

The embryological data of this monograph have been drawn partly from original sources, namely, from the embryos which I succeeded in rearing from artificially fertilized eggs, and partly from the work of other authors. The embryos of the common sturgeon here illustrated are, as far as I have been able to learn, the first of that species that have ever been figured. While it may occur to some persons that the attempt to complete the survey of the external features of the ontogeny of the sturgeons from the work of others is a useless duplication of labor, I wish to here state that it seems to me that, so far from that being the case, it has only thus been made possible to get something like an adequate notion of the remarkable changes through which these fishes pass, from the time the egg is fertilized until adolescence is reached. To this end I have had no hesitation in laying under contribution the labors of Knoch, Salensky, Parker, and Balfour, on the larval stages of the sterlet, in addition to what I have been able to glean in regard to the development of the common species.

Upon reaching the fishing grounds I was first made aware of the great unlikeness in the outward appearance of the young, from 5 inches to 3 feet in length, as compared with adults of the common species. This fact led me to examine somewhat closely into the visceral anatomy of the young, with the result of finding that the internal differences are as great as the external ones, as the accompanying plates displaying the viscera will testify. Between the youngest obtainable material and the embryos studied by Balfour, Knoch, Parker, and myself, there still remained a gap so great that, in the time allotted me for the completion of my work, it was impossible to obtain the required missing stages. Fortunately those gaps are almost completely bridged by the oldest larvæ figured by Parker, and the post-larval stages of the sterlet figured only two years ago by Zograff. Zograff's figures, in conjunction with an old figure of a very young specimen of the gigantic *Huso* of eastern Europe, published in 1833, by Brandt and Ratzeburg, enable us to trace very satisfactorily the history of the dermal armature of the genus. Comparisons of these disclose the fact that the dorsal row of scutes on the body appears first, then the lateral, and last of all the ventral rows. Other changes in outward appearance also occur, which can only be fully appreciated by reference to the figures which have been reproduced in the plates accompanying the text of this paper. These facts it seems to me are a sufficient warrant for my having drawn so largely from other sources. Moreover, since this report is intended, not simply for the information of naturalists, but more especially for those interested in the practical question of the propagation of the sturgeon as a source of food, I have felt it incumbent upon me to give as full and popular an account of its natural history as it was in my power to produce. Some of the most important literature on the subject being in German, French, and Russian, it is necessarily inaccessible to the general reader in this country. It has therefore been with much pleasure that I have here brought together the figures from such out-of-the-way or generally unreadable foreign authorities as will give such a reader a fair notion of the singular changes which these huge fishes undergo in the course of their lives.

The illustrations of the adults are from photographs, reproduced by one of the many recent and highly successful photogravure processes. These give an adequate notion of the forms of the heads of the adults and an idea of the texture of the surface of the skin of the fresh fish such as is impossible except at the hands of an exceedingly skillful but expensive artist. I have been impelled also to offer these new illustrations of the common sturgeon in view of the fact that there are not now in existence half a dozen illustrations of the external appearances of this species that are trustworthy as to details. Nearly all the figures in existence are either poorly executed or taken from distorted or "stuffed" specimens.

The illustrations of the young, 20 inches in length, are also photogravures, and serve to contrast the wide differences, in the form of the head especially, with that of the adults. The contrasts between these and the *Acipenser brevirostris* figured along with them are equally striking, and the latter may be also profitably compared with the illustrations of the heads of the adults. The photogravures of *A. brevirostris* also show the great difference in the dermal armature of that species in comparison with that of the young of the common species. In the former the strong spines of the bucklers have disappeared, while in the latter of the same age they are still retained.

2. SYSTEMATIC REVIEW OF THE STURGEONS OF THE EASTERN COAST.

The following systematic review of the sturgeons of the Eastern coast is here offered. The definitions of the order, family, genus, and the two Eastern species are modified and corrected so as to correspond with the present state of our knowledge of the group. This has been found necessary, since a few minor errors as to matters of fact have crept into the definitions given in Jordan and Gilbert's "Synopsis of the Fishes of North America," upon which the ones here given are based.

Order GLANIOSTOMI.

A præcoracoid arch; symplectic represented by cartilage, but without membranous ossification; maxillary present; no suboperculum or præoperculum; interoperculum present; mesopterygium distinct; interclavicles present; basihyals and ceratohyals without membranous ossifications; branchihyals partially invested by ossifications in membrane.

Family ACIPENSERIDÆ.

The Sturgeons.

Body elongate, subcylindric; skin armed with five rows of bony bucklers, each with a median longitudinal carina, terminating in a retrorse spine in the young and in some small species. A median dorsal series, and a lateral and abdominal series on each side, some of the abdominal series in later life (the preanals of *A. sturio*, and abdominals of *A. rubicundus*) becoming covered and more deeply embedded in the integument, so as to become invisible from the surface. The lateral rows of scutes give passage to the canal of the lateral line. Between the rows of large scutes the skin is rough with small, irregular, embedded dermal ossifications. Snout produced, depressed, conical or subspatulate, with sensory areolæ on inferior surface. Mouth small, inferior, protractile, with thickened lips, produced into characteristic marginal lobes. No teeth, except in the larval stages. Four barbels in a transverse series on the lower side of the snout in front of the mouth. Eyes small; nostrils large, with two openings, and with olfactory membrane with a smooth central disk, surrounded by a rosette of folds. Gills 4; branchial arches 5; an accessory opercular gill. Gill membrane united to isthmus. No branchiostegals. Maxillary distinct from premaxillary. Head covered by bony scutes or dermal ossifications united by sutures. Fin-rays slender, all articulated, except first spine-like ray of pectoral. Caudal with fulcra, pectorals placed low. Ventrals many-rayed, behind middle of body. Dorsal placed posteriorly; anal somewhat behind it, similar. Tail heterocereal; the lower lobe developed. Air-bladder large, simple, connected with the œsophagus by a spacious laterally compressed, short pneumatic duct. Pseudo-branchial or spiracular gills very small or obsolete. Stomach without blind sac. Rectum with spiral valve. Mushroom-shaped pancreas, divided internally into cæcal appendages, the external interspaces between which are filled up with connective tissue, so as form an apparently solid organ, the cavities in which open into the upper-end of the duodenum through three passages.

"Large fishes of the seas and fresh waters of Northern regions. Most of the species are migratory, like the salmon which are found in the same waters. Genera two, species about twenty, although more than five times that number have been described. The American species especially have been unduly multiplied, particularly by Auguste Duméril, who has found upwards of forty of them in the museum at Paris. The actual number of American sturgeons does not exceed seven, and is more likely still less. The changes with age are considerable; the snout in particular becomes much shorter and less acute, and the roughness of the scales is greatly diminished. * * * The number of plates, although one of the best specific characters, is subject to considerable variations."

ACIPENSER Linnæus.

Sturgeons.

Snout subconical above, more or less depressed below the level of the forehead; more or less nearly flat below. Spiracular opening nearly twice as far behind the tip of the snout as the eye. Caudal peduncle of moderate length, deeper than broad, the lateral rows of bony scutes distinct to the base of the caudal fin. Tail not produced into an abortive filament or opisthure, as in ***Scaphirhynchops*** (shovel-nose sturgeons), but with its tip bearing caudal rays. Gill-rakers small. Pseudo branchiæ or spiracular gills present. Only two sharply defined species found in the waters along the Atlantic coast of the United States. Possibly three other good species inhabit the United States; one of these is the very distinct lake or fresh-water sturgeon of the lake region, and two others are said to be found on the Pacific coast.

1. **A. sturio** L. Common Sturgeon.

Snout one-third of the length of the head; rounded above, nearly flat below, bluntly rounded in outline at tip, as seen from above, in the adult. Snout of young much more acute and produced than in the adult, and about half the length of the head. Barbels arising nearly midway between mouth and tip of snout, not reaching mouth; in the young longer and more slender. A median, lanceolate smooth fenestra or area between the parietal and frontal plates in the young, which entirely disappears with age. Gill-rakers small, slender, pointed, sparse, not longer than the pupil. Small dermal plates between dorsal and lateral rows tending to form successive oblique rows, in which many of these small plates tend to become lozenge-shaped. Average number of plates in dorsal row, 11; in lateral rows, 28; in ventral rows, 10; 4 or 5 preanal scutes. Opisthocentrous in young, mesocentrous in adult. Mouth narrow. Dorsal, 40–44; anal, 26–30; ventral, 26; pectoral, 35; caudal, 90; lower caudal lobe short; peritoneum never deeply pigmented, so that the viscera when exposed are nearly white. Color of skin olive-greenish above. Variety ***oxyrhynchus*** is based partly upon the young of this species and partly upon old individuals which retained their unusually lengthy snouts. My own opinion is that the snout of this species undergoes actual shortening and loss of substance during growth. The actual variability of this species can not be appreciated unless one has had the opportunity to compare hundreds of recent individuals. Atlantic Ocean; ascending rivers of Eastern sea-board.

2. A. brevirostris Le Sueur. Short-nosed or Blunt-nosed Sturgeon.

Snout of half-grown individuals about one-third the length of the head, but proportionally wider at base than in the preceding species. Barbels usually arising a little nearer to tip of snout than to the mouth; not reaching mouth. Little or no difference between the form of the snout of the young and adult. No smooth area or fenestra on the top of the head of the young, between the parietal and frontal plates in the median line. Top of head less deeply concave between the eyes than the preceding species. Small dermal plates between the dorsal and lateral rows of scutes never tending to form oblique rows. Smaller dermal ossifications never tending to become lozenge-shaped, except on the sides of the upper lobe of the caudal fin. Dorsal, lateral, and ventral scutes not so closely crowded together as in the preceding species. Average number in dorsal row, 10–11; in lateral row, 25; in ventral, 7–8; no preanal plates. Mesocentrous very early in life and in both sexes. The smaller dermal ossifications can scarcely be perceived by the touch in stroking the skin between the dorsal, lateral, and ventral rows of scutes in a fresh specimen. The species is in fact almost absolutely smooth over the unarmored parts of the skin when compared with the preceding. Mouth very wide; one-sixth wider in proportion than in the common species. Dorsal, 33; anal, 19–22; ventral, 17–21; pectoral, 30–31; caudal, 60; lower lobe of caudal long. Peritoneum dark brown, sometimes very dark, so that the viscera are nearly black when exposed upon opening the body cavity. Color of the skin above reddish brown; nearly white below.

This species occurs in the Delaware River, whence the author of its name obtained it, somewhere about 1817. Since no absolutely distinctive characters have been yet offered by which the species might be recognized, it has afforded me great pleasure to supply this lacking information in the entirely new diagnoses given above of this as well as the common species. How much more extensive than the Delaware River its range may be I have no means of knowing, as I have found only one specimen, besides the five obtained by myself at Delaware City, which can be regarded as an authentic example of the species. This single specimen is in the museum of the Academy of Natural Sciences of Philadelphia, and consists of a dried and stuffed varnished skin marked in white paint "84." It agrees in every essential external particular with my own alcoholic specimens, but no record of its history is accessible amongst the catalogues of the collections of that institution; all traces of the old manuscript catalogues of the Bonaparte and the other old collections of fishes belonging to the Academy's museum having been lost. I have, however, the strongest suspicion that this specimen, which is evidently very old, judging from its present condition, may be one of the originals of Le Sueur's description published in the Transactions of the American Philosophical Society for 1818, though it does not correspond in minor details. That it may possibly be one of the types of the species seems to me not at all improbable, from the fact that Le Sueur was also one of the early members of the Academy and may have presented the specimen. There can be no doubt of its identity with the fresh specimens which I have made out to be the true *A. brevirostris*, and I have, therefore, incorporated it in the list of material which I have used to frame the specific diagnoses of both forms. The figures of *A. brevirostris* on Plate I of Brandt and Ratzeburg's work, is from a specimen belonging to the Bloch collection and agrees closely with the dried skin in the museum of the Academy of Natural Sciences of Philadelphia, the lateral line being indicated in the figure as in the specimen mentioned, as a well-marked canal extending across the wide interspaces between the lateral plates. The figure reputed to be of this species which was published in the plates pertaining to the natural-history volumes of the quarto report on the Fisheries Industries of the United States is really that of the adult of the common species. The figure intended to represent the common species, *var. oxyrhynchus*, in the same work, is merely the young of the latter, and the figure of *A. rubicundus* is also from an immature young specimen, and far inferior to the beautiful etching of the adult, done by Le Sueur himself, and published with the same paper in which he described *A. brevirostris.* I append the original description of that form in order that the evidence as to the distinctness of this singularly well-defined species may be made more accessible.

"2. **A. brevirostrum.**

Head large, convex; snout short, pointed, with a black spot near its extremity; the four beards are flat, disposed in pairs, and placed nearer the nostrils than the end of the snout; nostrils near the eyes, though lower, the posterior one larger than the anterior one, which is small and almost round; pupil of the eye round, irides golden; the length of the head, from the tip of the snout to the end of the operculum is a fifth part of that of the body; body elongated, with five ranges of tubercles; back with nine tubercles and one at the base of the dorsal fin—these plates are pretty regular, oblong, radiated, and surmounted with a sharp keel; sides with twenty-six tubercles, irregular, largest on the anterior part of the body, and oblong on the posterior part, the latter presenting a small carina. Sometimes one remarks between these tubercles the rudiments of others; the plates of the abdomen are oblong and small, on the left side five, on the right side three, placed opposite to the center of the former; before each abdominal fin there is a small tubercle; the skin above is of a blackish color, tinged with olive, with oblique black bands, and other corresponding ones, of a paler hue, on the sides; the deep color of the upper parts does not transgress the lateral line formed by the tubercles; sides reddish, mixed with violet; abdomen white; the fins are of a medium size.

"The head, which is remarkable in this species, varies a little in the varieties which follow; in this it is short in proportion to its breadth, between the eyes it is depressed, and in width 2¼ inches, between the auricular orifices [spiracles] 3 inches, from the end of the snout to the eye 2¼ inches, length of the whole head 6½ inches; the auricular orifices are situate 1½ inches behind the eyes, and near the rim of the bony shield of the head; the plates in general of this species are rugose and regularly radiated; the skin which appears smooth, is nevertheless furnished with small spinous asperities which render it disagreeable to the touch, and there is a kind of regularity observable in the dispositions of these spines, which are scattered equally over the whole skin; the regularity is not perceptible in the *A. rubicundus* and its varieties, the spines of which are more numerous and more serrated.

"The individual described was a female; its length 2 feet 9 inches from the tip of the snout to the fork of the tail, which was furnished with lozenge-formed plates.

"This species is rare. I have been enabled to behold but two specimens. It inhabits the Delaware.

"First variety. Length 1 foot 7 inches; body with five rows of tubercles, all very entire, well defined, and radiated, surmounted with a carina, projecting behind into a spine; the two first abdominal plates are imbricated, the remainder at equal distances, and seven on each side; side plates twenty-six, dorsal plates nine, and one at the base of the fin; between the dorsal fin and the tail, and likewise between the anus and anal fin, and the last and caudal fin, there are sometimes one simple plate, and sometimes several plates, in this species; the head only presents the difference of its snout being a little more elevated, and it is not convex between the nostrils; the small asperities of the body are nearer together and more numerous than in the preceding. Inhabits the Delaware.

"Second variety. Dorsal plates ten, including that at the base of the fin, lateral plates twenty-three, abdominal seven; all pretty regular and radiated, without carina and spines—these plates appear to have replaced those of the first growth, they not having been worn or rubbed; head large, short, and resembling that of the first described of this species; snout larger and rounder than in the first variety; length of specimen 2 feet 4 inches. Taken in the Delaware.

"Third variety. This individual resembled the last in its form and size, but had its snout more pointed, flatter above, and more elongated, narrower, and more concave; body with five rows of tubercles, those of the back nine, including the one at the base of the fin, regularly radiated, raised into a sharp keel, and terminated in a central point; lateral plates twenty-three, slightly carinated; the plates of the abdomen are seven with a hardly perceptible keel—the form and disposition of the tubercles are pretty regular; between the lateral plates there are several smaller ones. It is very remarkable that the left side only of this specimen had a range of eleven tubercles and several rudiments of others, situate between the lateral and abdominal rows. Inhabits the Delaware.

"This species, which is not the object of a special fishery, is nevertheless more sought after, and commands a higher price, than the large common species, which attains to the length of about 10 feet. The *A. brevirostrum* and its varieties are brought to the Philadelphia market in the vernal season and fetch from 25 to 75 cents apiece. They are eaten by the common people only."

(These last remarks, as to the estimation in which the *A. brevirostris* was held in Le Sueur's time, do not hold at present. It does not seem to be eaten at all by the present generation of Delaware fishermen.)

The foregoing descriptions, based on the five specimens which fell into Le Sueur's hands, agree in all essential respects with my own observations. He gives the color perhaps too dark, as is also shown by the skin in the museum of the academy, but that specimen shows the dark bluish oblique cloudings or bands which he refers to as occurring on the sides, and which are faintly perceptible even below the level of the lateral rows of plates. Some of my specimens are much darker than others, deep brown on the back, verging to a warmer, richer brown on the sides, but reaching only, as he observes, to the lateral rows of plates.

Le Sueur also distinctly confirms my conclusion that the species is always small; his largest example was a female measuring but 33 inches; the largest one that I obtained was only 23 inches long. He also states that it is rare, just as I learned was the case upon making an attempt to get a series of examples, all of which were taken in herring and shad gill-nets. The characteristic dark-brown or brown color of the animal; its small size, wide mouth, comparatively smooth skin, early maturity, render it impossible to question the identification which is thus established. The color alone is diagnostic; none of the young of the common species are dark-colored, while the characteristic dirty olive green or brownish, with a shade of green in it, is always markedly characteristic of the common species at all stages of its growth. Le Sueur's incidental remark as to the length of the common species in his day shows, if his report signifies an average, that it has since then diminished in size.

A. brevirostris is never taken in the large gill-nets used in capturing the common form, for the reason probably that it never reaches a large enough size. This conclusion is confirmed by the fact that sexual maturity is reached much earlier than in the common form as is proved by the condition of the reproductive organs of the suite of examples in my possession. Out of the series of five specimens the sex may easily be made out by inspection of the young roes and milts of four of them. The smallest specimen even, although only a little over 18 inches in length, has the internal reproductive organs far more developed than specimens of the common species of the same size. In fact, I have not been able to make out the sex with certainty by simple inspection with the naked eye, in specimens of the common species, as large as my largest examples of *A. brevirostris*, measuring 23 inches in length. These data, taken in connection with the presence of the long lanceolate median fontanelle or fenestra on the top of the head of the sharp-nosed young of the common species, show that the latter matures much later and only after becoming much larger than the *A. brevirostris*. The latter probably corresponds to the sterlet of Europe as respects size and precocious maturity, but differs entirely from it in its dermal armature, which is essentially mesocentrous, while in the sterlet the dermal armature is opisthocentrous.

3. THE DERMAL ARMATURE OF THE BODY.

The armature of the body and tail is subject to a good deal of variation in both of the species of sturgeons found in the Delaware. This is well shown by the following table, giving the number of dermal scutes found in the dorsal, lateral, and ventral rows in the young and adults of *Acipenser sturio*, and in the young and probably two-thirds mature stage of *A. brevirostris* Le S.

(The vulgar fractions in this table are used to indicate the number of scutes in the lateral and ventral rows of opposite sides of the body.)

Specimens.	Dorsal scutes.	Lateral scutes.	Ventral scutes.	Preanal plates.	Remarks.
No. 1. *A. sturio*	10	29	10	Present	Young.
No. 2. *A. sturio*	11	26	11	do	Do.
No. 3. *A. sturio*	12	30	11	do	Do.
No. 4. *A. sturio*	13	30	11	do	Do.
No. 5. *A. sturio*	11	28	10	do	Do.
No. 6. *A. sturio*	11	29	10	do	Do.
No. 7. *A. sturio*	10	28	10	do	Do.
No. 8. *A. sturio*	11	29	$\frac{9}{11}$	do	Do.
No. 9. *A. sturio*	11	29	9	do	Adult.
Average	$11\frac{1}{9}$	$28\frac{2}{3}$	$10\frac{2}{9}$		

Specimens.	Dorsal scutes.	Lateral scutes.	Ventral scutes.	Pectoral.	Ventral.	Anal.	Caudal.	Total length.	Remarks.
								M.	
No. 10. *A. sturio*	10	$\frac{29}{30}$	$\frac{9}{10}$	....	....	....	90	2.085	Adult specimen in Cope's Coll
No. 11. *A. sturio*	11	$\frac{28}{30}$	$\frac{10}{10}$	35	26	26	90	.49	Delaware City.
No. 12. *A. brevirostris*	12	$\frac{24}{28}$	$\frac{7}{8}$	31	17	19	....	.54	Do.
No. 13. *A. brevirostris*	11	$\frac{28}{27}$	$\frac{8}{8}$	30	20	....	60	.46	Do.
No. 14. *A. brevirostris*	($9\frac{1}{1}$) 10	$\frac{29}{28}$	$\frac{7}{7}$	....	....	....	....	.58	Do.
No. 15. *A. brevirostris*	11	$\frac{23}{26}$	$\frac{7}{7}$	....	....	....	....	.56	Do.
No. 16. *A. brevirostris*	11	$\frac{29}{28}$	$\frac{8}{7}$	31	21	22	60	.812	Mus. Acad. Nat. Sci., Phila.

Frequently the last dorsal scute, just in front of the dorsal fin, is divided in the median line as indicated in the formula of the dorsal scutes of No. 14, or, there may be two small scutes partially intercalated between the tenth and eleventh dorsal on either side of the median line.

The contrasts between the dermal armature of the dorsal, lateral, and ventral rows of plates is sufficiently well marked to constitute a good specific mark of distinction; but these are not the only differences which the integuments of the two species present when compared together.

In the young of *A. sturio*, the most deeply pigmented portion of the integument lies above the lateral row of scutes, while the abdomen presents almost a silvery white tint. In the adult, on the other hand, the pigment is extended somewhat farther down the sides and becomes different in color; so that instead of being greenish-brown, as in the young, there is a more decided greenish or olive tint observable over the back and sides.

The skin of *A. brevirostris* in specimens up to nearly 2 feet in length is nearly smooth, in a fresh specimen, between the dorsal, lateral, and ventral rows of scutes, and of a richer and darker brown than in *A. sturio.*

In the young of a *A. sturio*, on the other hand, the skin in the same region is beset with minute, retrorse, dermal denticles, having an acuminate tip and a flat expanded base embedded in the integument. There can be little doubt that the sharp tips of these denticles represent, in part at least, the enamel caps of the dermal denticles of other fishes, while the expanded flat bases represent the cementum plates of such teeth.

As the animal becomes adult the well-marked roughness or shagreen-like feel of the skin in *A. sturio*, becomes less marked; the fine points or denticles projecting above the general level of the integument are no longer observable unless one exerts some pressure upon the skin, especially along the sides and ventral surface. The small, isolated denticles, with their circular basal plates, as seen in the young of *A. sturio*, are replaced in the adult by small lozenge-shaped integumentary ossifications standing in oblique rows between the dorsal and lateral rows of scutes. The edges of these lozenge-shaped pieces approximate each other much more closely than do the edges of the basal plates of the small integumentary denticles of the young. It is also clear that these latter stand in a genetic relation to the lozenge-shaped plates on the sides of the body of the adult sturgeon; that the basal plates of a number of the small dermal denticles of the young have fused together by their edges to form the larger rhombic scutes, just as in all probability the dorsal, lateral, and ventral rows of scutes were in part formed, but at a very much earlier stage.

The decreased roughness of the skin as observed in the adult of *A. sturio* is due in part to the erosion of the apices of the dermal denticles and the loss of the acuminate tips of the larger scutes, and in part also to the fact that the integument gradually thickens and the basal ossifications sink into it more deeply. This is well illustrated by the history of the preanal plates. These plates in the young are very obvious externally as a closely aggregated group, but in the adult they frequently become so deeply embedded in the integument that one must feel for their presence through the abdominal walls of this region.

The gradual loss of integumentary asperities is apparent in other regions in the transition from youth to age. This is especially noteworthy in regard to the pair of large, nearly rhombic bucklers between the bases of the pectorals just behind the isthmus. In the young of *A. sturio* these bucklers have strong carinæ along their inner, longitudinal borders; in the adult, on the contrary, these carinæ are quite obliterated externally.

The young sturgeon, as a consequence, is provided with a dermal armor which is in some respects much more efficient than that of the adult. One is reminded very strongly of the strong, sharp spines which are found on the heads and edges of the opercles of the young of many strictly marine fishes, where in some forms, such spines are so strongly developed as to render it difficult to realize that they are eventually suppressed so as to be practically without any spinous defensive apparatus in the adult stage.

That such a change occurs in the sturgeons generally is proved by the very prominent retrorse spines found surmounting the posterior moiety of each of the dorsal, lateral, and ventral plates of the young from 9 to 18 inches in length.

In still younger stages of *A. huso* under 2 inches in length, according to the figures of Brandt and Ratzeburg, Plate XLIV, Fig. 22, this central, thorn-like portion of each of the bucklers is still more prominent than in specimens a few inches longer. As the animal grows still larger, as in examples of from 6 to 10 feet in length, the retrorse, thorn-like character of the median prominence on each buckler vanishes, and all that remains to indicate its former presence is a very low conical, or ridge-like elevation in the middle of each plate. This change in the external armature of the bony plates is due partly to the manner in which they increase in size and partly to the erosion of the prominent external median portion.

The advantage of the markedly rougher armature of the young in the struggle for existence is obvious, as it is clearly adapted to render the young animals less convenient of deglutition or mastication by the more ravenous predaceous forms inhabiting the same waters.

The marked difference in external features between the young and the adult has invited the misguided attention of systematic writers, chief amongst whom must be mentioned Auguste Duméril, who has divided the genera found in various parts of the world upon the basis of the position of the armature of the bony integumentary plates. As a little acquaintance with the development of these fishes would enable any one to predict, the spinous prominences are found in a posterior position in the small species, while in the larger species this prominence is about the center of each plate. The groups, *Opisthocentres* and *Mesocentres*, of Duméril are therefore founded upon more or less unreliable and transient characters, as is proved by the fact that upward of forty American species have been discovered by this reckless author amongst the materials preserved in the Museum d'Histoire Naturelle at Paris. The actual number of American species of sturgeons is seven, according to Jordan and Gilbert (Synopsis Fishes, N. Am., p. 85), and probably even less according to these authors. The fictitious species, *A. oxyrhynchus*, has clearly been based for the most part upon the young of *A. sturio*, as is shown by some of the reputed figures of the former. Referring to the original description by Mitchill of *A. oxyrhynchus*, it is clear from a letter which he quotes from a Mr. De Witt, that then, as now, it was supposed by some of the fishermen that the sharp-nosed, small sturgeons were a distinct species. This belief is widely prevalent amongst the sturgeon fishermen of the Delaware River, where the young animal is popularly known as the "Mamoose," probably an Indian name, as I hear from my friend Mr. John Ford.

It argues very unfavorably for the sagacity of Mitchill that he should have omitted to note that in the young, sharp-nosed forms, the roe is never developed to maturity.

Only one large example of the long-snouted form amongst hundreds of specimens of *A. sturio* has fallen under my observation, and this specimen did not appear to me to be essentially different from the usual blunt-nosed adult form, except in a proportionally longer snout. Further observation also showed that no two individuals presented exactly the same form and proportions of the snout and head; it is therefore clear that the *Acipenseridæ* are variable to a high degree, and that the selection of a marked variation as the type of a distinct species, without the study of a great many specimens, is to say the least, a very unscientific proceeding. The extreme rarity of adult instances of this variation is further proof that it is scarcely fair to consider it a subspecies, especially since it is known that such individuals are taken in association with the usual form of *A. sturio*.

A careful study of the dermal plates of the young of *A. sturio* shows that they increase in breadth and length in the course of further growth, to some extent, at least, by the fusion of the basal plates of the dermal denticles to their edges. This is also very evidently shown by their greater height as compared with their breadth in still younger specimens, as shown by the illustrations of the very young of *A. huso* given by Brandt and Ratzeburg. This method of their growth is continued until the dermal plates measure 3 or 4 inches across, so that as a result the growth in length and breadth is much more rapid than their growth in height. This method of growth also serves to explain in what manner the distinction between the opisthocentrous and mesocentrous plates arises; as a consequence, it is easy to see that there can be no hard and fast line between the one and the other form, both being merely younger and older stages of the development of the dermal plates.

This conclusion may be still further fortified by the circumstance that it is only the species which are smallest that are markedly opisthocentrous, while the larger are mesocentrous, as shown by Duméril's own comparisons.

Of what value such characters are in classification may safely be left to those who have the proper morphological training to use them with discrimination. That these characters have not been used with discrimination is shown by the remark (Jordan and Gilbert, Synopsis Fishes, N. Am., p. 85), that "the same species at different ages may frequently belong to two or more of these subgenera," meaning those proposed by Duméril.

The figures of the young of *A. ruthenus*, the sterlet, given by Zograff, Figs. 19, 20, and 21, show that the dorsal scutes are developed before the lateral or ventral. This is also shown by the young of *A. huso*, figured by Brandt and Ratzeburg, but in not so marked a manner. The young of *A. ruthenus*, figured by Zograff, also shows that the scutes develop from before backwards. That is to say, there are as yet no fulcra shown on the dorsal margin of the tail, nor does the lateral series of scutes extend much beyond the vertical from the anterior end of the dorsal, as seen in Fig. 21.

The tail is, in fact, fringed above and below only by fin-fibers or actinotrichia, such as are usually the supports of the fins of young fishes. The narrow scutes or overlapping fulcra of the dorsal margin of the tail are developed later, and derive their origin in the main from tissue elements which lie deeper than those which give origin to the actinotrichia and ultimately to the fin-rays proper of the adult.

I am not inclined to agree entirely with Zograff as to the method in which the dorsal scutes are developed, as given in No. 29, cited in the list of papers at the end of this monograph. In other fishes the actinotrichia or fin-fibers become embedded in the calcifiable matrix deposited around them, as my studies upon the development of the fin-rays of the salmon prove. That the scutes of the dorsal median line in sturgeons do develop partly at the expense of the embryonic fin-fibers is doubtless a fact, but that they are the sole basis of origin of the calcifiable matrix of the scutes in these forms does not seem probable, judging by what is known of the rays of other types.

The so-called "fulcra" of the lower side of the caudal, at its anterior end, are not true fulcra, but ordinary fin-rays much modified. The same remark applies to the anterior elements of the dorsal. They are best developed in the adult in which they are much obscured by the increased thickness of the integument in the fully developed animal.

4. THE ORGANS OF LOCOMOTION.

The principal organs of locomotion are not the pectoral and ventral fins of the sturgeon, as might be inferred upon superficial inspection, but rather the powerful heterocercal tail, together with the dorsal and anal fins. The paired fins are subordinated in the main to the business of maintaining the equilibrium of the animal, that is, to keeping the dorsal aspect directed upward, and the ventral aspect turned in the opposite direction.

The quite young sturgeon, as shown by the appended Figs. 13, 14, 16, and 18, has a continuous dorsal and anal fin-fold the same as larval Teleosts. In other words, the sturgeon passes through a protocercal stage, as it was termed by Wyman, or a lophocercal condition, as the same stage has been called by the writer. Later, this continuous fin-fold finds support from within by the development of a continuous series of what have been inaptly called horn fibers, and which the writer has named *actinotrichia*. A large part of this continuous fold is absorbed and fails to develop, and only three portions persist and undergo further differentiation and growth as the dorsal, anal, and caudal fins.

The dermal rays which are most obvious and easily counted in the dorsal, number from forty to forty-four in the adult sturgeon, and are about the same in number in the young of 7 inches in length. These rays are derived, in part at least, from the actinotrichia mentioned above. They support only the outer thin portion of the fin, the rays of which are jointed at close intervals in the adult, but in the young the joints in the individual rays are fewer.

The dermal rays of the dorsal are supported at their lower ends upon about thirteen cartilaginous neural bars or processes which do not in turn rest in immediate contact by their lower ends upon the neural arches. The lower ends of the series of cartilaginous rods which support the dorsal fin extend over about five neural arches with their intercalary pieces.

The twenty-six to thirty dermal rays of the anal fin are supported on about ten cartilaginous hæmal processes, and these in turn are supported proximally by about four pairs of cartilaginous hæmal arches and intercalary pieces.

In the lower lobe of the caudal, that is, below the posterior part of the notochord, to its termination, in the caudal fin, there are about ninety dermal rays in the common species. These are supported on about twenty-five cartilaginous hæmal processes, which diminish in size toward the end of the tail so as to appear as if totally degenerate toward the last of the series. On the dorsal side of the caudal a series of fulcra are developed; these are merely a continuation of the more anterior series of median dorsal plates the development of which has been modified. The reason for this conclusion is the fact that, as Zograff has shown, in *A. ruthenus*, the dorsal series of scutes develop in the median fin-fold, which involves actinotrichia embedded in the membranous portions of the fold which intervene between the sharp tips of the scutes. The latter also in the earlier post-larval stages overlap much as do the scutes known as "fulcra" along the dorsal margin of the tail. These facts are of the greatest possible significance as giving us a more comprehensive view of the origin of the so-called fulcra of ganoid forms. This much is at least assured, viz, that the method of evolution of the fulcra in all ganoids will be found to be essentially the same. That the deduction reached above is true is further fortified by the fact that in young sturgeons 7 inches long there are present true primitive fin-fibers or actinotrichia behind the last formed fulcra and inclosed within the persistent continuation of the median dorsal fin-fold over the tip of the tail. Actinotrichia or primitive fin-rays are certainly involved in this process, to which other calcifiable matter is doubtless added in the later development of scutes and fulcra. The phylogeny of the fulcra as displayed by the sturgeon, by *Chondrosteus* and *Crossopholis*, the extinct sturgeons, is significant of how such consecutive modifications arose in other forms.

The further conclusion which is of some importance from a morphological standpoint, is the fact that the main parts of the fulcra are not wholly comparable with true fin-rays, but are derived from the cells of a deeper portion of the corium, which, as in the case of the large lateral, ventral, and dorsal scutes, involves the very deepest layers of the integument. Few or no true primitive fin-rays therefore persist along the dorsal margin of the tail, except at its extreme posterior extremity. The inferior side of the caudal fin may therefore be said to be the only portion which supports true "soft" rays. The expressions "upper" and "lower lobe" are therefore simply names for parts of the caudal which stand in dorsal and hæmal relation to each other, and have no real morphological significance, for even the rays of the upper and lower lobes of the caudal of symmetrically homocercal forms are really ventral to the primitive caudal axis or notochord. In the adult sturgeon this arrangement clearly persists in a comparatively embryonic form, with all of the true fin-rays in a ventral position.

The efficient portion of the caudal as a propelling flange is therefore in the main the wide inferior part supported by the jointed rays. The axial support and musculature of the tail are much nearer its dorsal than its ventral border. It results from this that the inferior flange or membrane of the tail, with its supporting rays, as it is swayed from side to side, is made to act in much the same way as an oar in sculling. The development of the wide inferior lobe of the tail has also effected an upward flexure or adjustment of its axis and musculature which could not, for mechanical reasons, have happened if the dorsal fin-fold had been as wide as the ventral one. This view seems to be proved by the chorda or axis keeping its perfectly straight primitive position along the center of the spatulate or diphycercal tail of *Protopterus* and *Ceratodus*, where the dorsal fold, with its rays, is as wide as the ventral one. This view is further strengthened by the fact that the tail of the embryonic sturgeon is spatulate or diphycercal, with the end of the notochord dividing it into two equally wide dorsal and ventral moieties, as shown in Plate V. That is, the tail of the sturgeon, in the beginning, is of the same type as that of *Ceratodus*. The cause of the upward flexure of the axis of the tail of *Acipenser* is, therefore, to be sought in whatever it was that induced the absorption or reduction of the dorsal fin-fold and the persistence of the ventral or inferior fold. The cause of that variation began to act early in the line of the true fishes since we for the first time detect it obviously manifested in *Chimæra*, one of the lowest types where the inferior fold begins to widen, and as a result we have the first faint inklings of the heterocercal state, that is, the posterior extremity of the notochordal axis is slightly bent upwards. This adumbration of the heterocercal condition in *Chimæra* is pronounced in proportion to the degree to which the difference in width between the dorsal and ventral fin-folds of the caudal is developed. This seems to be a rule or law of caudal differentiation in fishes.

The origin of the mechanism in question can not, however, be understood without reference to the mode in which its functional use would continually tend to intensify the hetorocercal condition, premising, of course, that some antecedent cause tended to widen the inferior caudal fold to begin with. That antecedent cause we do not know nor can we do more than guess what it may have been. The conditions under which the tail fin is used in life is similar to that of an oar in sculling, and it is quite plain that the parallelograms of force which are thus developed by the interaction of the tail moving laterally and alternately in opposite directions against the resistance of the surrounding water must bring about a constant tendency to induce an upward flexure of its notochordal axis. This effect can actually be imitated by means of a cardboard model, cut out in the form of a heterocercal tail and vibrated from side to side under water. In this manner only can the origin of the heterocercal form of the tail of fishes be explained. Natural selection is utterly incompetent to do so, because it must first explain the concurrent or simultaneous variation of about six thousand species belonging to no less than three independent phyla. If the tendency was all in the same direction, in three independent series, composed of a multitude of species, it involves the conclusion that there was no selection. The effect is manifestly the result of a habit of movement the initiation of which may, in part at least, be ascribed to the intelligence of the creature manifesting such a habit.

The soft or jointed rays of the sturgeon, as well as of all other soft-rayed fishes, owe their jointed condition to the interaction between the fins and the resistance offered passively by the surrounding water. This conclusion might be demonstrated beyond any possibility of question were this the proper place to discuss the matter. At any rate, I now possess irrefragable evidence of the truth of the conclusion that some six thousand species of living forms furnish a demonstration of Lamarck's theory that the use of an organ may and does modify its structure, or that the actions of an animal react upon its structure, and modify the latter in the same way at every succeeding generation. Whether these modifications are inherited is immaterial, since the doctrine of the direct effect of use and disuse is now demonstrable, and with all the rigor of method required in proving a proposition in Euclid.

5. THE VISCERA OF THE STURGEON.

The abdominal viscera of the sturgeon embrace only, as here considered, the alimentary canal and its appendages. The appendicular organs derived from the alimentary canal are the liver and gall-bladder, pyloric apparatus, and air-bladder. The organ mentioned by anatomists as pancreas in the sturgeon is not a diverticulum of the intestine, but belongs to the series of ductless glands, and therefore represents the milt or spleen, and is of mesoblastic, not of hypoblastic origin, as would be the case were it a true pancreas.

The alimentary canal proper is differentiated into three very clearly defined regions.

The first of these is the œsophageal portion, and extends as far back as to the opening into the air-bladder. It is the narrowest portion, and leads directly out of the branchial or pharyngeal region, beginning with the fifth and smallest and most posterior of the five branchial arches. The branchial arches as they narrow by degrees from the first to the fifth form a kind of funnel-shaped framework which directs the food into the anterior end of the œsophagus or gullet. The gullet proper is then somewhat narrowed at a short distance from its anterior end, and upon being laid open is found to be covered within for some distance, with backwardly-directed, soft, fleshy processes, into which its mucous membrane is elevated. At some distance, in its course farther back, its lining membranes again become smooth, but slightly folded longitudinally, and at a distance of an inch from its commencement, in a young specimen 9 inches long, it curves upon itself over to the left, and then forward and to the right, forming a loop, and becomes more spacious. At the point mentioned it in fact widens into the stomach, which lies slightly to the right of the median line. The stomach, especially at its pyloric end, is found to have very thick walls. This feature is so strongly marked in the adult that the organ acquires to a striking degree some of the characteristics of the muscular stomach or "gizzard" of a bird. This portion of the stomach of the sturgeon is, in fact, referred to by the fishermen in some localities as the "gizzard," no doubt on account of this resemblance.

Immediately following the thick-walled stomach proper there occurs a very marked constriction of the alimentary canal. This constriction corresponds to the pylorus of other vertebrates, and also marks the beginning of the duodenal portion of the alimentary canal, into the upper portion of which the pyloric apparatus or pancreas and liver discharge their secretions.

Just behind the constricted pylorus proper a fold of the wall of the upper end of the duodenum is developed, which partly conceals the three wide openings into the pyloric apparatus or pancreas.

The pyloric apparatus is so obviously a diverticulum of the intestine that it may very appropriately be considered at this point. Three very wide openings lead from the dextral and ventral sides of the upper end of the duodenum into the pyloric apparatus, showing that this organ, in its simplest embryonic form, must be regarded as a system of pyloric appendages, three in number. Further examination shows that the three primary pyloric diverticula have become divided at their terminations as development proceeded into a number of cæcal pouches after the manner of a compound, racemose gland. These branches of the original three diverticular, however, remain invested by a solid tunic of connective tissue and peritoneum, so that there is but little indication externally that the internal structure of the pyloric apparatus is that of a system of branching cæcal tubes. In the young animal this outer tunic of the pyloric apparatus though quite thick is not nearly so thick as in the adult.

The attachment of the pyloric apparatus in the fully developed animal embraces about half the circumference of the duodenum.

The expanded distal end of the pyloric apparatus is attached by fibrous cords (originally derived from the mesentery) to the posterior side of the terminal part of the stomach. The external form of the pyloric apparatus is that of an irregular lenticular body, the longest diameter of which is antero-posterior, with a narrower transverse diameter. The long diameter of the pyloric apparatus in the young of 9 inches is three-fourths of an inch, the short diameter one-half inch. The thickness of the organ in a vertical direction is about one-fourth inch in the young of the size mentioned above. It fits into and lies partly embedded in the first loop of the alimentary canal, formed, as above described, by the œsophagus, stomach, and upper end of the duodenum. Upon opening the body cavity the pyloric apparatus is one of the most conspicuous structures brought to view, as is shown in the accompanying figures 27, 52, and 53, which show its relations far better than can be done in a lengthy description.

In young sturgeons, 9 inches long, just as the œsophagus begins to widen and pass into the stomach, and at a point about 1¼ inches from the point where the gullet begins as a continuation of the pharynx, it gives off a very important dorsal diverticulum—the air-bladder. This organ communicates by way of a longitudinally widened, but short canal, known as the pneumatic duct, with the œsophagus, and is closed by a sphincter muscle, while muscular fibers radiate from the edges of the passage and traverse for a little distance the ventral walls of the air-bladder or pneumatocyst. The pneumatic duct joins the pneumatocyst at its anterior fourth.

The whole air-bladder has a compressed, oval form as viewed from above, and its thin walls may be distended so as to fill nearly one-third of the body cavity. The convex dorsal wall of the air-bladder lies in direct apposition to the body-wall, little or no peritoneum intervening, while its lower convex face is covered by a peritoneal investment which is continuous in the median line with the mesentery and at the edges of the air-bladder with the inner serous covering of the muscular wall of the belly. The air-bladder extends for two-fifths of the length of the body cavity. Its walls are quite thin in the young, except at the entrance of the pneumatic duct; in the adult they are relatively somewhat thicker, while the coating of peritoneum and connective tissue is also thicker. In a large sturgeon the capacity of the air-bladder would probably exceed 2 gallons; its walls are smooth, glistening white, and not vascular, thus contrasting markedly with the structure of the same organ in *Lepidosteus*, in which the highly vascular transverse trabeculæ give to the organ the aspect of a rudimentary lung.

The economic use to which the air-bladder of the sturgeon is applied makes it of some interest to know how it is treated when it is intended to prepare fish glue, ichthyocolla or isinglass, as its gelatinous product is called, when isolated for commercial purposes. The air-bladders are removed and the peritoneal and connective tissue coverings carefully scraped off. The bladders are then dried and afterwards treated in a digesting apparatus to extract the gelatine which they contain.

In the young sturgeon the course of the remainder of the intestinal tract is comparatively simple, and it maintains the same arrangement in the adult, except that the proportional length of the duodenum, small intestine, and spiral valve are not the same. In the young the duodenum is proportionally longer than in the adult, and the same may be said of the small intestine.

The duodenum extends from the pyloric valve or origin of the pyloric apparatus, backward and slightly to the left as far as a little beyond the beginning of the posterior third of the abdominal cavity, where it suddenly bends upon itself and passes forward to the right. This anteriorly deflected limb, or continuation of the duodenum, is the homologue of the small intestine of higher forms. It ends abruptly at the point where it passes into the hind-gut or spiral valve. The caliber of the spiral valve is somewhat greater than that of the small intestine and duodenum.

The spiral valve is formed by a spiral fold which is developed along the walls of the hind-gut of the embryo.

Beginning at the point where the small intestine bends upon itself abruptly to pass into the region of the spiral valve which takes a course straight backward, the spiral fold is seen to turn from left to right, or in the direction of the hands of a watch or dextral. The spiral fold makes seven complete turns or revolutions in the hind-gut, the last turn extending almost to the anus. In *Lepidosteus* there are but one and one-half turns in the spiral valve, and it does not extend to the anus. In *Chimæra* there are three turns in the rudimentary spiral valve; in the Dipnoans it becomes more developed, and in the Selachians reaches the maximum number of turns, though it would appear that the spiral valve in young embryos (*Mustelus*) have but three turns, while in the adult there are seven, so that at least four are added during the later development. This recapitulation by the embryo Selachian of the permanent condition found in *Chimæra* is interesting as throwing some light upon the phylogeny of the spiral valve. The function of the spiral valve is to increase the surface of the mucous membrane brought in contact with the intestinal contents without lengthening the intestine itself.

The minute structure of the hind-gut or spiral valve is of considerable interest on account of the remarkable development of lymphoid tissue which is found along the edge of the spiral fold. In cross-sections of the intestine through the region of the spiral valve, the edge of the latter is found to be so greatly thickened as to form a cord-like swelling along the whole extent of its free margin. When this thickened margin is examined microscopically it is found that its thickening is due to the presence of a strand of lymphatic tissue, subdivided by partitions of fibrous tissue into nodules, so that it presents a strong resemblance to the structure of the lymphatic glands found in certain parts of the bodies of higher animals. The resemblance to the lymphoid nodules of Peyer's patches in the walls of the ileum of higher forms is also suggested, and the presence of the largest lymph-cells gorged with nutritive substances along the surface of the glandular cord of the spiral valve of the sturgeon shows that the cells of this tissue are active here, as in other forms, in taking up the nutriment from the food which passes through the alimentary tract. The mucous membrane of the spiral valve is covered with villi, which are as well developed over the sides and edge of the spiral fold as upon the proper walls of the intestine of this region. The relations of the parts described are well shown in a cross-section of the region of spiral valve represented in Fig. 47.

The mesentery which suspends the hind gut, or spiral valve, to the dorso-median line of the body-cavity is entire, and six or seven blood-vascular branches are given off from the posterior mesenteric artery which take the curved spiral direction of the spiral valve after they reach and traverse the wall of the intestine. The mesentery of the hind gut is nearly one-fourth of an inch wide in a young fish 9 inches long. Farther forward at the V-shaped loop formed by the duodenum and small intestine together, the mesentery is much wider, and at the apex of the loop is perforate, and in this widened part of the mesentery of the last loop the spleen is embedded as a V-shaped glandular mass, having the same general curvature as the intestinal loop itself. The histological structure of this organ leaves no doubt of its spleen-like nature.

Still farther forward the dorsal median mesentery becomes narrower, so that the alimentary canal comes to lie in immediate contact with the dorsal wall of the abdominal cavity. Below, the median anterior ventral mesentery gives passage to the portal vessels from the liver, which pass to the auricular end of the heart. The Cuvierian ducts pass downward through the pericardium on either side of the œsophagus to join the venous end of the heart, thus collecting all the blood from the systematic circulation to return it to the heart. This is spoken of here since the pericardium, on its posterior face, is continuous with the serous lining of the body-cavity and the anterior median mesentery.

The liver is the largest glandular viscus of the young sturgeon, and it is lighter colored than in the adult. Its right lobe is considerably larger than the left, and both lobes have their thin posterior and inferior margins reflected over the pyloric end of the stomach. The gall-bladder lies in a fossa, or depression, on the median face of the right lobe, and between the latter and the thick-walled pyloric end of the stomach. The anterior portions of both the right and left lobes of the liver are so conformed to the shape of the anterior part of the body-cavity as to fit with great nicety to the configuration of the lateral walls of the abdomen and pericardium in this region.

The histological structure of the liver of the sturgeon has not been investigated by the writer, as it has not been the purpose to deal with especial minuteness with organs the functions and character of which are well known. The minute structure of the "pancreas" (so called by Weidersheim, Lehrbuch der Vergleichenden Anatomie, second edition, 1886, pp. 533–535), but correctly identified as the milt, or spleen, by Brandt and Ratzeburg (Medizinische Zoologie, 1833), is of more interest, since it displays the typical structure of spleen in a very simple form. In a matrix of lymphoid tissue, lymphoid nodules, or masses, very irregular in form, are embedded and traversed by blood-vessels. In sections of the organ, before staining and clearing is resorted to, very characteristic globular cells are found embedded in the lymphoid nodules of the organ; these cells are uniformly granular, opaque, and quite unlike the rest of the cells of the organ, and about three times as large as the usual type of cells which form the greatest proportion of the spleen pulp. They are very numerous in some of the lymphoid nodules, less so in others; the granules which they contain are quite small and uniform in size, but much smaller than the blood corpuscles of the animal. No traces of a racemose, glandular structure is visible anywhere in sections of the organ, such as would be necessary in order to constitute it a true pancreas.

The viscera hitherto considered lie either altogether, or for the most part within the body-cavity, as the air-bladder, for example, and all are intimately connected with or form a part of the alimentary apparatus. The ovary and testis which are to be next described lie within the body-cavity, but their functions are carried on in connection with passages or outways, the genito-urinary canals, which lie immediately external to the general body-cavity, and just dorsal of it on either side of the median line.

The great size of the ovary and testis or milt in the adult contrasts most remarkably with their small size in the young animal, 7 to 9 inches long, in which the internal generative organs, ovary and spermary, are represented by a pair of very slender whitish cords or low folds which lie on either side of the mesentery and on the dorsal wall of the abdominal cavity and diverge from each other from behind forward. Posteriorly, as shown in the Figs. 51 and 52, the genital folds *G R*, as the rudiments of the reproductive organs may be called in the young sturgeon, lie just internal to the course of the spacious genito-urinary ducts which converge to a common median outlet situated immediately behind the anus. They do not extend for the whole length of the abdominal cavity, but only along the middle half of its length.

In this first stage of the development of the reproductive tract there are protova present, as the first traces of the reproductive elements are called, and which in the early stages are very similar in both the ovary and the testis.

The reproductive elements are derived from the germinal epithelium of the genital folds; this epithelium, however, covers only a small portion of the surface of the genital folds and only becomes distinctly marked off to the naked eye at a considerably later stage. At this stage the tract of genital tissue is a more distinct, flattened, yellowish cord than in the younger 7-inch stage, and varies in width from one-eighth to one-fourth of an inch. On its inferior side in the young female there is present a well-marked band of closely opposed transverse ridges which extend across about one-third or one-half its lower surface. This series of transverse ridges is guarded by a flap or fold at either edge, and sections show that the ridges contain the young ova. The development of the testis does not show this longitudinal series of short transverse folds at any stage. In cross-section at this stage, the reproductive tissue proper is found to include only about one-fourth of the whole genital fold, the remaining part of the organ being composed of minute undifferentiated connective tissue which continues to grow for some time, and represents the homologue of the fatty body appended to the internal reproductive organs in anurous batrachians and reptiles. The numerous transverse ridges which are found on the inferior side of the genital cords are in fact parallel laminæ which extend down into the substance of the organ for about half of its thickness. These laminæ are far more numerous at this stage than the lobules of the mature ovary, so that it is obvious that some of them must degenerate in the course of the further development of the organ.

The subsequent stages by which the genital ridge is converted into the ovary or testis with an accompanying establishment of the sex of the individual has not been fully traced, but it is certain that the conditions observed in the stage last described are not much subsequent to the time when the protova or primitive germinal cells common to young individuals of both sexes, first make their appearance. The method of the further differentiation of the protova and the manner in which the small laminæ with the involuted germinal epithelium between them becomes indifferently converted into ovarian lobules or seminiferous tubules remains to be worked out.

All of the data bearing on the development of the internal reproductive organs given above have reference to the common sturgeon, *A. sturio*, but I fortunately happen to be in possession of materials from young individuals of the smaller species *A. brevirostris*, which will probably throw light upon this aspect of the subject.

All of the young specimens of *A. brevirostris* which I have been able to obtain show the internal reproductive organs in a more advanced condition of development than young individuals of *A. sturio* of the same size. In *A. brevirostris* measuring from 18 inches to 2 feet in length the sexes could be very readily distinguished, since the internal reproductive organs were either testes or ovaries according to the sex. In the ovaries the young ova were distinguishable as such in the ovarian tissues, with a pocket lens, and in the males the testes had assumed the opaque pinkish-white tint of those organs in the adult male. In the young female of *A. brevirostris*, however, the young ova had not yet shown any tendency to develop pigment granules within their superficial protoplasm; in other words, they were found to be of the same very pale amber color as the completely spent roes of the adult female of *A. sturio*. The young male of *A. brevirostris* showed the seminiferous tubes of the testes developed, but there were as yet no signs of the production of spermatozoa in sections of the organ.

In both sexes of the young of *A. brevirostris* the reproductive organs, both ovary and testis, are found embedded in depressions on the inner face of a rich, creamy-yellow body which is considerably more voluminous than the reproductive tissue itself. This yellow body is composed in great part of fatty tissue, and there is but little doubt that it is developed from the non-reproductive portion of the genital fold lying on either side of the tract of transverse laminæ already described as being found in a much earlier stage of the reproductive organ in *A. sturio*.

The later history of this fatty body shows that it does not keep pace with the growth of the proper reproductive tract, which becomes more and more voluminous as sexual maturity is reached until the ovary becomes the bulkiest organ in the body-cavity, as shown in the ventral view of the adult female with the nearly mature roes exposed, as shown in Plate LI. In the mature male there is relatively more of the fatty body present than in the female, in which it is completely concealed from view by the great size and width of the lobules of the ovary. What remains of the fatty body underlies, and is closely adherent to, the basal membranes by which the ovaries and testes are suspended to the dorsal walls of the abdominal cavity. These membranes form a mesovarium and mesorchium in the female and male respectively. These structures are, in both cases, derived from the basal part of the genital folds, which remain narrow at the base in cross-section, while the reproductive tract widens and becomes very voluminous at its distal end and depends into the abdominal cavity.

The changes which take place in the course of the development of the roes to maturity, as a result of the increase in the size of the vast number of ova of which they are largely composed, is of great interest. While the young ova are still embedded in the narrow ovarian lamellæ they show a tendency to aggregate the yolk material at one side, while the globular nucleus, with numerous chromatin spherules adherent to its walls in a single layer, is more or less peripheral in position. As soon as the ovum has reached the size of one-hundredth of an inch the nucleus is obviously shifted from its central position. From this time onward the ova present much the same appearance till sometime after the period when they reach somewhat more than one-half the diameter of the mature egg. They then begin to show signs of pigmentation which vary in amount, as already stated, in different individuals. This pigment, like that found in the ovum of the frog, is mostly superficial in its distribution and consists of minute granules, nearly opaque, which form a thin stratum just beneath the egg membrane and embedded in the superficial protoplasm. This pigment is also finally distributed, in varying quantity, at different points at the surface of the egg, so that the darkened discoidal germinal area is marked out by it, as shown in Figs. 1 and 2. This definite distribution of the pigment is accomplished by the time the ovary reaches its maturity when the whole organ assumes its characteristic dark color, due to the presence of the pigment in the individual eggs.

Sections of the mature roe show that each egg is inclosed in a vascular capsule or follicle in which it reaches its full size. A thick homogeneous egg membrane is developed just external to the pigmented layer of the ovum. This membrane resists the action of carmine and remains colorless when treated with an alkaline solution of that dye. A layer of substance just external to the egg membrane and of about the same thickness is readily stained by carmine. This outer layer is the partly soluble glairy substance by means of which the ovum adheres to foreign bodies, and which finally hardens and cements them firmly to whatever they touch. The next layer is the vascular capsule or follicle which is traversed by a delicate plexus of capillary vessels which nourish the maturing ovum. This follicle is finally ruptured when the ovum drops into the abdominal cavity, from which it escapes by way of the genito-urinary passages presently to be described.

The ovaries, after the ova have been discharged from their follicles, present a shredded or torn appearance. This is due to the presence of the great number of collapsed egg follicles and to the more or less degenerate vessels which traverse the stroma or supporting substance of the tissue of the ovary, and which are undergoing retrogressive changes. These retrogressive processes, after the ova which have been matured for that season have been set free, go on until the ovary again contains nothing but very immature eggs, each of which must grow greatly in size in order to bring up the ovary to the size it had reached before ovulation began. Since the "spawning," as the process of ovulation is called, takes place but once a year, it is clear that it is a periodic phenomenon, just as the process of ovulation is even amongst higher animals. There is a period of preparation for the business of ovulation, and this begins for the next year with the cessation of the process for the preceding season. This preparation involves the collapse and diminution of the caliber of the blood-vessels which have supplied the ovary during its period of greatest functional activity, and also the absorption of the ruptured follicles in which the last crop of ova were matured.

Some few mature ova do not seem to be discharged at all, but undergo absorption within the follicle, together with their enveloping membranes or zonæ radiata, and glairy coverings of mucigen. Such degenerating ova, in sections of the "spent" recuperating roe, are found to contain a large yolk mass somewhat irregular in form and thrown into folds or wrinkles superficially with the pigment granules not aggregated at the surface, but irregularly distributed throughout the substance of the yolk mass.

The outgoing passages from the abdominal cavity are somewhat difficult to understand without reference to Figs. 51 and 52, to which the reader's attention is directed in the accompanying Plate LVIII. The oviducts of the sturgeon (Müller's ducts) open into the abdominal cavity by capacious funnel-shaped mouths on either side of the air-bladder. They open forward and are so spacious at their anterior extremities that the whole hand may readily be thrust into them at that point in the adult fish. They gradually narrow in their backward course and extend for a few inches only as separate canals which overlie the more deeply embedded urinary passages into which they open at their posterior terminations. After the oviducts open into the urinary passages, from that point backwards the latter become properly entitled to the designation of genito-urinary, since they then form a common outlet for the escape of the renal secretion from the Wolffian body as well as the generating products set free by the ovary. The common genito-urinary passages of either side are then continued backwards till they become confluent near the vent, just behind which they open to the exterior.

In the male the arrangement appears to be somewhat different. The spermatic ducts from each testis open directly into the urinary duct (segmental or Wolffian duct), though the oviducts are also well developed in the male and not at all rudimentary as in the males of higher animals. The spermatic secretion or milt does not therefore pass out of the testes by way of the oviducts, but takes a more direct course into the urinary duct (Wolffian), which extends in both sexes much farther forward than the oviduct. The urinary passages, which are as spacious in the male as in the female, therefore become, for a greater portion of their length than in the latter, efferent genito-urinary outlets.

The mesonephros, Wolffian body, or permanent kidney of the sturgeon, discharges its secretion into the primitive segmental or Wolffian duct, which widens as it passes backward just before it receives the oviduct which joins it. Upon slitting open the widened posterior portion of the urinary or segmental duct the mouths of the collecting ducts of the segmental tubules of the kidney are exposed, and are seen to be scattered over its dorsal wall, showing that the renal secretion is poured out directly into it. There is no dilatation of the posterior portion of the segmental duct into a urinary vesicle or bladder as occurs in many Teleosts.

The posterior portion of the mesonephros of the sturgeon is most strongly developed; and in this region it lies just internal to the segmental ducts as a flattened and widened series of renal lobules composed of closely agglomerated uriniferous tubules and Malpighian glomeruli. In the region of the air-bladder, and overlying it on either side of the vertebral column, the renal lobules become suddenly much smaller in the young, while in front of it they again increase in size. How much of the pronephros or head-kidney persists is not known, nor has it been determined in just what way the secretion from the anterior part of the mesonephros reaches the segmental ducts. The proportions of the glandular portions of the renal apparatus at different points of its extent is shown in Fig. 51, Plate LVIII, showing the dorsal wall of the body-cavity as viewed from below.

The foregoing account of the viscera of the sturgeon deals in the main with the naked-eye appearance of its parts.

6. THE LATERAL LINE SYSTEM OF THE STURGEON.

This structure is not mentioned by systematic writers, or at least by none that I have been able to consult. In specimens 9 inches in length the lateral line is traceable as a distinct canal which perforates the posterior lateral plates just below the longitudinal ridge which extends along their outer faces. It is traceable from the exterior as far forward as the vertical cutting across the dorsal and anal fins, and opens by way of pores to the exterior between the edges of the last two or three lateral plates. Behind the last lateral plates the lateral line suddenly changes its course and follows the general inclination of the upper or longest lobe of the tail, traversing a narrow armored strip of the lateral caudal integument just below the lateral caudal armature, which consists of a pavement of small rhombic plates, without strong carinæ or points. In the young animal, the lateral line developed along the sides of the upper lobe of the tail is a simple tubular canal traversing the integument, and at short intervals it opens to the exterior by way of pores.

In the adults it is not so easy to trace the lateral line forward, but on the sides of the upper lobe of the tail it may be observed to open by a series of pores in close proximity to the site of the lateral line in the young, but the pores are no longer linear in their arrangement, indicating that the canal has branched and gives off short lateral branches as adolescence is attained. This description applies to *A. sturio*.

It is unfortunate that the failure to obtain a complete set of the stages of development will not enable me to give a fuller account of the ontogeny of this structure in *A. sturio*. Fortunately, in a memoir by N. Zograff (Studies from the Zoological Laboratory of the Museum of the University of Moscow, in Russian, t. LII, pt. 3, Moscow, 1887, p. 44), the lateral line of the head and trunk of *A. ruthenus* is figured at a stage which shows that there is a supra- and infraorbital, occipital, lateral, rostral, and supraopercular system of canals with punctiform end-organs. This arrangement of the lateral sensory nerve-hills is probably very easily made out in quite young stages of the sturgeon, before the epidermal lateral canal closes and sinks down into the deeper layer (corium) of the skin. A careful dissection of the lateral line region of young individuals of *A. sturio* 8 to 9 inches in length shows that the lateral branch of the vagus nerve is present along the middle line of the side as a very conspicuous cord, just beneath the lateral row of scales and slightly embedded in the lateral muscular mass, invested by a connective tissue sheath. Careful inspection also shows that the lateral scutes along the sides as far forward as the opercle are perforated by a canal, which is supplied, as described by N. Zograff, in *A. ruthenus*, with small twigs from the lateral branch of the vagus nerve. These small twigs terminate in groups of hair-cells—nerve hills—forming part of the ectodermal lining of the system of lateral canals. The structure of the system of canals on the head is of the same character, but the end-organs and canals are not as numerous and complex as in *Amia* and many Teleosts.

Another sensory apparatus of some complexity are two pairs of barbels in front of the mouth. These appear in *A. sturio* to be innervated by a large sensory branch of the fifth nerve, which is very easily traced upon removing the integument on either side of the middle line, on the under side of the snout. The barbels themselves are considerably longer in proportion in the young sturgeon of 10 inches to 2 feet than in the full-grown *A. sturio* measuring 7 to 10 feet in length, while the transverse incisures on their surfaces also become deeper and the lateral flattening of these organs is also more apparent in the adult.

When the young sturgeon first leaves the egg there are no outward indications of the barbels. The anterior and inferior part of the head is bluntly rounded, and there is little or no indication externally of the presence of a suctorial disk such as is seen in the larvæ of *Lepidosteus*, where this disk subsequently degenerates and is carried to the tip of the snout. This is well seen in the recently hatched larvæ of the common sturgeon figured in the appended plates.

The barbels grow out a few days after hatching at a point just in front of the mouth as two pairs of short, blunt, fleshy processes on either side of the median line, as shown in Figs. 54 and 55, p. 89, Vol. II, of Balfour's Comparative Embryology, and in Figs. 14, 15, 16, and 17 on Plates XL and XLI of this paper. This blunted, cylindrical appearance of the barbels is retained until the young sturgeon has reached some size, as shown in Figs. 19, 20, and 21, of the young sterlet before the lateral plates of the body are much more than indicated and when the snout is beginning to become pointed and grow in length rapidly. The bases of both pairs are also more closely approximated during these early stages, though there is great variation in this respect even in different adult individuals, but in the latter the pairs never seem to arise from the same base as do the barbels in the very young fish. The barbels of the embryo of the sturgeon do not grow out so precociously as do those of the cat-fish, as shown by the writer in *Ictalurus albidus*, where they, moreover, have a cartilaginous supporting axis. This fact, as well as their tactile function in both cases, militates, it seems to me, strongly against the opinion that the barbels of fishes are necessarily derived from the papillæ of a suctorial disk such as is found in the larvæ of *Lepidosteus*. Besides, the late appearance of the barbels at the angle of the mouth in *Cyprinus carpio*, and of the chin barbels in *Menticirrus*, *Gadus*, *Onos*, etc., indicates a want of community of descent.

Another epidermal system of sense organs extending over the under side of the snout of sturgeons both young and old is of interest, since it is probably a part of the system of tactile apparatus represented by the barbels. The structures now referred to are the depressed areolæ found in front of the mouth, and divided partially in the median line by the roughened carina, formed by the produced parasphenoid bone, on the lower side of the snout, into a pair of triangles with their acute extremities directed forward. The small depressed areolæ at the anterior part of this area are oblong; back near the mouth they are nearly round, with irregular margins. Zograff's results indicate that these areas are the points where sensory nerves terminate. My dissections indicate that their nerve supply comes from the most anterior branch of the fifth nerve. The position of these organs is such as to bring them into play as accessory to the barbels in seeking for food at the bottom of the estuaries where the sturgeon doubtless spends most of its time when feeding.

7. THE LYMPHATICS OF THE STURGEON.

The lymphatic system of the sturgeons is somewhat remarkably developed, and recalls in some respects that of the lampreys. In the lampreys, a stout triangular cord of lymphatic tissue overlies the spinal cord. This cord of lymphoid tissue, in those forms, is invested by the fibrous connective tissue which also invests the spinal canal as the dura mater and as the outermost fibrous covering of the notochord. It occupies, in part at least, exactly the position of the ligamentum longitudinale which traverses longitudinally the neural arches of the other groups, embracing the true fishes. The fibrous cords traversing this organ, as seen in the lampreys, may, through degeneration of the lymphoid tissue, have given rise to the ligamentum longitudinale, through some common ancestral type.

This lymphoid organ in the lamprey also contains black pigment cells mixed amongst the lymphatic tissue, but the organ extends for the greater part of the length of the vertebral column in the lampreys.

In the sturgeons there is no cord of lymphoid tissue extending above the spinal cord, for its whole length, but at its anterior end the spinal canal is greatly widened, and in this dilated portion of the latter there is a mass of lymphatic tissue included which is not traversed, as in the lampreys, by fibrous connective tissue, but as in them is found to contain scattered black pigment cells. This mass of lymphoid tissue in the sturgeon lies partly within the dilated anterior part of the spinal canal and partly within the skull, and extends down over the sides of the anterior end of the spinal cord and medulla oblongata. This mass of lymphatic tissue therefore occupies partly an intracranial position and does in fact extend slightly in front of the auditory region of the skull.

While it is difficult to identify the lymphoid tissue found in such close relation with the nervous system of the sturgeon with the massive trihedral lymphoid strand overlying the spinal cord in the lamprey, the comparison is at least suggestive.

A still more remarkable lymphoid organ is found investing the ventricle of the heart and the bulbus aortæ of the sturgeon. It is one of the most striking structures found in the sturgeon, and at once attracts the attention of the anatomical tyro upon opening the cavity in which the heart lies. It is, in fact, the tissue which gives to the surface of the heart of the adult a lobulated appearance entirely different from that of the heart of all other fishes. These lobules are the outward expression of compartments in a thick layer of lymphoid tissue, which are found to be lined with processes that are produced into plates, or lobes, internally that are often dentritic or branched as seen in cross-section. In portions of this structure lymphatic tissue has been found of the usual type met with in higher types, but no muscular fibers have been observed. Besides this there have been found masses of a homogeneous substance in some of the lobules, which recall the masses of similar matter seen in the closed sacks of the thyroid body throughout the vertebrates generally. Its function has never been clearly determined, but my own opinion is that it probably belongs to the category of ductless glands and that it may have some relation to the thymus or thyroid, probably the latter, as long ago suggested by J. F. Meckel. The history of this singular organ can only be made out definitely by a study of its development, from fresh materials, extending over a great many more stages than are at my command for that purpose. Until that is done it will be useless to speculate as to the true nature of the singular lymphoid structure which covers nearly the whole heart of the sturgeon. It completely covers the ventricle and bulbus; is firmly attached to their outer surfaces, and forms, so to speak, a second, and highly differentiated wall lying external to the muscular coat of the heart. Only one other suggestion occurs to me as respects its true nature, and that is that it may possibly be a greatly thickened epicardium in which lymphatic tissue has been developed, but even this suggestion would have to be verified by further embryological research, for which the required material is not yet at hand.

A third tract of lymphatic tissue is found extending along the free margin of the spiral valve. The free margin of this spiral valve or fold is greatly thickened throughout its entire course. Cross-sections of the portion of the alimentary canal in which this structure is found discloses the fact that the thickening of the edge of the spiral fold is due to the presence of a cord of lymphoid tissue, which is indistinctly subdivided into lobules by strands of fibrous tissue. That there are true lymph-cells present in this part of the fold is readily demonstrated in stained preparations of cross-sections of this part of the intestine. Such lymph-cells, are, moreover, apparently migratory and move up and down within the papillæ or villi with which the intestinal wall is here thickly studded. They probably have an important work to perform in taking up the digested nutriment which passes through this part of the alimentary tract. The relative proportions of this cord of lymphoid tissue is indicated in the partially diagrammatic cross-section of the spiral valve, represented in Fig. 47 at *Ly*.

It is therefore obvious that in the sturgeons we have the lymphatic system quite highly developed, more so in fact than in almost any of the Elasmobranchs, Teleosts, Dipnoans, or Ganoids. No close comparisons with other types can be made with respect to the lymphoid structures of the spinal canal. The closest comparison seems to be afforded by the strand of lymphoid tissue overlying the spinal cord of the lampreys.

With respect to the spleen of the sturgeon, which has been frequently identified as pancreas, sections show that it is really lymphoid. Large Malpighian bodies are discernible in sections, which agree closely with the appearance of those seen in sections of the spleen of Selachians, some of which I have been enabled to compare with sections of the sturgeon's spleen through the kindness of Mr. W. F. W. McClure, of Princeton College.

8. THE DEVELOPMENT OF THE STURGEON.

The recently deposited ovum of the common sturgeon measures 2.6^{mm} in diameter. That of the sterlet, upon which species the most of our information as to development is based, is much smaller, measuring only 2^{mm}. As already stated, besides the egg membrane a glairy viscid substance forms a considerable layer on the exterior of the eggs, which becomes soft and stringy upon contact with water, but hardens later into a firm substance which finally cements the ova firmly to whatever they may be brought into contact.

The micropylar apertures appear to be multiple in the egg of the sturgeon. There appears to be one central one in the egg of the common sturgeon, which is surrounded by a cycle of others, as represented in Fig. 2, Plate XXXVII. The micropyles from the first overlie the dark germinal area, and through these minute openings in the egg membranes the spermatozoa or male elements find their way in order to impregnate or fertilize the egg. The micropyles occupy the central position over the germinal area before the egg is mature, and set free from the ovarian follicle in which it grew and ripened. In the species of sturgeons studied by Kowalewsky, Owsjannikow, and Wagner seven micropyles were observed. Salensky found from five to thirteen in the eggs of the sterlet.

The segmentation of the egg begins at the dark pole and is unequal, and at first it is only partial. Later the segmentation furrows extend through the whole egg, as seen in Fig. 5, after segmentation is completed. About this time a segmentation cavity appears within the egg, roofed over by the smaller segmentation spheres of the dark pole, while it is inclosed below by the large spheres of the lighter pole, which comprises the yolk. Just at this point there is an inconsistency in the account given by Salensky which it is hard to reconcile with the very large persistent yolk of the later stages. The large segmentation spheres seem to have their segmentation furrows obliterated at a later stage; at any rate the yolk is said to be inclosed by the walls of the primitive entoderm of the intestine, after the segmentation of the yolk substance has become less obvious than at first, and after its nucleated segments had become pretty numerous. If the inclusion of the yolk cells by the intestine actually occurs as described by Salensky, the process is without a parallel among the vertebrates, the nearest approach being the mode of yolk absorption lately described by P. and F. Sarasin as occurring in the embryos of *Ichthyophis glutinosus*, one of the footless, worm-like batrachia of Ceylon.

The further development of the germinal area at the dark pole of the egg presents many analogies to that of the osseous fishes, especially as respects the manner in which the yolk is finally covered in and completely inclosed. Upon comparing Fig. 6 with the stage represented in Fig. 5, it will be seen that the upper pole is now covered by a cap of cells which leave only the lower coarser yolk cells exposed. This cap has resulted from the more rapid segmentation of the small cells shown at the upper pole of Fig. 5. These smaller cells of Fig. 5 have in fact, in Fig. 6, become so small by repeated division that the artist has found it impracticable to represent them according to the scale of enlargement adopted in the last-mentioned figure. The cap of cells has grown all around its margin in such a way that it has gradually extended over the yolk. At one side of the cap the rudimentary embryo is visible as a light band rounded at the upper end. A linear depression runs through the middle of the rudiment of the embryo; this represents the center of the so-called medullary plate, and is also the middle of the medullary groove to be folded in later when the margins of the medullary plate are turned upward and fuse immediately over the former to form the medullary canal or passage way through the primitive spinal cord, which is developed in the way above described.

In the next stage of development, which is reached in about twenty-four hours after impregnation, we have the appearance presented in Fig. 7. The only portion of the mass of yolk cells which now remains exposed is indicated by the little rounded, nearly black area, at the lower pole of the figure. The yolk is now completely inclosed, except this small portion, by the continued growth of the lower edge of the cap represented in Fig. 6. This small area of yolk still exposed is the yolk blastopore or prostoma.

At this time the rudiment of the embryo becomes widened in front, as shown in Fig. 7, so that the medullary plate, anteriorly, becomes expanded like the broad end of a spatula. This widened end of the medullary plate is the rudiment of the future sturgeon's brain, and behind this widened part, the edges of the medullary folds become more distinctly evident, since the development of the spinal cord of which they form a part is now more advanced than in the preceding stage. The embryonic area at this time presents some characteristic features of coloration in the common sturgeon. The area immediately around the embryo is light-colored; some little distance from it there is a darker band of color. This dark band is oblong, with the sides curved inward, so that the whole reminds one of the form of the body of a violin, with the embryo lying in the middle line, or lengthwise, in the paler central area.

While these changes have been in progress, the cap or mantle of smaller cells from which the embryo is formed, and which now almost completely envelops the yolk, has undergone internal changes. These relate mainly to the splitting or folding of its constituent cells in such a manner, over the embryonic portion especially, as to form two layers. From the outer of these the skin and nervous system of the future sturgeon will be formed, while from the inferior and thicker layer the rudiments of the muscles, blood-vessels, intestine, cartilage, etc., of the future completely developed animal will be evolved.

The changes which follow, and which are visible from the exterior, relate partly to the outermost and partly to the innermost layer of cells which cover the yolk. On either side of the embryo, in Fig. 7, there are distinct longitudinal swellings, W G. These indicate the beginnings of the kidneys, which are still more distinctly visible in Fig. 8 as a pair of narrow bands. In this figure further changes are taking place in the fore part of the medullary plate; the anterior and posterior parts of the brain are in fact becoming defined, while still further back the four pairs of blocks of cellular substance mark the rudiments of as many segments or flakes of the muscular system of the adult. Behind these the thickened rim of tissue surrounding the blastopore will furnish additional muscular segments as development proceeds, while it is also obvious that the rudiments of the posterior limbs of the kidneys embrace this ring of tissue.

These points are still better shown in Fig. 9, in which the medullary tube or rudimentary spinal canal has become folded off from the muscular segments at the sides, and which have greatly increased in number. The whole embryo has also lengthened, so that only the posterior portions of lateral rudiments of the head, *k p l*, are visible, while the blastopore has closed posteriorly. Additional muscular segments are also seen to be progressively split off, from before backwards, from the rim of tissue which in the preceding stage surrounded the blastopore. The Wolffian ducts or embryonic renal apparatus is also seen to extend to or beyond this region.

Still more advanced stages are represented in Figs. 3, 4, 10, and 11. In Figs. 3 and 10 the first visceral arches *va′*, *va″*, *va‴* are obvious, while the first outward signs of the sense organs, the ear, eye, and nasal pits are plainly visible in Fig. 3.

In Figs. 4 and 11 are shown very nearly parallel stages of development in the common sturgeon and sterlet. Fig. 4 is from below, and Fig. 11 shows the head end of the embryo of the sterlet from above. In the latter the anterior ends of rudiments of the kidneys or Wolffian ducts are seen to have their anterior ends more recurved than in the less advanced stages shown in Figs. 9 and 10. At this time the head becomes obvious at the anterior end of the embryo, extending some distance forward beyond the fore part of the head, as a pulsating tube, which receives the embryonic blood from a paired system of vessels extending over the yolk.

Fig. 12 shows the just-hatched Russian sterlet, while Fig. 18 shows the common sturgeon just after it has left the egg, on the sixth day after impregnation. The yolk in the sterlet is now much larger in proportion to the body than in the common sturgeon. There does not seem to be any sign of the pectoral fin developed in the just-hatched sterlet; but in the common sturgeon this fin is the first of the paired ones to be developed, and is very conspicuous as a delicate but low fold on the top of the yolk-sack, a little distance from the side of the body at *f*, Fig. 18.

In Fig. 18 there is no outwardly visible evidence of branchial clefts as in Figs. 12 and 13 of the sterlet, but the opercular fold *op* already conceals the visceral arches from the outside. The tail fold is also much wider in the recently hatched embryo of the common sturgeon, as Fig. 18 clearly shows. A single spacious Cuvierian duct, *c v*, carries the blood from the head and body down over either side of the yolk to empty it into the inferior or venous end of the heart, H, which lies in a spacious concavo-convex cavity *p c*, within the anterior end of the somatic wall of the yolk-sack. This space is continuous with that of the general body-cavity posteriorly.

No barbels are developed at this stage in the young of the common sturgeon, nor are they present in the same stage of the young sterlet. The nasal sack is now a simple depression in the epidermis of both. The various portions of the brain are now differentiated, while the notochord is formed and the lateral muscle plates are numerous, nearly twice as many in fact as in most young Teleosts of the same stage. In this respect the sturgeons resemble the Elasmobranchs rather than the group of Ganoids or Teleosts. Only a few of the long-bodied Teleosts have the muscle plates very numerous in the embryo.

The spiracular cleft is very obvious in the recently hatched sturgeon, as indicated in Fig. 18 at *sp*. The eye is relatively very small, a feature in which the embryo of the sturgeon agrees with the embryonic lampreys and batrachia more closely than with any fishes except *Lepidosteus*. The mouth appears very far back from the tip of the snout and is at first almost completely concealed from below as a narrow, transverse cleft in the angle formed by the upper anterior extremity of the yolk-bag and the under side of the head of the recently hatched larva.

Later, as the head lengthens and the yolk-sack is absorbed to some extent, the mouth becomes obvious from beneath as a wide transverse opening with a row of about ten formidable teeth in each jaw, as shown in Figs. 14, 15, and 17. The barbels now appear as four papillæ placed in a transverse row in front of the mouth, as shown in Figs. 15 and 16. In front of the row of barbels there is a depression, seen in Fig. 15, which may be the homologue of the preoral disk found in *Lepidosteus* and *Amia* by Mr. A. Agassiz and Mr. Allis.

The branchial filaments now begin to grow rapidly so as to be extended beyond the posterior margins of the gill covers. They consequently become visible from the side, as shown in Figs. 14, 15, and 16. The yolk is now almost absorbed and the ventral pair of fins begins to be evident, as shown in Fig. 16, while the pectoral is quite large, but still rounded at the margin and not pointed as in the adult. A notch between the dorsal and caudal begins to separate these two, while the same thing is occurring on the ventral side, so as to separate the lower lobe of the caudal from the anal. The partial atrophy of the median fin-fold in front of the rudiment of the dorsal now begins, as shown in Fig. 16. At the same time the extensive median preanal fin-fold begins to be absorbed.

In the head region the barbels are becoming more conspicuous, while the snout is longer but still remains rounded off. The nostrils are beginning to become divided externally by the upgrowth on the dorsal and ventral borders of the nasal sack of two processes which will eventually fuse and form a bridge running diagonally across it as in the adult.

The next changes which are of interest in the progress of the metamorphosis of the sturgeons have been illustrated by N. Zograff, whose figures of the young sterlet I have not hesitated to lay under contribution. In these the snout is seen to have become distinctly more pointed and flattened underneath, as shown in Figs. 19, 20, and 21. The barbels have been lengthened, but seem to radiate from a central point, as shown in Fig. 20, from below.

The greatest interest, however, attaches to the history of the median dorsal row of scutes or bucklers. These seem to arise within the partially suppressed median dorsal fin-fold and, as shown in Fig. 26 (considerably enlarged), their points are very sharp and overlap somewhat in the same way as do the fulcra or plates on the dorsal margin of the tail in the adult. The dorsal bucklers appear first and before the fulcra. The lateral plates appear at the same time as a row of smaller calcifications in the integument of the sides, the anterior plates being the largest. The ventral rows of bucklers seem to be wanting, but they evidently appear, in some species at least, very soon after this stage has been passed over. This conclusion is supported by the condition of an older stage of another species, *A. huso*, represented of the natural size, in Fig. 22. In this figure all the bucklers seem to be present, except the fulcra of the dorsal margin of the caudal fin. The form of the head and snout also presents very nearly that which is so marked in the young of all the species, namely, the great elongation, flattening, and narrowing of the portion in advance of the eyes.

In Fig. 17 it is seen that fine cartilaginous branchial arches are developed in the larvæ behind the hyomandibular bar, which indirectly helps to support both the lower jaw in part and the hyoid arch wholly. The arrangement of these parts is still more clearly shown in Fig. 44, illustrating the cartilaginous cranium of the adult. Though there are five gill-bearing arches developed, it is only the four anterior ones which support true gills; the hindmost or fifth is reduced in length and is completely embedded in the tissues at the posterior end of the branchial chamber, and bears no branchiæ even in the adult.

The figures of the young larvæ and post-larval stages show that the head is at first without armor-plates or scutes; in other words, it is covered by the naked integument only during the early life of the animal. In the young fishes from 4 to 5 inches long the cranial plates are already formed; their arrangement over the top of the head is essentially that displayed in Fig. 45, for all the species, barring minor variations. The most constant plates are the supraoccipital, exoccipital, parietals, and frontals. These form, together with smaller plates over the top and sides of the snout, a complete bony investment for the cartilaginous skull or brain-box shown separately in Fig. 44. The armor is completed at the sides by the large single opercular plate and below by the parasphenoid. All, or nearly all of this bony investment of the skull, except the posterior portion of the parasphenoid bone, is developed from calcifications which start from separate centers in the skin, so that all of these superficial bones of the head are regarded together with those on the back, sides, and under sides of the body as dermal or integumentary bones. They grow in extent by adding more bony substance to their edges, so that their roughly-indented edges ultimately fit together at their edges so as to form a more or less close union by the method which is known to anatomists under the term sutural. As pointed out elsewhere, the last pair of plates to unite and thus completely cover in the cartilaginous cranium in the common sturgeon are the parietal and frontal pairs, so that a fontanelle or hole may be detected in the top of the head of young sturgeons up to 2 or even 3 feet in length, where the inner edges of these dermal bones have not yet developed a complete junction.

The vertebral column of the sturgeon consists of a notochord almost completely surrounded by rings of cartilage, the latter of which answer to the bony disks found in the vertebral columns of other types. Unlike all other types, except Branchiostoma, the lampreys, and a few Ganoids, and Dipnoans, the notochord of the sturgeon continues to grow uniformly in length and thickness throughout life, and does not grow between the vetebral bodies only, as happens in the great majority of fishes, nor does it even undergo partial suppression within a thickened outer sheath, as happens in the Chimæroids.

The paired fins are supported on cartilaginous basal pieces. The form of these pieces is well shown in Fig. 49, representing in stippled work the cartilaginous supports of the rays of the ventral fin of the blunt-nosed sturgeon. The curious asymmetry of the segments of the basal pieces in this figure is worthy of notice. It is obvious that the three pieces of which the basal plate of either side is composed are greatly unlike.

The further changes in the form of the head particularly, from youth to adult age, in the sturgeon, can best be realized by reference to the illustrations of the young of the common as contrasted with that of the blunt-nosed species on the three plates, XLV to XLVII, inclusive, and these compared in turn with the heads of an adult male and two females seen in three different positions, as shown in Plates XLVIII to L.

These figures are the first adequate pictorial representations of these fishes which have been published, and since they have been obtained with the help of the photographic camera, from fresh materials, they can be depended upon as being accurate. The proportionally narrower head of the adult male is well shown on Plates XLVIII and L, while the great difference in the width of the mouth of the young of *A. sturio* and *A. brevirostris* is strikingly displayed on Plate XLVII. The first loop of the intestine exposed in the young of the common sturgeon, and represented on Plate XLVII, is seen to extend proportionally much farther back than in the adult, shown with the viscera exposed, in Plate LI, where this portion of the intestine is the only part of the alimentary tract which is uncovered. The metamorphosis of the sturgeon, according to the data given in this brief sketch, is seen to extend over a prolonged period, and to involve not only the fins and integumentary plates but even the relative proportions of the viscera.

9. THE SOURCES OF THE FOOD OF THE STURGEON.

When the young of the common sturgeon is first hatched it measures barely half an inch in length. At this time there is still present a quite large yolk-sack filled with a yellow opaque yolk subtance, the sides and upper surface of which are shaded with brown, owing to the presence of fine granules of pigment embedded in its superficial stratum. After a few days this yolk material is absorbed and the young fish, now measuring nearly three-fourths of an inch,[1] must begin to forage for itself. As

[1] The embryos of *Acipenser sturio* are considerably larger than those of *A. ruthenus* as measured by Salensky and Balfour. This difference is doubtless due to the difference in the size of the ova of the two species, the eggs of the common sturgeon being more than half a millimeter larger in diameter than those of the sterlet. The former measure 2.6^{mm}, while the latter measures only 2^{mm} in diameter. The larval sterlet, furthermore at the time of hatching, measures only 5¼^{mm}, while the larva of the common American species at the same stage measures 11^{mm}.

the oral opening is very small at this time it is necessary that the food taken be quite small. The mouth now becomes transverse and ventral in position, more or less protrusible as in the adult, and up to the third month the jaws support microscopic teeth of a very simple, conical type. The food taken at this time must be microscopic in character, and probably consists of rhizopods, unicellular algæ, infusoria, minute larvæ of insects and worms, crustaceans, etc., so that the range of forms upon which the life of the young sturgeon depends during its early stages of growth is a very wide one. The rhizopods, algæ, and infusoria are probably skimmed from the surface of the ooze at the bottom of the estuaries where the young sturgeon must feed during the early part of its life. That the young sturgeon does feed upon rhizopods to a large extent is to be inferred from the similar habit of the young of the *Catostomidæ* or suckers as first determined by Prof. S. A. Forbes. In slides prepared by Professor Forbes from the intestinal contents of a species of *Myxostoma* and one of *Erimyzon* (Proc. Acad. Nat. Sci., Philad'a, 1881), Professor Leidy was able to distinguish the shells of six distinct species of rhizopods or test-covered protozoa. The habits of the young sturgeon must be similar, for a time, to those of the *Catostomidæ* on account of the similarity of the mouth of both, so that, inferentially at least, there is strong probability that amœboid protozoa at first constitute an important part of its dietary.

It is thus rendered at least highly probable that there is an interdependence of the one upon the other in the struggle for existence. And one may legitimately speculate as to the still lower origin of the food of the protozoa.

The latter take into vacuoles or spaces in their sarcode minute vegetable and animal organisms which are digested and incorporated into their own substance, which is thus made to grow in amount. The rhizopods, in turn, are swallowed by the larval sturgeon, and we thus perceive that the minute accumulations of organic matter represented by the lowest protozoa are finally incorporated and become an integral part of a still larger aggregation of organic matter with a much higher grade of organization. The first process of digestion and integraticn took place in a mere cavity in the protoplasm of the very lowest grade of organization; the next step in the process of digestion and integration of living matter took place in a higher type in a differentiated alimentary tract with cellular walls and special glandular appendages which furnish the special food solvents or digestive ferments.

After the young sturgeon becomes somewhat older, larger forms are preyed upon. By the time the young animal has reached an inch to an inch and a half in length, the dorsal and lateral plates begin to appear, and the cartilages of the head and vertebral column have been formed, but the ribs are not yet developed, according to the sections figured by Zograff. Minute teeth are present on the pharyngeal floor and the food may be identified in the sections through the region of the stomach and intestine. The most characteristic and abundant of the intestinal contents at this time are the tests and remains of the soft parts of *Cladocera* or *Daphnidæ*, small water fleas, the summer broods of which are parthenogenetic and multiply at a prodigious rate, so as to be very abundant in the fresh-water estuaries where the young sturgeons are numerous. The figures of sections given by Zograff of the young of the sterlet, display the stomach and intestine literally packed with the remains of *Daphnidæ*, so that it is obvious that during some portion of the sturgeon's life and under certain conditions these forms stand in a vital relation to the latter as its food. Doubtless other forms, such as algæ, minute fresh-water worms, fish larvæ, insects and their aquatic larvæ, and fresh-water copepods are also taken. Many of these are again dependent upon the far more minute protozoan and microscopic plant life about them. This is notably the case with *Daphnidæ* themselves, in which certain appendages are used to sweep the microscopic infusoria and swimming algæ into the mouth, so that the water in which swarms of daphnids are kept is soon cleared of its microscopic life.

As the sturgeon grows larger and its mouth more capacious it becomes capable of capturing still larger prey. When they reach a length of from 5 inches to 2 feet, in some localities at least, they begin to prey in the main upon amphipods and isopods, two groups of crustaceans found in great abundance in the waters of the estuaries frequented by the sturgeon. These larger organisms in turn, which at this stage become the prey of the sturgeon, must feed upon smaller organisms, so that they become accumulators, so to speak, of the food of the fish at this stage, just as were the daphnids during an earlier period. The amphipods and isopods are found in great numbers in the spiral valve of young fish under 2 feet long, and besides occasionally the undigested cuticular covering of earth-worms is encountered. The remains of the larger organisms are, however, always mixed with more or less mud or ooze, which contains diatoms, rhizopods, etc., so that these low forms furnish some nutriment even in a relatively advanced stage, if not for the entire life of the animal. Of the amphipods *Amphithoë* and *Gammarus* were most abundant in the stomachs of young sturgeons. The commonest isopod found in the intestine is a species of *Idotea.* The fish from which these were taken were caught in brackish water, where these amphipods and isopods are very abundant, often adhering to the gill-nets of the shad fishermen operating in the same waters, to the number of many thousands. They are known, for this reason, to the fishermen as "shad lice."

After the sturgeon becomes adult larger organisms are sought for as food, though the writer has been surprised to find how little there remains in the digestive tract after death to indicate what formed their principal dietary. Occasionally the shells of *Mytilus* or *Modiola* are found, thus indicating that the mollusca are laid under contribution as a source of food. These mollusca, living as they do fixed to one spot, are in turn dependent upon the microscopic protozoan and larval life which is found in the surrounding waters.

From the foregoing inventory of the food of the sturgeon at various periods of its life, it is obvious that its existence is dependent upon that of a great multitude of diverse forms, which serve it merely as accumulators of pabulum to be converted into its own tissues Starting with the lowest grade of organization, the larva can feed for a time only upon forms not over a line in length, and which are minute enough to be sundered and rent by its microscopic teeth. At a later stage larger organisms are captured, measuring half an inch or more in length, while during adult life large mollusks and other organisms of 1 to 2 inches in diameter are readily taken and swallowed.

The story of the life of a sturgeon is therefore seen to be bound up with the lives of vast myriads of organisms in no way related to it in the system, but only as sources of nutriment. It is quite certain from what has preceded that if the minute life upon which the young sturgeons subsist were exterminated, the sturgeon would also become extinct. It follows from this that whatever affects the relative abundance of the minute life of the rivers and estuaries where sturgeons are found, must also affect the survival and abundance of the latter. The importance of a study of all the organisms upon which the sturgeon is directly or indirectly dependent must therefore be obvious to every one. The legitimacy of the inquiries into the life-histories of all organisms, even those in no way directly related to the economy of the State, should therefore need no apology from those engaged in the study of the problems of economic fish-culture.

10. HABITS OF THE STURGEON.

The habits of this fish, as might in fact be inferred from the conformation of the head and mouth, are essentially those of a scavenger and bottom feeder. The toothless, protusible mouth of the adult is in itself sufficiently suggestive of the mode in which a very large proportion of its food must be taken, notwithstanding the statements made by some European observers that the sturgeon may even rise to the surface to seize from beneath and swallow, in an entire state, such unwary water-birds as may be disporting themselves there. That the young do pursue, capture, and swallow rather active prey is proved by the fact that great numbers of the exoskeletons of amphipod crustaceans are found, together with other ingesta, in the region of the hind gut, modified to form a spiral valve. Whether these amphipods are taken while the sturgeons are swimming about through the water some distance from the bottom is uncertain, though it is probable that the young fish take them at the bottom, from the fact that large quantities of mud are found associated in the intestine with the remains of the crustaceans.

Adult sturgeons are frequently encountered, in the intestine of which the broken fragments of the shells of mollusks, bivalves as well as univalves, are met with. Fragments of *Mytilus* and other brackish-water forms are found in the alimentary tract of such individuals. This dietary is sufficiently indicative of the mode in which the animals take their food, and it is probable that annelids, nemerteans, etc., also enter largely into the dietary of these fishes. I have also met with the remains of earth-worms in the intestine of young sturgeons.

The mechanism by means of which the sturgeon is made aware of the presence of the living forms at the bottom consists of a transverse row of four pointed, highly sensitive barbels, which are placed about half way between the tip of the snout and the mouth. In the young these barbels are more slender and proportionally longer than in the adult, in which they present a series of transverse incisures or laminæ ranged side by side, and which are covered by a sensitive, tactile epithelium. This apparatus supplements the soft sensitive lobes which surround the entrance to the mouth more or less completely, and constitute a system of organs of touch by the help of which the animal is made aware of the presence of the living food at the bottom upon which it subsists.

The snout of the adult sturgeon appears to be used more or less after the manner of a digging implement. Mr. Elkington informs me that at Tampa Bay in Florida the schools of sturgeons may be observed near the shore digging up the soft bottom of shoal places with their snouts. The object of such a habit would seem to be the search for half-buried mollusks, annelids, etc., which are doubtless swallowed, together with more or less dirt, as we saw in the case of the amphipods taken by the young animals. My informant also stated that the Florida sturgeons had a shorter, more recurved snout than those of the Delaware. Whether this difference is merely varietal, or whether it is indicative of the existence of a different species in Florida can not be determined without specimens from there for comparison. It is barely possible, judging from the rarity of *Acipenser brevirostris* in the Delaware and its small size, that that species reaches its greatest development farther to the south. *A. brevirostris* is not of any commercial importance in the sturgeon industry of the Delaware, for, amongst the many hundreds of *A. sturio* which I saw at Delaware City, no specimens of *A. brevirostris* were taken either for the sake of their roes or the flesh. The shorter, plumper build, and blunt snouts of the Florida form noted by Mr. Elkington would agree very well with the view that the species there met with is the true *A. brevirostris.*

The habit which the sturgeon has of jumping up out of the water at an angle and projecting the body through the air for some distance is probably of the same nature as that of the gar-pike, which rises to the surface for the purpose of taking air into the complex, lung-like air-bladder. The sturgeon has been known in leaping to jump into small boats, and in one instance, Mr. Reeves, of Delaware City, informed me that a large individual had actually jumped from the water high enough to go through one of the dead-lights, near the water's edge, in the hull of a passing passenger, side-wheel steamer, and thus find itself an unexpected prisoner in the hold of the vessel.

The habits of the female during the spawning season are probably somewhat peculiar, and, it may be, quite characteristic. Those which had spawned and were observed by the writer exhibited a remarkably flabby, or empty appearance of the abdomen. After their ova have been discharged the spent females are known amongst the sturgeon fishermen of Delaware City as "slunkers," and are of no value to them for caviare, but for the flesh only. Later in the season these same spent roe, or "cow fishes," as they are called in the local vernacular of the fishermen, recuperate and become again quite plump, acquiring considerable additional weight. They are then more highly prized for their flesh than during the spawning season.

The roe fishes seem to get rid of their eggs by rubbing the belly against hard places on the river bottom. This would seem to be the case judging from the inflamed appearance of the skin covering the abdomen of spent fishes. This irritation of the skin may arise as the result of an attrition of the abdominal walls against hard places on the river bottom, or possibly it is induced by attrition with the surface of the bodies of the males, two or more of which are said to follow the females, according to Russian writers, the males pressing against the abdomen of the female, thus favoring the extrusion of the eggs and at the same time discharging their own milt to fertilize the ova.

As the season advances the spawning schools move upwards from the salt waters of Delaware Bay and in the neighborhood of Fort Delaware and Delaware City, 45 miles south of Philadelphia, where they pass into brackish or nearly fresh water. From this point southward 20 miles, and northward as many more, it is probable that a large part of the spawning now occurs. Those that escape the meshes of the hundreds of sturgeon nets which are every day stretched across their spawning grounds go farther north to get rid of their burdens of ova. Many more are deprived by the fishermen of the privilege of thus unburdening themselves, and are taken to the killing and butchering floats at the wharves of the dealers along the river at various points where the nearly ripe roe is removed for the purpose of being made into cavaire.

The upward movements of the schools seem to be affected to some extent by a rise of the prevalent temperature of the water and air, thus making the fishing for the time more profitable. Conversely, a decline in the prevailing temperature is often apparently followed by a diminution in the numbers of fish on their way up the river, and a cold, late season retards the appearance of the fish from the salt waters farther south. A very rainy season, which has caused an unusually abundant flow of fresh water down the river, also interferes with their early appearance in the waters above Delaware City. This is supposed to be due to the fact that the water becomes fresh farther south than usual where the schools then remain to discharge their spawn. The fishing season at Delaware City is at its height during the months of May and June, but fish are caught during the summer and autumn and until as late as September and October.

The spawning fish or "runners" (those with the eggs set free from the ovarian follicles and lying loose in the abdominal cavity) are usually most abundant about the middle or end of a "run" or school of fish. The period during which the most spawning fish have been observed at Delaware City is during the month of May, especially the last half of the month. It is then that the greatest success may be looked for in getting the eggs for purposes of artificial incubation in large enough quantities to make such an enterprise important from an economical point of view.

The young sturgeons, which are found in certain places in the river in such numbers as to be a great annoyance to the shad and herring fishermen, in whose nets they become entangled, are found mostly over certain kinds of rather firm bottom not far from the shore, where they may be supposed to feed, and where they are known to pass the greater part of the year. In none of the young sharp-nosed forms of *A. sturio* have I been able to find any evidence of a fully developed roe or milt, and I infer that the anadromous or migratory habit is probably not developed until the reproductive powers are fully matured, when the migratory impulse assumes control of the movements of the animal. The young immature fish have been taken from under the ice in the river in mid-winter, indicating that they remain in the fresh water the whole year.

The young of the common sturgeon reaches a length of about 3 feet before it begins to lose to a marked degree the sharp or acuminate snout which gives it such a characteristic appearance, and which has misled not only naturalists, but fishermen also, into the belief that these sharp-snouted forms were a distinct species. Naturalists as well as fishermen have bestowed names upon the young fish in the belief that they were specifically distinct from the large fishes.

The mature fishes seek a hard bottom upon which to deposit their spawn in from 1 to 5 fathoms of water. Except when leaping out of the water and when moving upstream rapidly they do not seem to habitually rise to the surface. The tendency of the fish to seek the bottom is taken advantage of by the fishermen in the construction of their gill-nets, the cork line of which is not made to come to the surface, but the wooden floats are attached to cords so as to leave the upper edge of the net about a fathom below the surface. The nets of about 300 fathoms length and 3 to 4 fathoms deep are laid out from sail-boats specially constructed for convenience in stowing and liming the net in a slightly raised compartment at the stern. The fishing is done during the day-time on the Delaware, each boat being manned by two men, who put out their net at the beginning of flood-tide and drift upstream. The net is fished during slackwater, and the fish are hauled on board by means of stout, long-handled hooks made of five-eighth inch round iron. The fish usually reach the wharves at the beginning of ebb-tide, and are usually alive if they have not been too much exposed to the sun. The fish as soon as they are gilled make but little effort to get free, being singularly tractable and manageable in spite of their great size, individuals of from 9 to 10 feet in length being sometimes taken. The most usual size of the "cow fishes" or females is about 8 feet, and they are also stouter and longer than the males, which are usually shorter and more slender, ranging in size from 6 to 7 feet, with a slightly more narrow head, as is shown in the accompanying plates.

The meshes of the nets used in gilling the sturgeon measure 8 inches on a side, or 16 inches across, when stretched taut. These nets will gill fishes ranging in length from about 5 to 10 feet. The smaller blunt-nosed sturgeon, *A. brevirostris*, is never taken in these large-meshed gill-nets as far as I am aware, and, judging from the advanced condition of the reproductive organs in individuals only 20 inches in length, it is probable that it never reaches a great size in the Delaware. Upon special inquiry of old fishermen, I was not able to hear of any specimens of the short-nosed species being taken which had measured over about 3, or at most 4 feet. In such cases the females of this darker-colored, short-nosed species were found to have mature roes.

11. THE SPAWNING FISH.

The majority of the roe fishes which are brought in to the butchering floats are not quite ready to spawn. The nearly mature roe of such fishes is hard and firm, and the eggs have not yet ruptured the walls of the follicles and escaped into the general cavity of the body. The roes of such individuals are known to the fishermen and caviare dealers as "hard roe." The hard roe, as it is called, is the kind most prized by the packers of caviare.

Occasionally fishes are taken in which the roe is quite immature. In such cases it is smaller in quantity than the kind mentioned in the preceding paragraph, and is worthless for caviare.

Another kind of roe is that which is the most valuable to the fish-culturist. This sort is the kind which is just mature and ready to be artificially fertilized. Most of the eggs of the ripe roe have ruptured their follicles, and as soon as the abdomen is cut open the ova escape in great quantities, to the amount of several gallons in the case of a large fish. The quantity of eggs yielded by a single fish may, in fact, vary between 5 and 15 gallons. Estimating by the number of pailfuls of hard roe, each holding 3 gallons, it may be assumed that the average is about 10 gallons. This is a fair estimate, as the average is probably a little above three pailfuls, each holding 3½ gallons. The eggs measure 2.6^{mm} in diameter, or a little less than one-ninth of an inch. At this rate we should find about 168,000 eggs to the gallon, and a total of from 800,000 to 2,400,000, according to the amount of roe in a single fish estimated in gallons.

The eggs, when in exactly the right condition, are globular, nearly a ninth of an inch through, and vary in color from a very light brown to a very dark brown. At one side a darker round disk may be observed, the diameter of which is about one-fourth of the circumference of the egg. This disk is also quite as visible in ova which have not yet escaped from the follicles in which they were developed, as in the "hard roe," for example. The darker discoidal area is the germinal area of the egg of the sturgeon, and is the point where development first manifests itself to the unaided eye through certain changes in its shape.

The eggs of the kind above described should retain their globular form, like so many shot, and should show no signs of adhering to each other. If the round area at one side of the eggs should appear distorted or broken, it is also a sign that the eggs are probably worthless for fertilization.

Eggs with a round disk, if they flow freely from a slit cut through the walls of the abdomen of the recently caught living fish, may be fertilized without difficulty, provided a ripe male is at hand. Eggs which do not answer to the requirements given in this paragraph it is not worth while to waste time over.

It frequently happens that running or ripe fishes are brought in which have a great abundance of loose eggs in the abdominal cavity, which are entirely worthless for purposes of fertilization. Upon examination, it will be found that in such cases the eggs either have the discoidal germinal area distorted and injured, or else many of the ova have had their thin covering or zona radiata ruptured, and the yolk has been crushed and has escaped as a slate-colored substance. This rupture and injury to the eggs is due to the entrance of water from the outside, through the oviducts and genito-urinary passages, into the body-cavity, the presence of the water causing the glairy, adhesive coating to set or harden, and with which all the ova are covered upon leaving the follicles in which they were matured. This hardening of the mucigen which covers the eggs, in the presence of water, and while still with the body of the mother fish, will cause the bursting of the egg-coverings if such fish do not get the chance to discharge their eggs at once, or happen to be roughly handled in the boats, as the ova adhere in great masses, the breaking or crushing of which also ruptures the individual eggs of which they are composed. Such roes are of no service whatever as a source of supply for purposes of artificial fertilization. Roes of this kind may be at once distinguished by their sliminess and the slate colored appearance of the contents of the broken eggs.

Another type of roes are those of the entirely spent fish, which has discharged all of its mature eggs. The roes of such fishes are no longer brown, and the leaflets of which they are formed are made up of very small pinkish or pale, and very young ova. Such fishes may be distinguished by the flabby, collapsed, or shrunken abdomen, since the remnant of immature roe left behind in the body-cavity is hardly a tenth part of the volume of the ripe ovaries as seen in fishes with mature or "hard roe." The remnant of the roes of a fish which has only recently got rid of its burden of eggs looks ragged when the ovary is wetted and floated out with water; this is due to the presence of the collapsed leaflets formed of the vascular and cellular tissue from which the ova have escaped. These leaflets of the roes are disposed transversely on either side of the mesentery, or thin membrane, which fastens the alimentary tract to the middle line of the dorsal wall of the body-cavity.

While the nearly mature roes of the females are relatively of great size—greater in fact than any other viscus of the body—they are also usually dark in color, as may be gathered from the figure in Plate LI, showing the roe exposed. The color of the nearly mature or "hard roe" is also subject to some variation. Occasionally fishes are found in which the roe is quite pale, and hardly darker than the other viscera. This is due to the nearly complete absence of pigment granules in the yolk of the individual eggs, the pigment being diffused in fine particles throughout the substance of the egg of the sturgeon, somewhat as it is throughout the ovum of the batrachia. The next grade of coloration of the roe is a very much darker one; brownish, with a decided shade of gray or lead color, when the roe is viewed as a whole. This last-mentioned shade of roe, which is quite common, is known as "light roe" amongst the packers of caviare. Several gradually darker shades may be recognized between this last-named variety and the next, or the quite "dark roe" as it is called by the dealers, who are careful not to mix the lighter and darker kinds together in the manufacture of caviare; the reason for which is, that the light and dark eggs when mixed together give to the caviare so prepared a "pepper and salt" appearance which is not considered desirable by dealers.

These differences in the color of the roes is wholly due to the presence of more or less pigment in the individual eggs. The germinal area or disk of the eggs of the dark roe is almost black, while in the light roe this area is not so dark, and there is a distinct dark dot or spot in the center which is surrounded by a light zone, outside of which there is a much darker superficial ring of pigment which marks the edge of the germinal area.

The internal reproductive organs or testes of the male sturgeon are not nearly so large as the roes of the females, which may vary in weight from about 50 to as much as 120 pounds. The testes probably never much exceed 10 or 15 pounds in weight, and are cream-colored, with a shade of pink, instead of having the dark tint which characterizes the roes of the females. The form of the testes is that of a compressed irregular series of bodies, separated from each other by narrow constrictions, and present as paired organs on either side of the mesentery. In cross-section the segments of the testes are oval, the mature, sexually active organs being nearly 2 inches thick and 3 to 4 inches wide, and extending for a distance of 18 inches to 2 feet on either side of the body-cavity. The transverse subdivisions of the testes is subject to variations in different individuals, some having them subdivided into a greater number than others.

When the testes are mature, upon cutting them across, the larger ducts will be made apparent from the readiness with which the milk-white, viscid seminal secretion escapes from their cut ends. The testes may be removed from the living male and the semen, or milt, pressed from the fragments, especially from the larger ducts found along the dorsal border of the organ. I have upon two occasions tried to fertilize the eggs with milt pressed from fragments of the testes, but without success; yet this experience is not to be taken as conclusive that it may not be done. In both cases the ova which were at my disposal were probably not in condition to be fertilized. Where large numbers of the eggs of the sturgeon are to be fertilized, I think that it may be necessary to resort to this method, as I find that it is somewhat difficult to press out much milt from the testes by means of pressure upon the abdomen of the sexually mature male. If the abdomen is firmly pressed with the foot, accompanied by a firm backward stroke of the leg, a few drops of a milky secretion are forced out of the genito-urinary opening just behind the vent. The secretion forced out in the manner described is thin and watery, not being much more consistent than skimmed milk, whereas the secretion from the ducts of the testes is intensely white, glairy, and viscid, but readily breaks up and thins out in the presence of water to form a milky mixture, swarming with spermatozoa. The only successful results in fertilizing the eggs were with the thin milt forced out from the abdomen and testes by pressure and strokes upon the abdomen with the foot, though there is no reason why good results should not be obtained by pressing the milt from fragments of the testes, in the same manner as the spermatozoa of the oyster, star-fish or of worms are obtained, when it is desired to artificially fertilize the ova of these forms. That good results may be thus obtained in dealing with the milt and eggs of the sturgeon I have no doubt whatever, since the only good lot of eggs which I had the opportunity of successfully fertilizing was one batch which were removed from the old fish by cutting open the abdomen.

In practice I should recommend such a method of pseudo-Cæsarean section above every other, because in attempting to forcibly press out the ova of the sturgeon through the genito-urinary passages I believe that they would probably be far more liable to injury than if removed from the old fish by slitting open the belly.

In getting all the eggs out of the abdominal cavity, I would suggest that the abdomen of the live fish be slit open in the median line, and its head raised so that the eggs may be run out into large pans to a depth of 2 or 3 inches, a little water added and the live milt put with them and gently stirred about with a feather so as to mix the eggs and milt. The very important steps which must *immediately* follow the removal and fertilization of the ova are very important and may be stated under the head of

12 HANDLING THE EGGS.

Not more than twenty minutes should be allowed to elapse after the time the milt and eggs are mixed together till they are spread upon cheese-cloth trays, one egg deep, or in a single layer. If this is not done immediately the eggs will stick together in large masses, causing those at the center of these masses to be asphyxiated for want of oxygen, which under such circumstances cannot find access to them. Other equally serious evils follow from allowing the eggs to adhere together in large masses, and the principal one is that if such masses are irregular and of any size, if broken, the eggs along the line of fracture of the mass will be broken and destroyed.

It is therefore very important that a large number of trays properly constructed be at hand upon which to spread the eggs if any extensive hatching operations are to be conducted. The eggs will adhere very firmly to the surface of the cheese-cloth in a few hours, after which further watchfulness is necessary, in order to keep down any fungus which may appear upon the dead eggs, of which there will always be some. It may be possible that panes of glass would serve the same purpose as the cheese-cloth trays, if a current of water were allowed to flow very slowly between a superimposed series of glass plates properly disposed in a trough.

The experience of European investigators, Knoch, in 1871, being amongst the earliest, has been the same as that of myself in finding that the ova of the *Acipenseridæ* were adhesive. Knoch worked with the eggs of *A. ruthenus*, or the sterlet, and his account of the adhesiveness of the eggs of that species agrees closely with my own.

I find that the ova are more or less adhesive immediately upon their removal from the abdominal cavity, so that if one tips for an instant a vessel to one side in which the eggs are contained they at once form a coating of a single layer over the surface to which they have been thus momentarily exposed. Upon admixture with water the adhesive material with which the eggs are covered seems to be dissolved somewhat and becomes diffused through the water, so that the whole becomes ropy. If a lot of the eggs is taken up in the hand from the water glairy filaments formed of the ropy solution will trickle down between the fingers, and if the wind is blowing these may be drawn out for the length of 2 feet or more.

This glairy or ropy character of the partly dissolved coating of the eggs persists for some time, usually for thirty minutes or so, after which time the glairy substance hardens or coagulates in the presence of the water and the gases held in solution by it. In process of hardening the glairy, sticky coating of the eggs firmly fastens them to whatever they are brought into contact with, and after that has occurred it is scarcely possible to detach them without injury to their delicate, thin envelops and their soft, viscid contents, consisting of yolk substance and protoplasm. The sticky coating of the eggs finally remains as a grayish-white, tough, slightly elastic covering enveloping the egg membrane proper, and varies in thickness at different points on the surface of the ova. It is also the material which will cause the eggs to adhere in clusters or masses, sometimes as large as a man's head, if they are left together in large quantities in a vessel with a little water.

The trays used at Delaware City, on board the steamer *Fish Hawk*, were made by tacking cheese-cloth to light wooden frames a foot wide and 18 inches long, then loading the edges of the frames with strips of sheet lead to keep them immersed. These trays placed on ledges in a superimposed series, in a trough through which the water is allowed to flow gently, is a very efficient hatching device. Floating hatching boxes with brass wire gauze bottoms and small openings at the sides covered with the same kind of gauze have been successfully used by the Germans, one having been brought from Germany by Mr. S. Feddersen, of Port Penn, Del., from Hamburg. This device is quite simple and was placed at my disposal through the courtesy of Mr. R. Anderson, of Delaware City. It seems to me very well adapted for the purpose for which it is designed.

The floating box in which the writer succeeded in hatching out a batch of the eggs of the sturgeon was exceedingly simple in construction and consisted of a soap box with the top and bottom removed, the bottom for which was then replaced by tacking cheese-cloth to the lower edge of the rim, and by nailing wooden strips to serve as floats to the sides of the box, a very efficient hatching device was extemporized. These boxes so modified were placed at the edge of the large fresh-water pool near the extreme eastern end of the Chesapeake and Delaware Canal at a point where there was a constant flow of fresh water under them. The only lot of fertilized eggs which the writer succeeded in obtaining were spread on the bottoms of these boxes and left to hatch. In six days from the time of fertilization the young fish made their appearance. The rapid appearance of a parasitic fresh-water fungus, however, caused such extensive mortality amongst the eggs that very few embryos survived to escape from the egg membranes. This fungus, which appeared to be a *Saprolegnia*, is developed from spores which seem to be almost everywhere present in fresh water. The mycelium spreads very rapidly, attacking dead eggs first, and spreading from them to the live ones, which are then invaded and killed or asphyxiated by the fungus. The only way in which this pest can be kept down is to go over the trays and with a small forceps pick off the dead eggs and keep the living ones as clean as possible. Where the work of propagation was being conducted upon a large scale the attendants would probably have to be very vigilant in their attention to the eggs in order to keep the fungus under control.

The method of incubating the eggs upon trays of cheese-cloth, will enable the attendants to readily handle the attached eggs in shallow troughs of running water, and in a good light all the dead eggs or those with any fungus attached may be very readily removed. With close attention to the details of the work of propagation very important results might be attained and the work of restocking the Delaware and other streams might be undertaken with a very fair prospect of success. This view I think may be assumed as fully warranted when it is remembered that as many as 800,000 eggs may be obtained from a single fish. These would cover fifty trays measuring 12 by 18 inches, or about 75 square feet of surface.

This large number of trays might be operated in a small space in troughs aboard a vessel adapted to fish-hatching or the trays might be placed in wire cages to keep out predaceous fishes, insects, etc., and partly sunk into the water in such a place as the fresh water pool near the canal lock at Delaware City. With a small pumping engine the supplies of fresh water might be supplied for the purpose of cleaning and overhauling the eggs in a small building near by which might be provided at a slight expense for this purpose.

13. OBTAINING THE EGGS.

The best source of supply for eggs the writer has found to be the live fish which are brought to the Delaware City butchering floats, directly from the gill-nets. These fish, if they have been handled with a slight amount of care, will be found alive and in condition to yield living spawn. Two precautions may be taken by the fishermen which will be of great service in keeping the fish alive in the boat. These are to cover them so as to keep the sun off, and to occasionally sprinkle the head with water to keep the gills wetted. As an inducement to the fishermen to take extra precautions with the fish it might be found expedient to offer them the same compensation for a fish with good ripe roe, suitable for fertilization, as they could get for a hard roe from the dealers in caviare. In order to get the male fish in good condition it might be well to offer an equal consideration for a male with flowing milt. Fishes of either sex would then be handled by the fishermen with such care as to aid largely in guarantying the availability of their spawn.

It has also been suggested that the spawning fish be "haltered." The haltering is accomplished by passing a rope through the mouth and gills and tying the animal to a boom or post near the shore. The difficulty in that case is the ease with which lampreys and eels attack the sturgeon; besides, it is said that the eggs of such fishes as have been haltered or kept in confinement become valueless for purposes of fertilization. Such, at least, has been the experience of the Russian investigators who have undertaken to obtain their supplies of embryo from fishes kept in confinement. It is probable that the eggs of the sturgeon, as has been found in the case of the clupeoids or herrings, when kept in confinement, become disorganized and incapable of fertilization. In the case of certain members of the herring family, the mature eggs of fishes kept in confinement undergo such changes of disorganization as to be readily noticeable under the microscope. This singular effect of confinement upon the ripe eggs in the roes of fishes has been supposed to be due to fright. Such an explanation of the fact would seem to find some confirmation in the circumstance that many feral mammals when placed in confinement refuse to breed and become practically sterile.

Judging from the number of live spawning fishes brought into Delaware City, Port Penn, and other places on the Delaware, there is but little doubt that several millions of ova for hatching purposes might be obtained each season by vigorous and faithful exploitation of all the sources of supply. To get the eggs will require that spawn-takers be distributed to each of the principal points where the caviare is packed and to closely watch the character of the fish as they come in and to immediately take the spawn in pans. If no mature or milting males are at hand the eggs are, of course, of no value.

Owing to the great size and weight of the fish, taking the spawn from them directly in the sturgeon boats of the gillers will be found impracticable, since there would be too little room in which to work comfortably; besides, the fishermen would object to having their boats littered with the adhesive eggs, which stick to everything with which they come in contact.

Pennsgrove, Port Penn, and perhaps other points besides Delaware City, will be good points to operate, provided the water is not too brackish, which is greatly dependent upon the season, the river, as remarked before, being fresh much farther south during one season than during another.

Important aid has been promised the agents of the U. S. Fish Commission by the State commissioner of New Jersey, and I have found that intelligent fishermen and caviare packers were also very ready to lend valuable assistance at Delaware City. Amongst those at the latter place to whom I have been under great personal obligations I must not omit to mention Mr. Reuben Anderson.

14. METHODS OF STERILIZING THE WATER USED IN HATCHING THE STURGEON.

Our experience with adhesive eggs of all kinds has always shown that it is difficult to prevent the lodgment and rapidly fatal germination of the spores of *Saprolegnia* or *Achlya*, genera of fungi or moulds, found in all fresh waters upon dead as well as living fish eggs, and the rapid and fatal spread of the mycelium from affected to unaffected ova. So rapidly does this fungus grow that in a very short time its ravages will extend over an entire tray of adhesive eggs, so that in the course of four or five days the whole lot will be found to be covered with a mycelium, which by that time has not only passed into the fruiting or spore-producing stage, but has completed its work of destruction.

The eggs are destroyed by the fungus sending filaments into their substance, while the mesh of the mycelium also affords lodgment for dirt, so that the two together effectually shut off the possibility of oxygenating the ova, so that they are smothered. The ova so affected are finally appropriated as nutriment by the fungus, which rapidly produces its spores or germs in vast myriads, only to pollute the water still more plentifully with its destructive germs.

How to prevent the inroads of this pest is a matter of the very highest importance, since upon the successful solution of this difficulty depends the success or failure of the artificial propagation of the sturgeon from artificially fertilized ova.

My experience with eggs of the sturgeon at Delaware City proved that they were particularly subject to the destructive attacks of this type of fungus, and that unless some practical method was devised of overcoming losses from this cause it would be of little use to attempt to do much in the artificial propagation of this fish. In the course of about five days the eggs, which were placed on the cheese-cloth bottoms of the floating hatching boxes, which I had arranged in the large fresh-water pool connected with the eastern end of the Chesapeake and Delaware Canal, were for the most part attacked so as to be beyond the possibility of rescue. Not more than about 5 per cent. of the whole number were by that time free from the parasitic fungus, so that those which survived to hatch on the sixth day were very few in number.

A serious difficulty was also encountered in the firmness with which the affected eggs adhered to the cheese-cloth and to the good ones, so that it was found to be very hard to remove the damaged ova without injury to the good ones in attempting to thus prevent the spread of the scourge. In consideration of this circumstance the only practicable remedy seems to be prevention; that is, the germs of the fungus must be removed from the water used in treating the ova when they are fertilized and in hatching them. Or, the water used in fertilizing and hatching the eggs must be sterilized. Of these two methods the first seems to be the simplest and easiest of application, since the spores of the *Saprolegnia* are comparatively large, so that they may be removed from the water by a system of filtration.

If a system of cotton-wool filters were attached to the supply from the pumps in such a way that the water could be continuously forced through one of a series of filters, while others of the system were being cleaned and renewed, it would probably be possible to get the water used in the hatching operations free from the noxious spores or germs of the fungus. This plan would not involve the expenditure of any additional steam-power and but little additional labor and expense. The hatching troughs, with their trays of eggs, would of course have to be provided with tight-fitting covers to exclude the dust and possible contamination from the air.

Another more expensive but perhaps more thorough method would be the sterilization of the water used in the hatching operations. This could only be accomplished by means of heat, supplied by the superheated steam from the boilers of the pumping-engines conveyed into a closed iron chamber with an outlet for the condensed steam. Through a coil of pipe placed in this heating chamber, the water used in the hatching operations would be forced and heated up to a point in its passage through the coil at which the germs of the fungus would be killed. The heated water for hatching would then have to be passed through a second coil, submerged in the cold running water of the river, to again lower its temperature to that of the water before heating, after which it would be safe to let it flow over the eggs. The water if heated in this way, however, might be so deprived of air which it had contained, that it would be necessary to aerate it. This could probably be done by allowing it to flow under pressure from fine nozzels in a fine spray, so as to carry air into the water in the tanks, the nozzles being so disposed as to have their outlets elevated several inches above the surface of the water, in the same manner as the water is aerated for the aquaria at the Central Station of the U. S. Fish Commission at Washington, and in the hatching rooms in the laboratory buildings at Woods Holl, Mass.

Another method which suggests itself, is to force the water for purposes of sterilization through a coil of copper pipe, suspended over a furnace grate arranged somewhat after the manner of a Herreshoff steam coil-boiler, then conveying the water through a second coil submerged in running water at the ordinary temperatue, and then through an aerating apparatus similar to that described above, to fit it for hatching purposes.

These methods if carried out rigorously will assure the success of hatching out the eggs of the sturgeon to the extent of many millions, so that the chances of survival of great numbers of protected young may be reasonably counted upon, and thus enable the Fish Commission to increase the source of a good supply, the value of which can only be appreciated by those who have investigated the magnitude of the sturgeon fisheries of the United States, and the large annual value of the caviare now very extensively exported to Europe.

15. SKINNING THE STURGEON AND PREPARING THE FLESH FOR MARKET.

Except the eel and cat-fish the sturgeon is one of the few fishes which is skinned and dressed before it is sent to market. Attempts have been made to convert the skin of the sturgeon into leather; the microscopic structure of the integument of this animal is in some respects very favorable to its conversion into leather, since the deeper layer of the skin contains a great abundance of fibrous tissue. The presence of the great dermal bony bucklers or scutes, however, interferes with the necessary processes of manipulation in tanning, so as to leave holes in the tanned skin. These bucklers are so firmly embedded and form such an integral part of the skin that it is not probable that it can be successfully or profitably converted into leather.

The fish, when brought in to the floats to be opened to remove the caviare and dressed, are laid upon the side and the operator proceeds to cut about eight short longitudinal slits in pairs on either side of the middle line in the inferior part of the abdominal walls. These are very quickly made by thrusting the point of the butcher's knife through the abdominal walls with a rapid stabbing motion.

The abdomen is then slit open along a line midway between the four pairs of short slits, from a point just behind the inferior part of the pectoral arch backward to the anus. The short slits which are thus left near the edges of the great flaps formed by slitting open the abdomen, serve as "hand holds" and assist in a most important way in removing the skin, which is removed from the flesh of the trunk and anterior caudal region by freeing it first along the ventral and lateral region and at last along the back.

The head is removed with a cleaver, cutting through the fore part of the trunk and so as to remove the lower part of the pectoral arch and pectoral fins. The tail is also cut off across the narrow peduncle. The tail is often cut off first in order that the fish may bleed freely from the caudal aorta and die quickly, as the powerful tail, if the fish is still alive and struggling, may strike the operators disagreeable or even dangerous blows. The heads, tails, skins, and viscera are carried off from the floats, where the fish are dressed, by small vessels which gather this offal and take it to guano factories where the oil is extracted and the remaining flesh, bones, and cartilage dried for the purpose of converting it into guano.

After the removal of the skin the carcass of a large female sturgeon will weigh about 100 pounds, usually somewhat less. The value of the dressed carcass varies, according to the condition of the market, from 3 to 10 cents per pound. The dressed carcasses are packed in ice for shipment in the usual way. When the shippers are waiting for advance in the price the eviscerated carcasses with the heads and tails removed are packed in their ice-houses without removal of the skin. This is done because it has been found that the flesh keeps longer and in better condition in ice, under those circumstances.

16. THE MANUFACTURE OF CAVIARE, AND THE VALUE OF THIS INDUSTRY ON THE DELAWARE.

The "cow-fish" with "hard roe" is the only kind that is available in the manufacture of caviare. In this type the roe is firm and the individual eggs are sufficiently resistant, with their double covering consisting of the egg-membrane and the investing vascular follicle, not to be readily ruptured and discharge their contents while being separated. The roe is carefully removed from the abdominal cavity so as to not bring it in contact with water, and as soon after the capture of the fish as possible. From three to five pailfuls of roe, each holding 3½ gallons of eggs, are removed from a single fish. This includes the investing membranes of the ovary, the vessels, and supporting tissues of the organ. These portions are in reality a very small part of the organ, so that there is but little waste from this source. This waste from the sturgeon roe is a favorite bait with fishermen who fish for eels, the eel-pots being baited with this refuse by the fishermen operating near the caviare packing establishments.

The process of "rubbing the roe," as it is called, is very simple. The fresh masses of roe are placed upon a screen, which fits over a zinc-lined trough 18 inches deep, 2 feet wide, and about 4 feet long, and with its bottom sloping to one end, where an outlet is arranged. The meshes of the wire screen are just large enough to let the separated eggs fall through as the masses of ova are rubbed back and forth over it by the operator. The separated ova fall into the trough and are drawn off at one end through an opening closed by a sliding door into clean half-barrel tubs. After the roe is brought into the condition in which the eggs are all separated a certain proportion of the best German salt, from Lüneburg, is added and carefully stirred in with the eggs in the tubs. The manipulation of the eggs is done altogether with the hands, and at first, when the salt is added to it, the effect is to dry the mass, but very soon the strong affinity of the salt for the watery constituents of the ova causes it to abstract their water and a brine is formed which soon becomes so copious that the contents of the tubs may be poured. The brine, formed as above, appears in about ten or fifteen minutes after the salt is added. The salted eggs are then poured into sieves which hold from 8 to 10 pounds of the salted eggs. These sieves, with their contents, are then placed upon sloping planks with a strip nailed on each side in order to drain off the brine. After several hours the draining is completed and the product is the caviare of commerce. From the sieves the caviare, as the separated and salted ovarian eggs are henceforth known, is transferred to small, oaken casks, holding about 150 pounds apiece. Into these casks the caviare is carefully packed so as to fill the vessel completely, and when closed is ready for the market.

Careful packers keep the dark and the light varieties of roe separate, since mixing the two gives a speckled appearance to the product which is not desired by the dealers. Cleanliness in handling the product is also insisted upon by experienced caviare packers. The finest caviare made in America goes to Europe; the inferior grades are retained for the less critical home market. The import duties paid to the German Government by packers of the American product is about 18 cents a pound, and the amount of the tax thus paid into the Imperial Treasury of the German Empire must be considerable, since a single dealer, operating on the Delaware during the season of 1888, put up about 50 tons of it for the German market. The principal port of entry for this product into the European market is Hamburg.

The caviare produced from the lake sturgeon (*Acipenser rubicundus*) is said to be the best, the eggs being somewhat larger than those of the common species, *A. sturio*. The whole of the caviare produced upon the eastern coast of the United States is made from the roes of *A. sturio*, the short-nosed species, *A. brevirostris*, not being found in sufficient numbers or size to make it an object to collect its roes for caviare. Caviare is also prepared from the *A. transmontanus*, white sturgeon, Columbia River, or Sacramento sturgeon as it is variously called, although this industry is not yet conducted upon so extensive a scale upon the Pacific as upon the Atlantic coast. The roe of the green sturgeon, *A. medirostris*, of the west coast, does not seem to be used for caviare. The white sturgeon is the largest, rivaling in size the common eastern sturgeon, while the lake sturgeon is smaller, not usually much exceeding 100 pounds in weight.

On the eastern coast the Delaware River and Bay is now the principal resort of the common sturgeon and the seat of the only profitable fishery of this species, unless the Florida sturgeon should prove to be the same form. The amount of capital invested in boats, nets, and small sloops engaged in this business on the Delaware is very considerable. The experience of the dealers and fishermen shows that a steady falling off has occurred in the catch within a few years. This, coupled with the circumstance that the fishery is now only profitably conducted south of Wilmington and that the Delaware now has the only profitable sturgeon fishery north of Florida, is sufficient to prove that it is high time that something was being done to stay the extinction of this fish. The total value and enormous yield of eggs of the Delaware fishery may be inferred from the fact that a single caviare packer collected and shipped, as stated above, about 50 tons of this product to Europe during the season of 1888. The great demand for the caviare has, within a very recent period, made the fishery profitable to the fishermen, many of whom own their boats and gill-nets. From all the information that I can gather, it is safe to assume that the annual value of the sturgeon fishery of the Delaware must be somewhere between $100,000 and $200,000 per annum. This industry may be maintained by prompt and efficient action, and to this end it is the hope of the writer that the foregoing account of experiments, results, and observations may successfully contribute. The only means of maintaining and increasing this industry is through the artificial propagation of this fish, which I have every reason to think may be successfully accomplished at a comparatively insignificant outlay.

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16. KOWALEWSKY, A., PH. OWSJANNIKOW, and N. WAGNER. Die Entwickelungsgeschichte der Störe. Vorläufige Mittheilung. Bull. de l'Académie Impériale des Sciences de St.-Pétersbourg, tome XIV, 4to, 1870, pp. 318–324. (Seven figures in text, relating to the early stages of development of *A. ruthenus*.)

17. LE SUEUR, C. A. Description of several species of chondropterigious fishes of North America, with their varieties. (Read October 17, 1817.) Transactions Amer. Philos. Society, New Series, vol. I, 4to, Philadelphia, 1818, pp. 383–394, pl. 12. (Contains the original figure and descriptions of two varieties of *A. rubicundus* or Lake Sturgeon; describes *A. brevirostris* for the first time, with three varieties, and *A. maculosus*. *A. oxyrhynchus* Mitch. mentioned.)

18. MONRO, ALEXANDER. The structure and physiology of fishes explained and compared with those of man and other animals. Folio, Edinburgh, MDCCLXXXV. (A beautiful work, illustrated with copper plates, of which those numbered VIII, IX*, and XL contain illustrations of the visceral anatomy of the Sturgeon, which have not been much improved upon since.)

19. MITCHILL, SAMUEL L. The fishes of New York arranged and described. Transactions of the Literary and Philosophical Society of New York, vol. I, 4to, New York, 1815, pp. 355–492, pls. I–VI. (It is assumed, pp. 461–462, that the Sturgeon of the Hudson River is the same as *Acipenser sturio* of Europe. The *A. oxyrhynchus* is first mentioned on pp. 462, 463, and it is stated that it is seldom over 5 feet in length. This statement and extracts from a letter by a Mr. De Witt, quoted by Mitchill, render it almost certain that the *oxyrhynchus* of this first American ichthyologist was founded upon the young of the common species.

20. OWEN, RICHARD. On the Anatomy of the Vertebrates. Vol. I, Fishes and Reptiles, 8vo, London, 1866. (Contains considerable information on the anatomy of the Sturgeon.)

21. PARKER, WILLIAM KITCHEN. On the structure and development of the skull in Sturgeons. Philosophical Transactions Royal Society, vol. 173, 4to, London, 1882, pp. 139–185, pls. 12–18. (Gives figures of the larvæ of *A. ruthenus*, supplied to the author by Professor Salensky.)

22. RETZIUS, GUSTAV. Das Gehörorgan der Wirbelthiere. 4to, vol. I, Stockholm, 1881. (The internal ear of the Sturgeon is very accurately figured in this great work.)

23. ROSENTHAL, FRIEDR. Ichthyotomische Tafeln. 2te Auflage, Berlin, 1839. (Plate XXIV represents the skeleton of *A. sturio*.)

24. SALENSKY, W. Zur Embryologie der Ganoiden (Acipenser). Zoolog. Anzeiger, I, Nos. 11, 12, and 13, 1878.

25. SALENSKY, W. Development of the Sterlet (*Acipenser ruthenus*). Two parts. Proceedings of the Society of Naturalists in the Imperial University of Kasan, 1878 and 1879 (Russian). See also Hoffmann and Schwalbe's *Jahresbericht* for 1878 and 1879, for abstracts in German.

26. SALENSKY, W. Recherches sur le développement du Sterlet (*Acipenser ruthenus*). Archives de Biologie, tome II, 8vo, Gand et Leipzig, 1881, pp. 233–341, pls. XV–XVIII. (Fully illustrated abstract in French of this author's work on the early stages.)

27. SEELY, H. G. The Fresh-water Fishes of Europe. 8vo, London, Cassell & Co., 1886, pp. x and 444, figures 215. (Recognizes ten valid species of Sturgeons in Europe. The illustrations are borrowed from the German work of Heckel and Kner, No. 14.)

28. ZOGRAFF, NIKOLAUS. Ueber die Zähne der Knorpelganoiden. Biolog. Centralblatt, VII, No. 6, May 15, 1887, pp. 178–183, and Nachtrag in same, No. 7, June 1, 1887, p. 224. (Discusses the palatine teeth of young Chondrosteans.)

29. ZOGRAFF, NIKOLAUS. Embryonale Rückenflosse des Sterlet. Biolog. Centralblatt, VII, No. 17, November 1, 1887, pp. 517–521.

30. ZOGRAFF, N. Material toward the study of the organization of the Sterlet. First series. In reports from the laboratory of the Zoological Museum of the University of Moscow, 4to, tome III, third series, Moscow, 1887 (Russian). (Some of the new results recorded in the above are contained in the two preceding papers by the same author. The outlines showing variations in the forms of the heads of the various species of Sturgeons found in Russian waters and the carefully prepared tables of measurements are doubtless an important contribution to the natural history of these fishes; but, unfortunately, the language in which the work is printed makes it inaccessible to naturalists and students speaking other languages.)

31. —— Article, "Sturgeon," Encyclopædia Britannica. Ninth edition, vol. XXII, pp. 611–612. (Illustrated by a finely executed figure of *Acipenser ruthenus*.)

18. EXPLANATION OF THE PLATES.

EXPLANATION OF REFERENCE LETTERS IN PLATES XXXVII TO LIX.

A, Vent or anus; *Au*, Auditory capsule.
B, Barbels; *Bf*, Branchial filaments; *BA*, Bulbus arteriosus.
Ch, Chorda or notochord; *Cop*, Copulæ; *CV*, Cuvierian duct.
De, Dentary ossification.
E, Eye; *EO*, Exoccipital scute.
F, Frontal scute; *F*, in fig. 51, membranous floor of aorta.
GB, Gall-bladder; *GR*, Genital folds or ridges; *G*, Genital opening.
H or *Ht*, Heart; *Hb*, primary cerebral vesicle; *Hy*, Hyoid; *HA*, Hepatic artery; *HM*, Hyomandibular bar.
I, Inner coat of intestine in fig. 47; *I*, *I'*, *I''*, intestine, and first and second loops of intestine; *i*, *ii*, *iii*, *iv*, *v*, branchial arches.
II, *V*, *X*, Foramina for second, fifth, and tenth cranial nerves; *IA*, Inferior arches of vertebræ.
KpL, Embryonic, cephalic mesodermal tissue.
LL', Right and left lobes of liver; *Ly*, Lymph cord of spiral valve.
M, Mouth; *M'* and *MK*, Meckel's cartilage; *M'''*, Mesentery; *M''''*, Bristle through opening in mesentery; *MD*, Muller's duct or oviduct; *MCA*, Anterior coraco-arcualis muscle.
N, Kidney or Wolffian body; also, nasal scute, fig. 45; *Na*, Nasal capsule.
O, Outer coat of intestine; *OE*, Œsophagus; *Or*, Orbit; *Op*, Opercle.
P, Pancreas.
PA, Abdominal pores; *PC'*, Transverse or pericardial septum; *PC*, Pericardial cavity; *PF*, Pectoral fin; *Pf'*, *Pf''*, Pre and post frontal scutes; *Pf*, Pectoral fin, in fig. 18; *PN*, Pneumatic duct; *PV*, Hepatic vessels; *Pl* and *PQ*, Palatopterygoid or palatoquadrate; *Py*, Pylorus.
R, Rostrum and rostral scutes; *Rm*, Adductor muscle of mandible.
S, *S'*, Spleen.
Sp, Spiracle; *Stf*, Rostral disk; *SV*, *SV'*, Spiral valve; *ST*, Stomach; *Sy*, Symplectic; *SF*, Spiral fold; *SO*, Supra-occipital scute; *Sp*, Neural spines.
UG, Urogenital canals or ducts.
V, Ventricle; *V'*, Nerves going to barbels; *VN*, Swim-bladder; *VF*, Ventral fins and their site in fig. 52; *VA'*, *VA''*, *VA'''*, Primary visceral arches in fig. 10.
WG, Wolffian ducts in embryos figured.

EXPLANATION OF PLATE XXXVII.

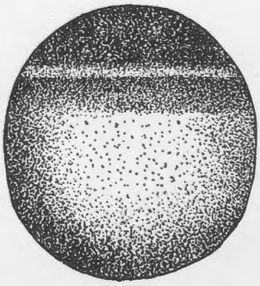
Fig. 1. Mature egg of the common sturgeon, enlarged sixteen times, dark variety, seen in profile, showing the dark germinal pole above with the light and dark rings around it.

Fig. 2. Mature egg, pale variety, of the common sturgeon, from the upper pole, showing the dark spot in the center of the germinal area in which the micropyles are situated, with a pale ring around them, beyond which comes a darker zone.

Fig. 3. Embryo of common sturgeon of ninety-six hours, showing rudiments of three visceral arches, the eyes, auditory organs, cerebral vesicles, and heart; enlarged sixteen times.

Fig. 4. Ventral view of an embryo of the common sturgeon in the egg, showing the front of the head and the flattened tail curled over the yelk-bag; slightly younger than the preceding.

Fig. 5. Egg of the sterlet at the completion of segmen'ation of the yelk. The smaller blastomeres at the upper pole represent the germinal or embryonic area. After Salensky.



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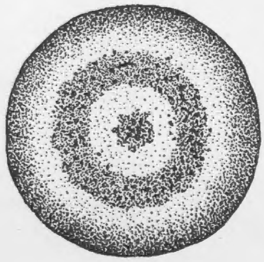

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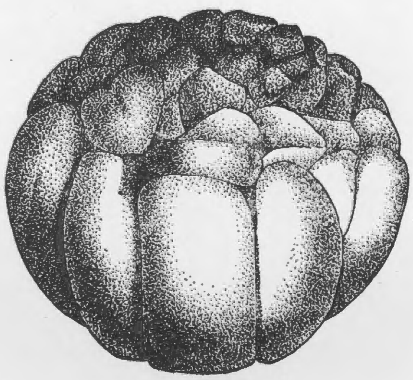

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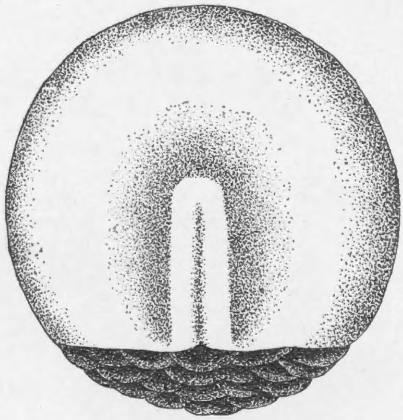
EXPLANATION OF PLATE XXXVIII.

Fig. 6. Egg of sterlet with the large yelk cells nearly included by the embryonic membranes. The embryonic area and medullary groove is distinctly defined. After Salensky.

Fig. 7. Still more advanced embryo of the sterlet, showing the medullary groove closing in the median line, and the blastopore at the lower pole. After Salensky.

Fig. 8. Dorsal surface of still more advanced embryo of sterlet. Cerebral vesicles differentiated, while the Wolffian ducts and five somites or segments of the trunk of the embryo are visible. After Salensky.

PLATE XXXVIII.



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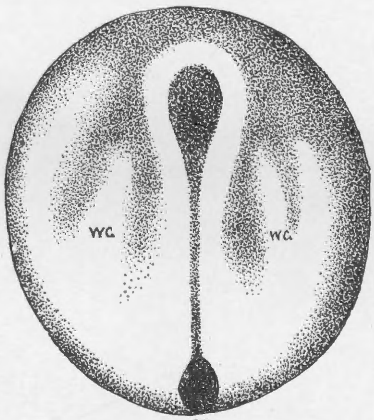

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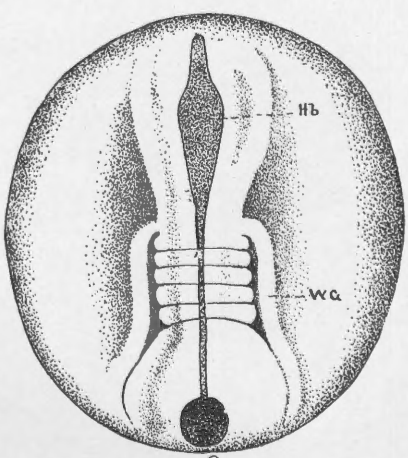

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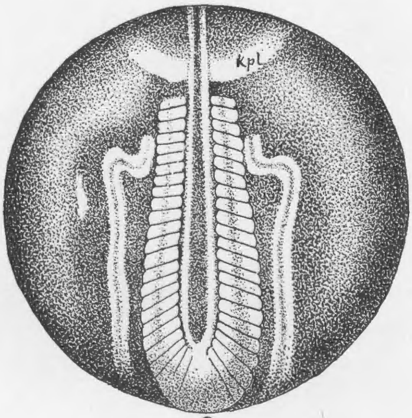
EXPLANATION OF PLATE XXXIX.

Fig. 9. Embryo of sterlet, still more advanced, after the closure of the medullary groove and formation of spinal cord; twenty-four embryonic segments visible and the two pronephric or Wolffian canals formed on either side, while in front (upper pole of figure) the cephalic plates of mesoblast appear on either side of the rudiments of the brain. After Salensky.

Fig. 10. Embryo of the sterlet, showing its anterior end from above; three visceral arches, frontal process, the cerebral vesicles, auditory pits, Wolffian ducts, and twelve embryonic segments are developed. After Salensky.

Fig. 11. More advanced embryo of the sterlet, showing the anterior part of the body and head. Auditory and nasal organs, heart, vitelline circulation, and brain more developed than in preceding figure. After Salensky. This figure represents a stage slightly more advanced than my figure 3 of the embryo of the common sturgeon.

PLATE XXXIX.



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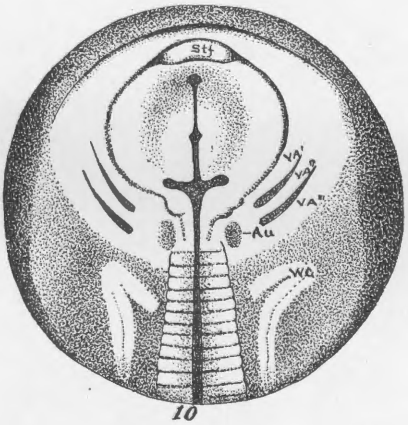

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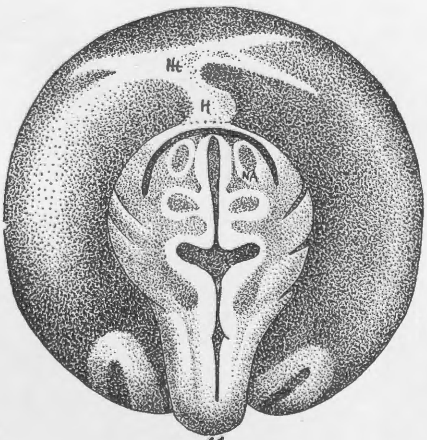

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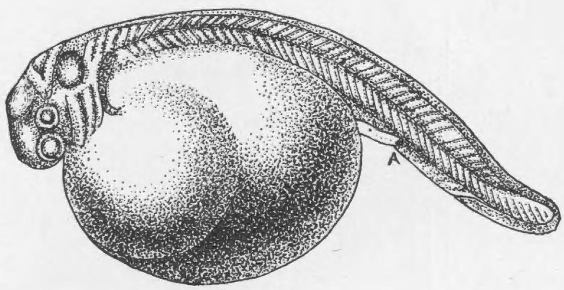
EXPLANATION OF PLATE XL.

Fig. 12. Young sterlet, recently escaped from the egg; yelk-bag still very large. Total length, 5½^{mm}. After W. K. Parker.

Fig. 13. Young or larval sterlet, somewhat older than foregoing, 6½^{mm} long. After W. K. Parker.

Fig. 14. Larval sterlet 9½^{mm} long, showing the branchial filaments exposed beyond the membranous operculum, the pectoral fin, the young barbels, and the strongly developed teeth with which the jaws are armed at this period. After W. K. Parker.

Fig. 15. Under side of head of larval sterlet 8½^{mm} long, showing the well developed teeth in the jaws at this stage, the four rudiments of barbels in front of the upper jaws, and the depression still farther forward, which probably answers to the "suctorial disk" observed by A. Agassiz and Edward Allis in the same region in *Lepidosteus* and *Amia*. After W. K. Parker.



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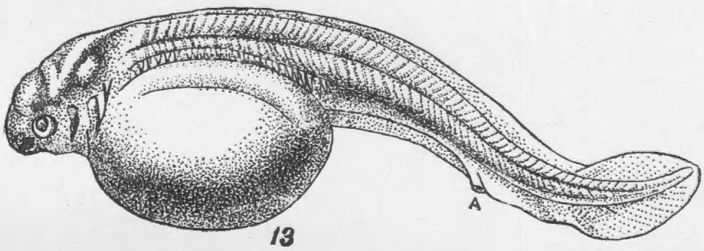

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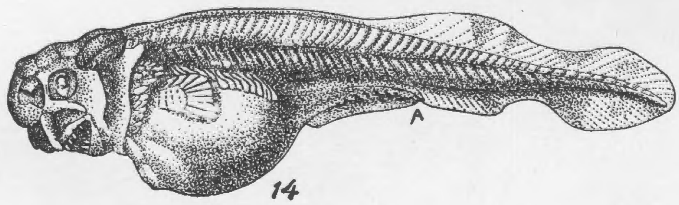

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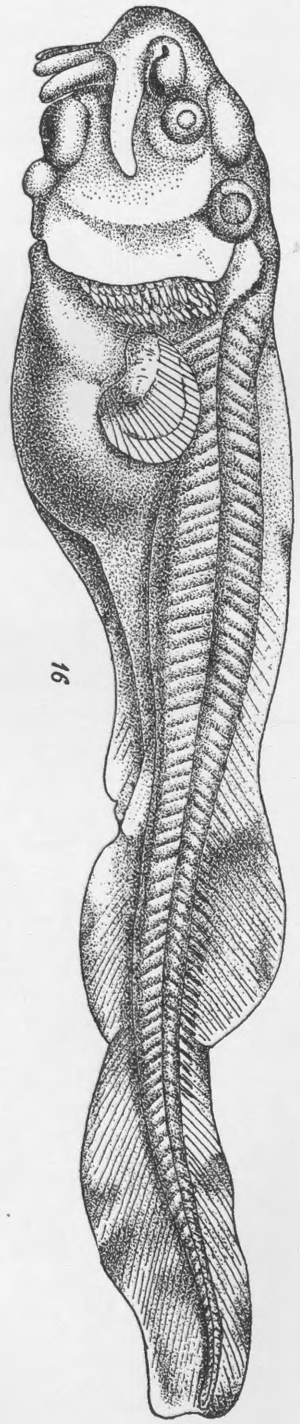
Bull. U. S- F. C., 88——19

EXPLANATION OF PLATE XLI.

Fig. 16. Larval sterlet, $13\frac{1}{2}^{mm}$ long. The median fin-fold is being differentiated into the caudal, dorsal, and anal. The sense capsules, nose, eye, and ear more developed, and the barbels are more elongated. The gill filaments are exposed beyond the margin of the operculum. The yelk is nearly absorbed. After W. K. Parker.

Fig. 17. Head of larval sterlet of the same length as the individual of the preceding figure, but dissected so as to expose the cartilages of the jaws and gills of one side. The palatopterygoid and Meckel's cartilage are seen to support teeth. After W. K. Parker.



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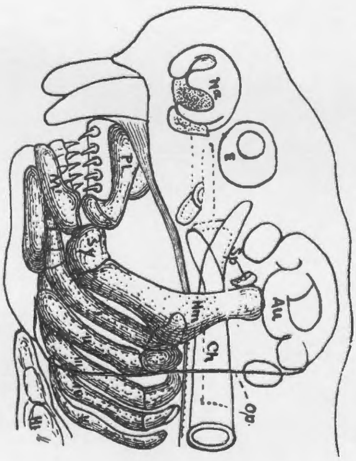

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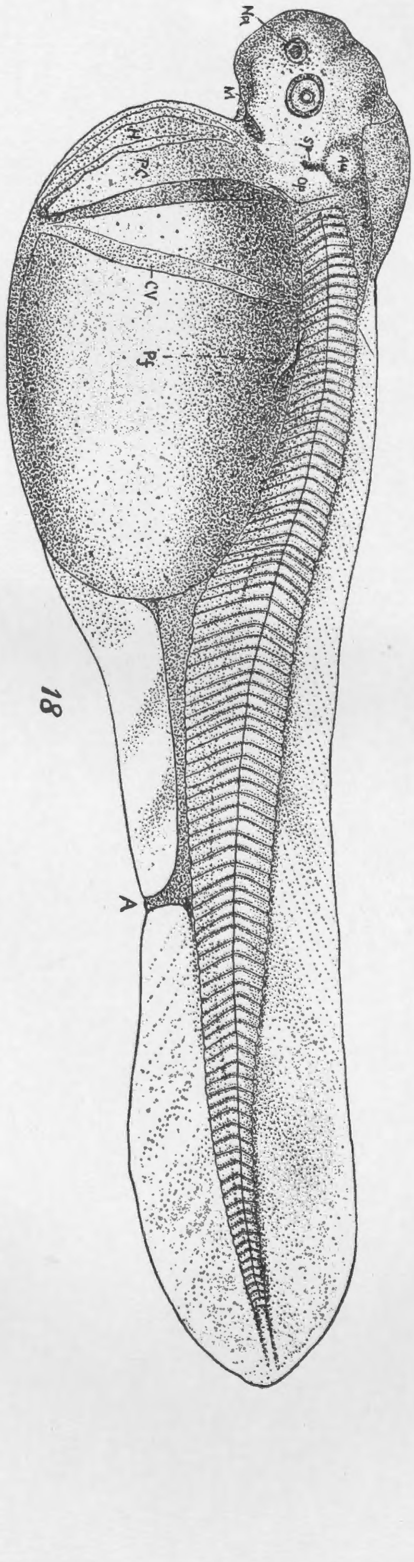
EXPLANATION OF PLATE XLII.

Fig. 18. Side view of the just-hatched larva of the common sturgeon on the sixth day after the eggs were fertilized. There is a large cavity at the front of the yelk-sack in which the heart lies at this stage. A simple Cuvierian venous duct embraces the front end of the yelk, and extends from a point just a little in front of the still exceedingly rudimentary pectoral fin to the ventral side of the yelk. The tail is lanceolate in form and lophocercal in structure. There are no barbels, and the larva is now $11\frac{1}{2}^{mm}$ long, or more than twice the length of the just-hatched sterlet. The figure is sixteen times natural size.



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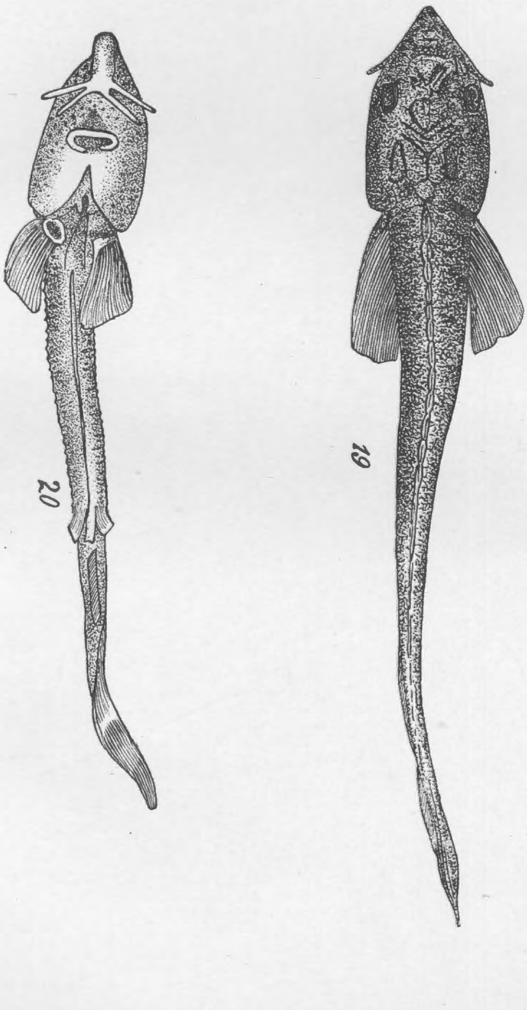
EXPLANATION OF PLATE XLIII.

Fig. 19. Young sterlet, two months old, viewed from above. (How much these figures are enlarged is not stated in the original Russian monograph from which they are copied.) After N. Zograff.

Fig. 20. Young sterlet, age two months, from beneath. After N. Zograff.

PLATE XLIII.



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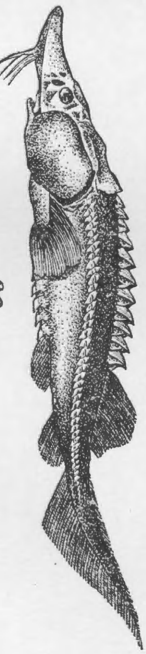
EXPLANATION OF PLATE XLIV.

Fig. 21. Side view of young sterlet of two months. The nasal bridge is developed. The dorsal scutes are seen to now overlap, as do the fulcra of the upper margin of the tail at the later stage. The fin-folds and actinotrichia seem to have a share in the development of the dorsal scutes and fulcra. Lateral series of scutes still rudimentary, and abdominal wanting. After Zograff.

Fig. 22. The quite young of the great *Huso* of eastern Europe, *Acipenser huso*. Natural size. From a specimen brought from Russia by Ehrenberg. This specimen serves to illustrate the next advances beyond the preceding, since the lateral and ventral rows of scutes are well developed, while the operculum quite covers in the branchial processes. After Brandt and Ratzeburg.



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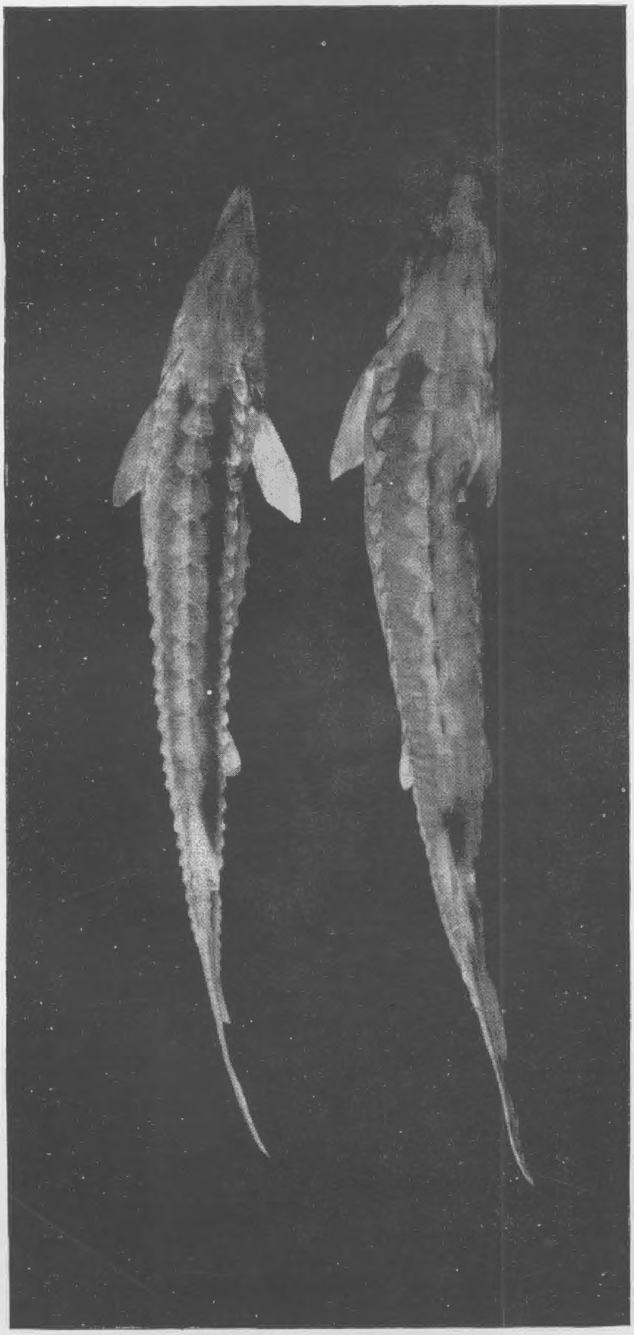
EXPLANATION OF PLATE XLV.

Fig. 23. View of dorsal aspect of the young of the common sturgeon, 20 inches long. From a photograph.

Fig. 24. View of the dorsal aspect of the young blunt-nosed sturgeon of the Delaware, *Acipenser brevirostris* Les. Twenty inches in length. From a photograph.



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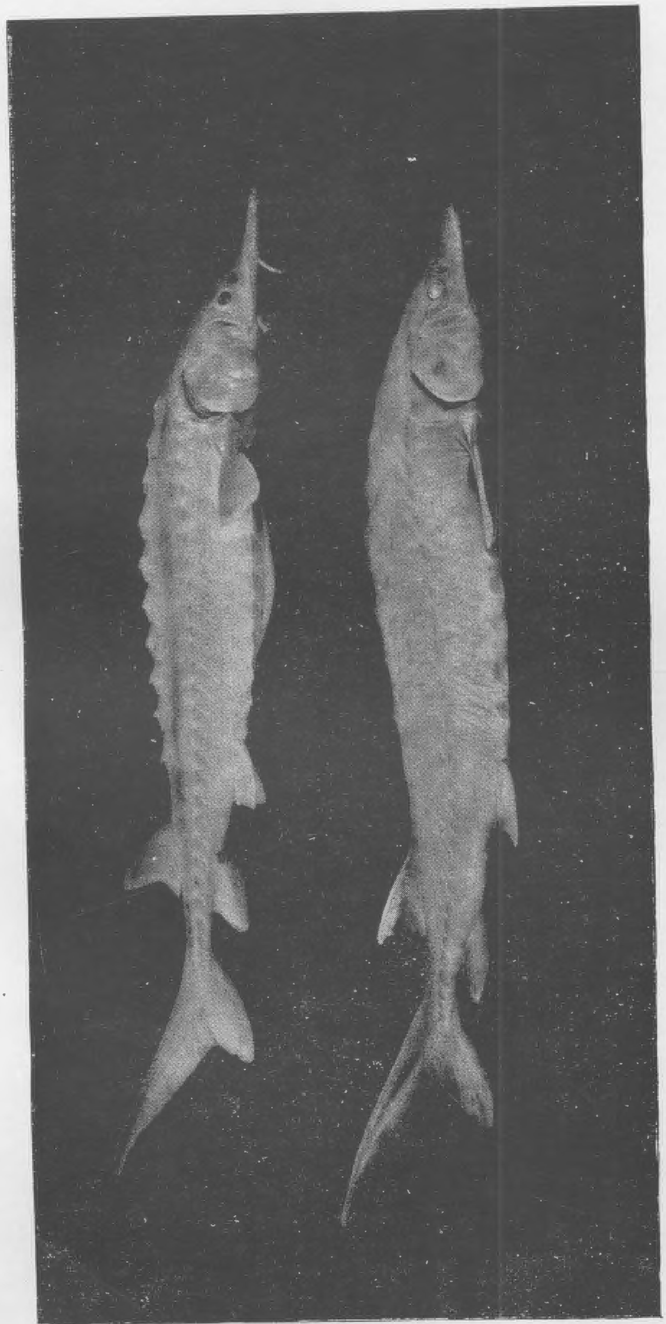
EXPLANATION OF PLATE XLVI.

Fig. 25. Side view of a young specimen of the common sturgeon, 20 inches long. From a photograph.

Fig. 26. Side view of young specimen of the blunt-nosed sturgeon of the Delaware, *A. brevirostris* Les. From a photograph. The recurved spines on the scutes are seen to be far less prominent than in the preceding.

PLATE XLVI.



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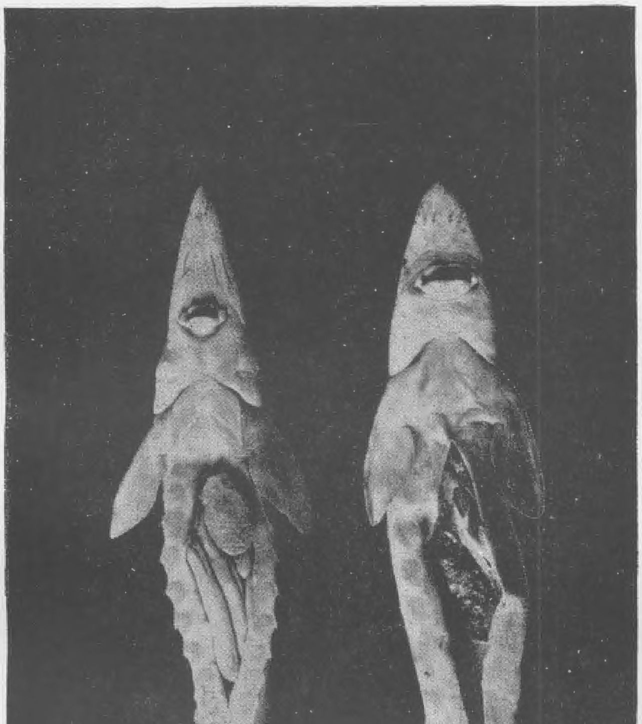
EXPLANATION OF PLATE XLVII.

Fig. 27. View of under side of a young specimen of the common sturgeon, 20 inches long. Note the narrow mouth, the recurved spines of the abdominal and lateral scutes, the backward extension of the duodenal intestinal loop, the mushroom-like pancreas, and the very distinct areolation on the under side of the snout in front of the mouth. From a photograph.

Fig. 28. View of the under side of a young specimen of the blunt-nosed sturgeon of the Delaware, *A. brevirostris* Lee. Note the very wide mouth, blunt snout, smooth ventral and lateral scutes, as compared with the foregoing. From a photograph.



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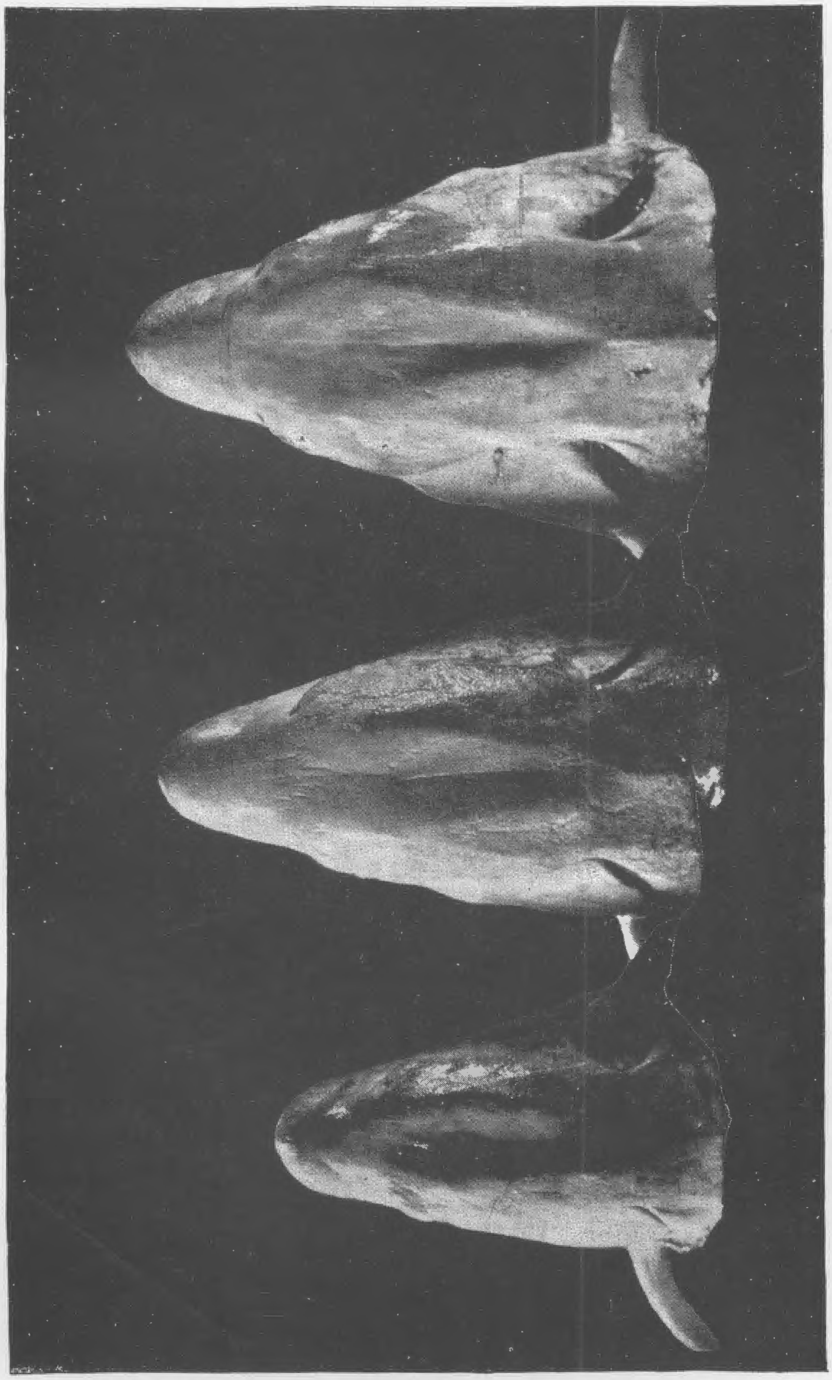
EXPLANATION OF PLATE XLVIII.

Figs. 29 and 30. Views of the upper surfaces of the heads of recently killed females of the common sturgeon, show ing variations. From photographs.

Fig. 31. View of the upper surface of the head of the adult male of the common sturgeon, showing the more gently tapering and blunter form of the snout, with relatively less width at the base of the cranium. From a photograph.



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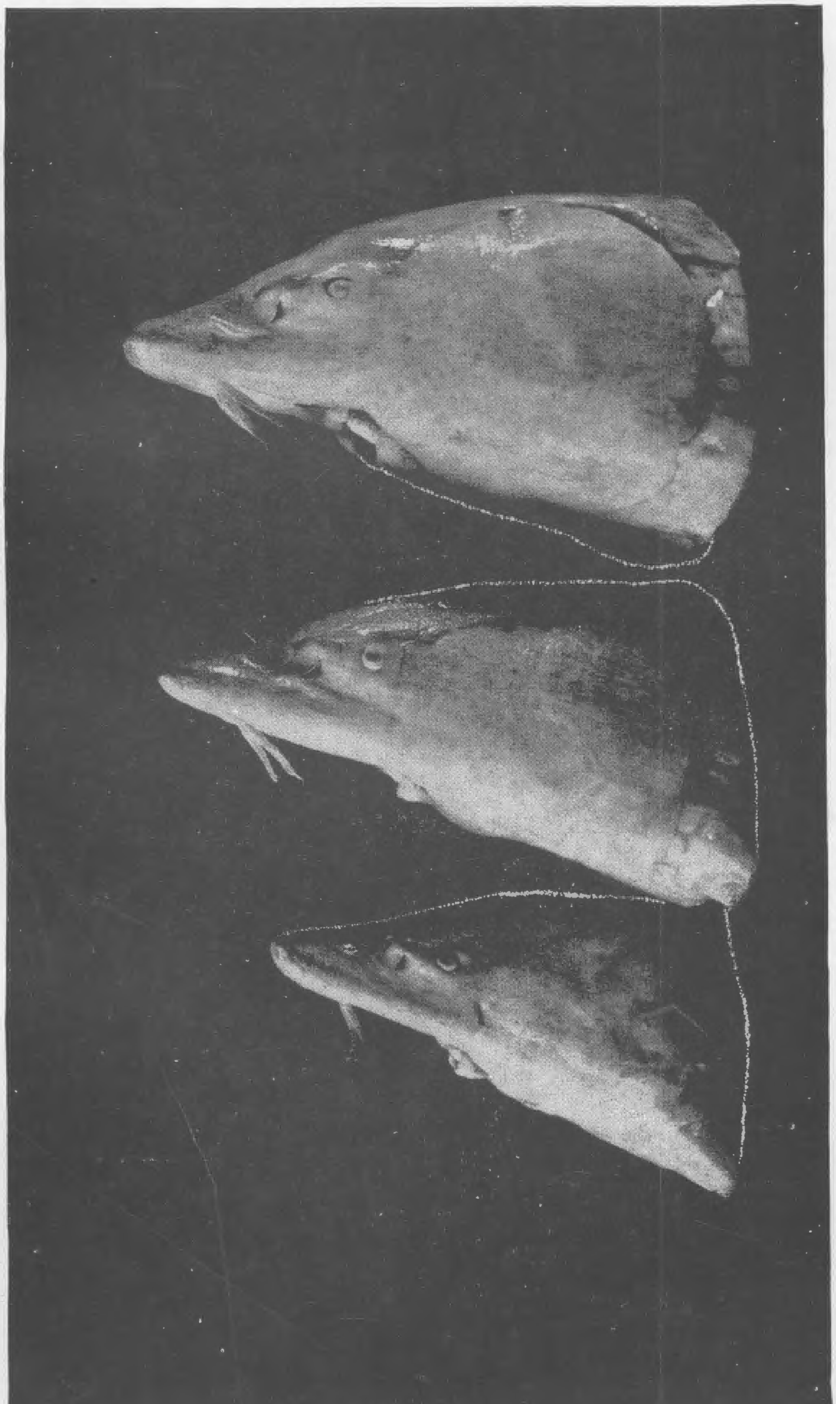
EXPLANATION OF PLATE XLIX.

Figs. 32 and 33. Side views of the heads of the adult females of the common sturgeon. From a photograph.

Fig. 34. Side view of the adult male of the common sturgeon. From a photograph.



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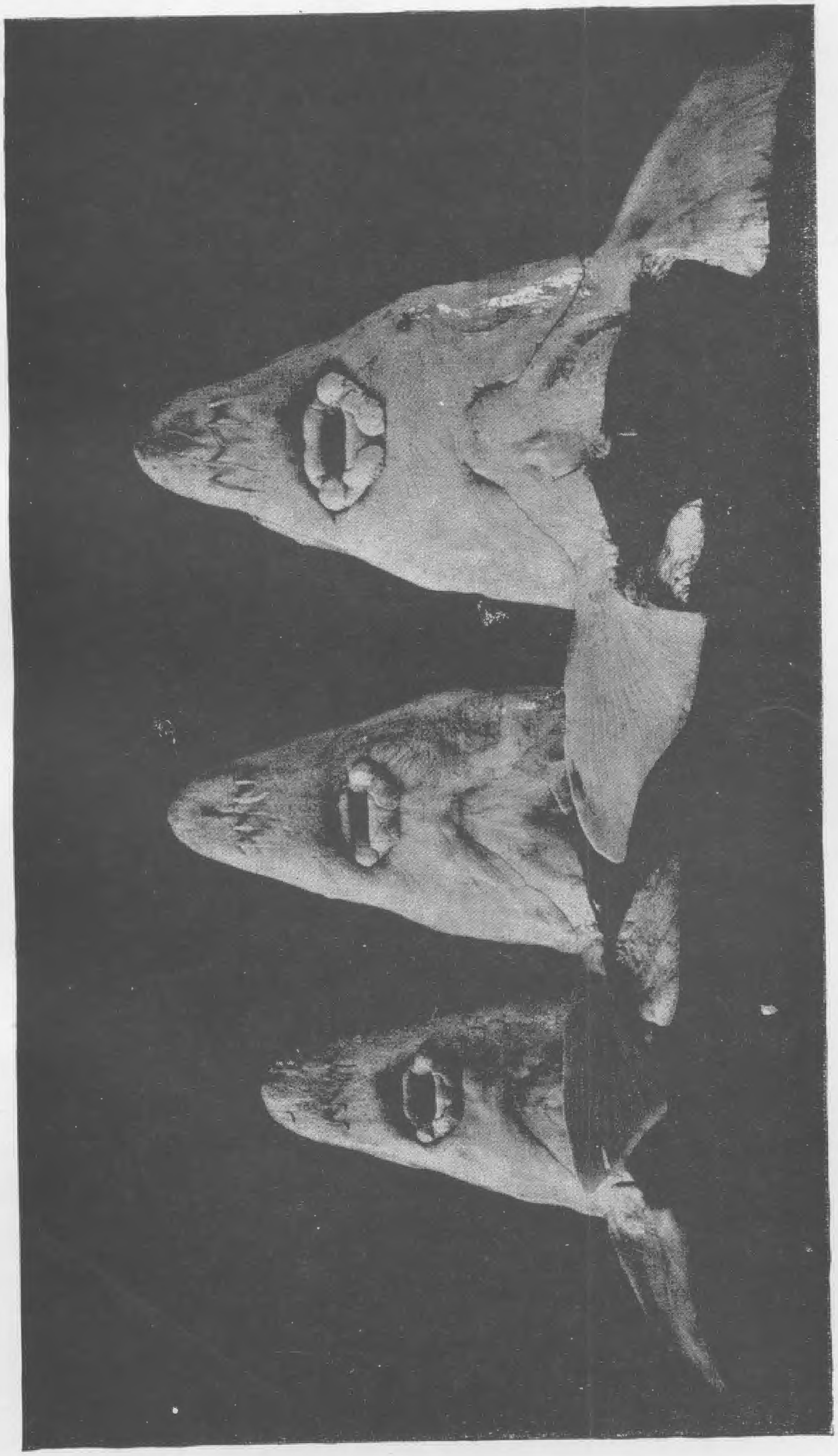
EXPLANATION OF PLATE L.

Figs. 35 and 36. Views of the under sides of the heads of adult females of the common sturgeon, showing the relative position of the barbels and mouth, with its undistorted fleshy marginal processes as seen in the recently killed animal. From photographs.

Fig. 37. View of the under side of the head of an adult male of the common sturgeon, showing the areolation on the under side of the snout in front of the mouth, the areolæ being sensory tactile areas supplied by the fifth nerve. From a photograph.



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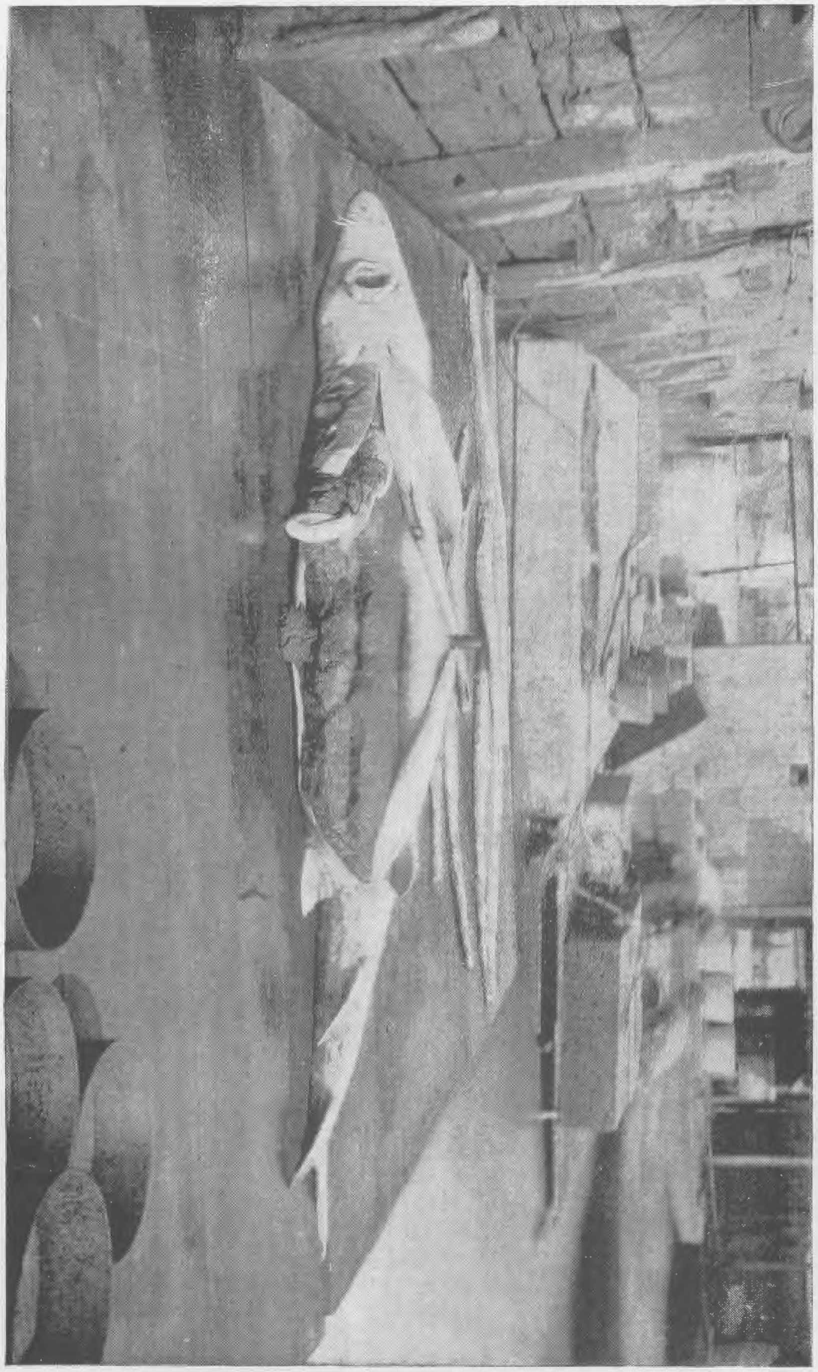
EXPLANATION OF PLATE LI.

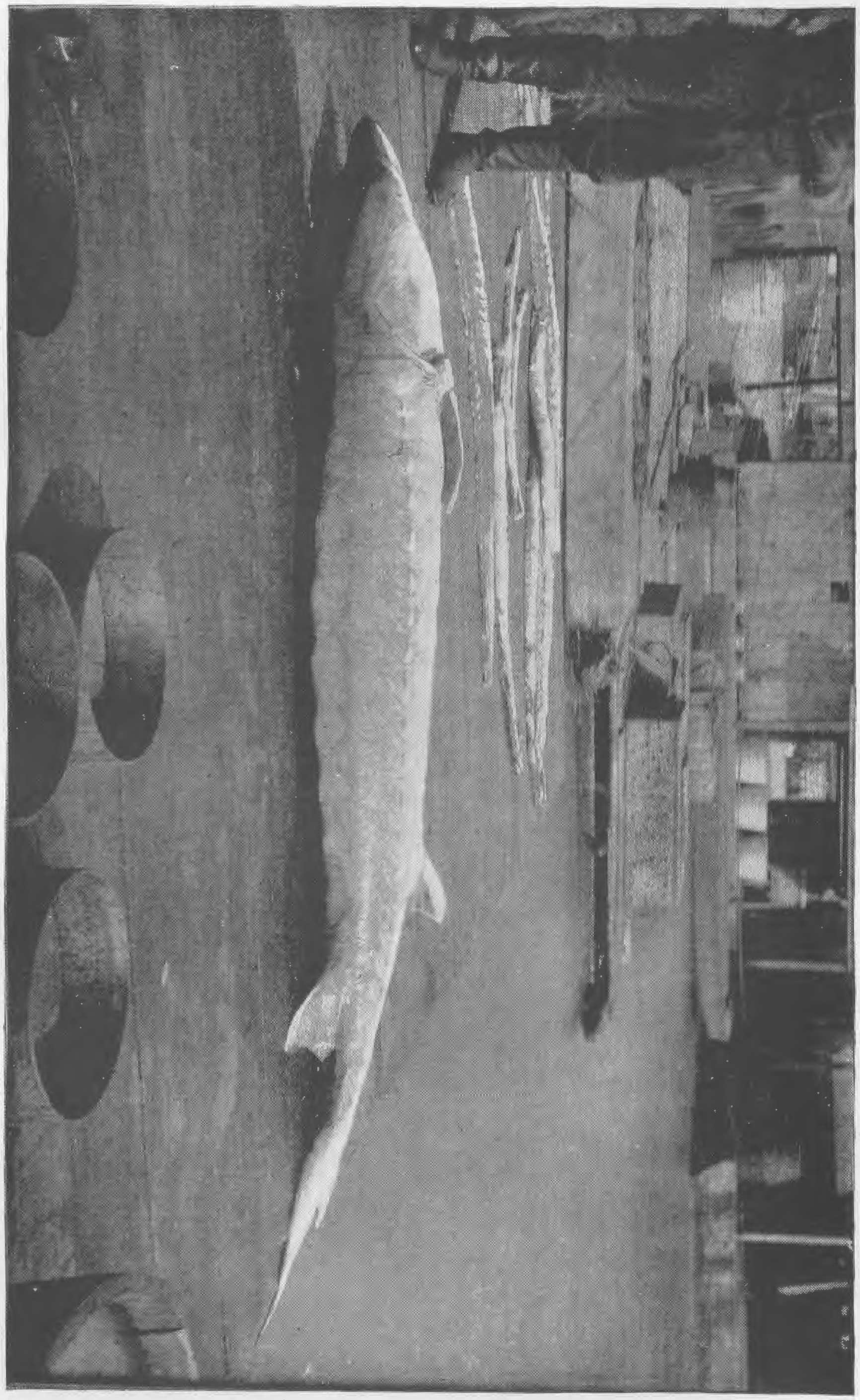
Fig. 38. View from beneath of an adult female of the common sturgeon, 8 feet long, with the abdomen cut open to expose the enormous mass of dark-colored roe. The duodenal loop of the intestine is seen to be farther forward than in the young, and to be smaller in diameter in proportion to the dimensions of the animal. On the "killing floats" are seen the sieves and tubs used in the manufacture of caviare.



38. ACIPENSER STURIO. Female with roe exposed.

EXPLANATION OF PLATE LII.

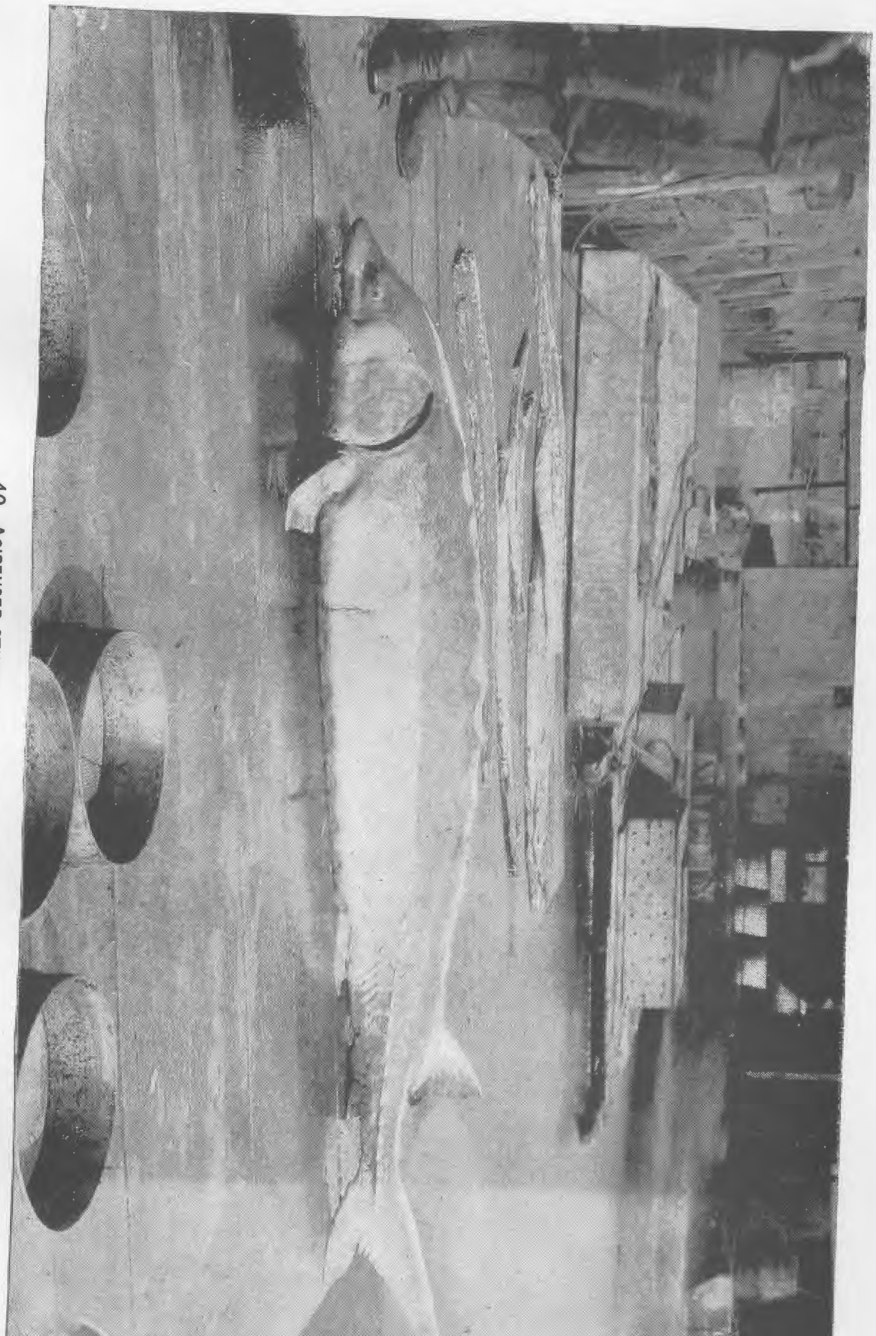
Fig. 39. View of an adult female of the common sturgeon seen obliquely from above. Photograph of a specimen about 8 feet long. Float in the distance with caviare apparatus, and shed for draining salted caviare, etc.



39. ACIPENSER STURIO. Dorsal view of female.

EXPLANATION OF PLATE LIII.

Fig. 40. Side view of adult female of the common sturgeon, 8 feet in length. From a photograph. This figure serves to illustrate the striking change in the outlines of the head and body of the adult as compared with the side view of the young of the same species on Plate XLVI, Fig. 25.



40. ACIPENSER STURIO. Lateral view of female.

EXPLANATION OF PLATE LIV.

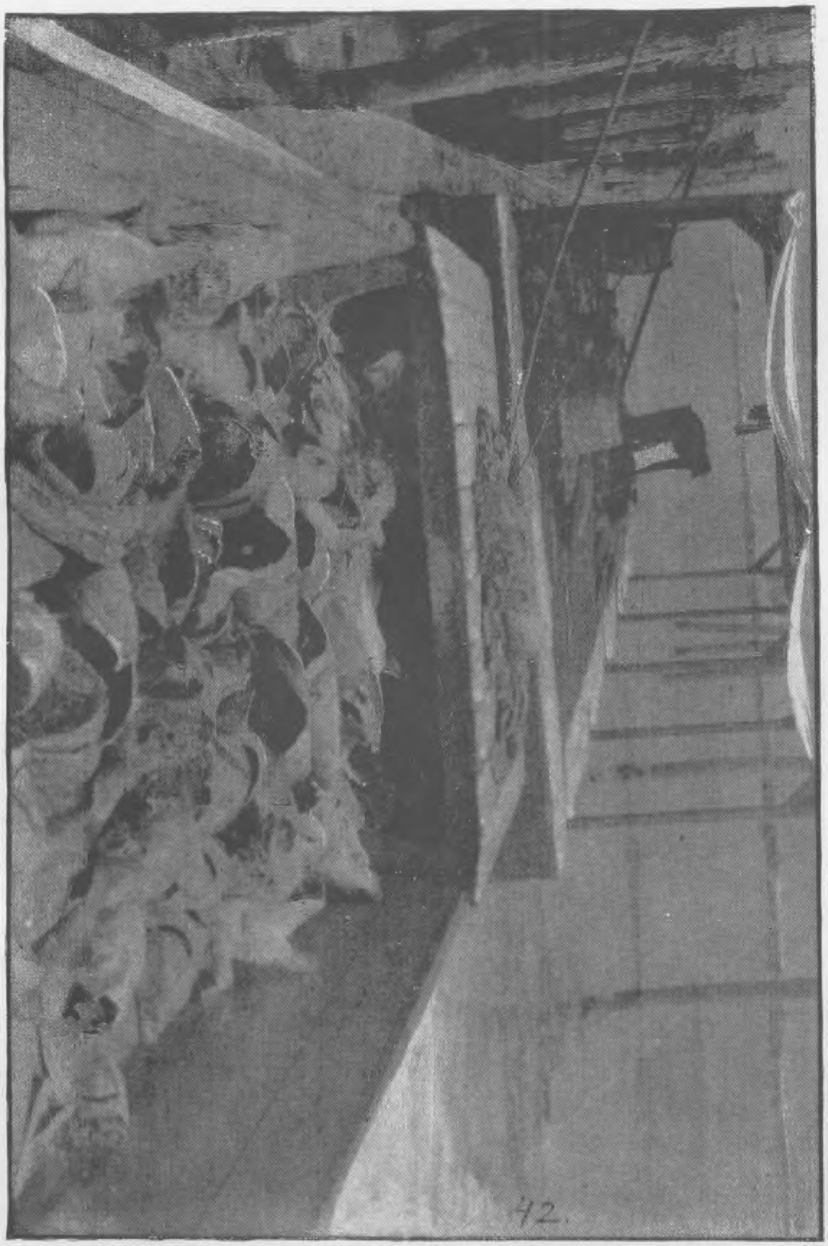
Fig. 41. View from the under side of an adult female sturgeon, 8 feet long, showing the robust proportions of a specimen containing roe, in just the right condition for purposes of caviare. From a photograph.

PLATE LIV.

41. ACIPENSER STURIO. Ventral view of female.

EXPLANATION OF PLATE LV.

Fig. 42. Canvas-covered butchering float in the distance, with "butcher" at work cutting open and removing roe from "a cow sturgeon." Barge in the foreground, containing heads, tails, viscera, skins, etc., of sturgeons awaiting removal to the guano manufactory, and representing the accumulations of two or three days' fishing and butchering.

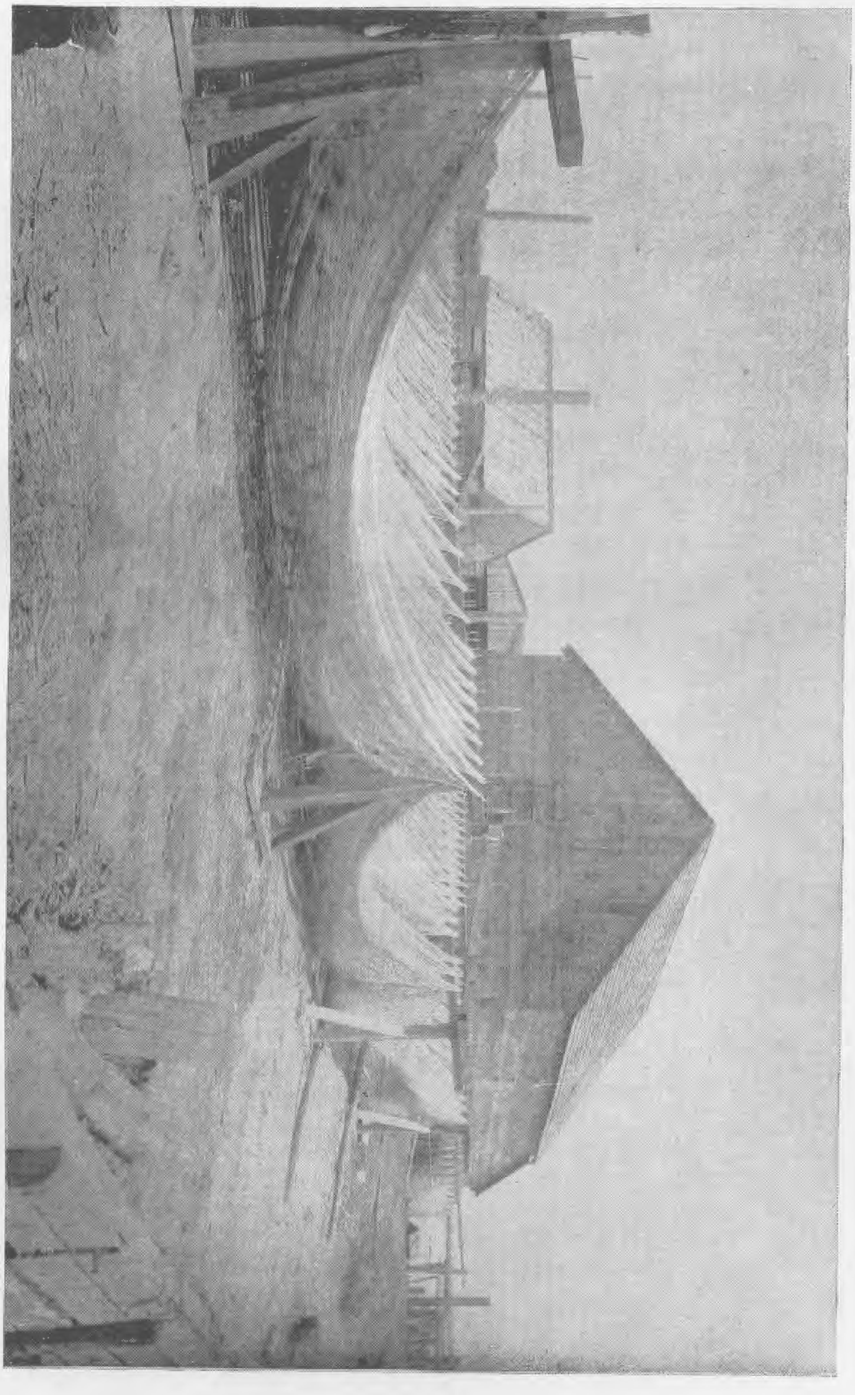


42. REFUSE, HEADS, ETC.

EXPLANATION OF PLATE LVI.

Fig. 43. View on the wharves at Delaware City, Delaware, to show the manner of suspending the sturgeon nets when drying or after being overhauled and repaired.

PLATE LVI.



43. STURGEON NETS.

EXPLANATION OF PLATE LVII.

Fig. 44. Side view of cranium of the common sturgeon, modified from Wiedersheim.

Fig. 45. Dorsal view of dermal armature of the head of the common sturgeon, modified from Gegenbaur.

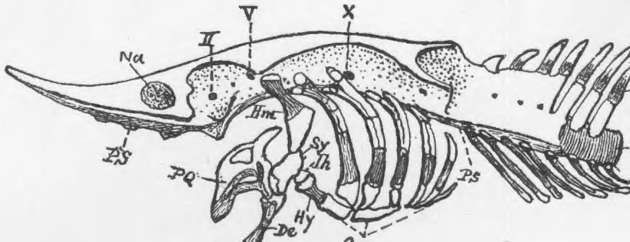
Fig. 46. Mandibles and palatopterygoid of the young sturgeon with its musculature.

Fig. 47. Cross-section through the spiral valve of the intestine of *A. brevirostris*, showing the manner of flexure of the spiral fold *S F*, and the large lymphoid cord *L* at its margin in section. The fold itself is covered with villi as well as the intestinal wall. Enlarged three diameters.

Fig. 48. Pyloric end of stomach, pylorus, and duodenum laid open so as to display the three openings into the latter from the pancreas.

Fig. 49. Figures representing the cartilaginous elements of the ventral fins of *Acipenser brevirostris*.

Fig. 50. Figure of the cartilages of the right pectoral fin of a young specimen of *Acipenser sturio*.



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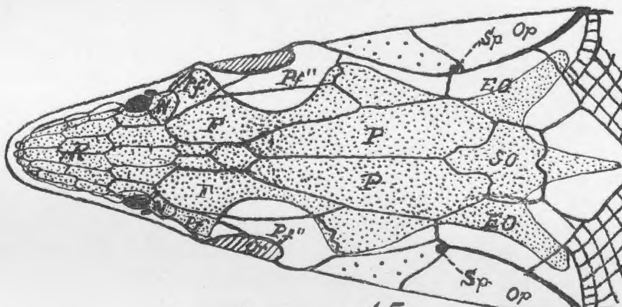

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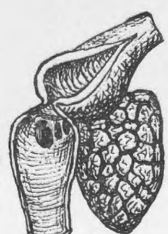

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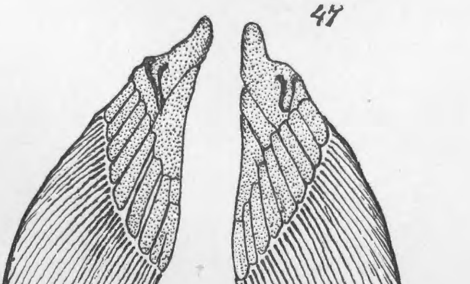

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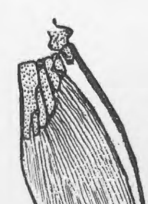

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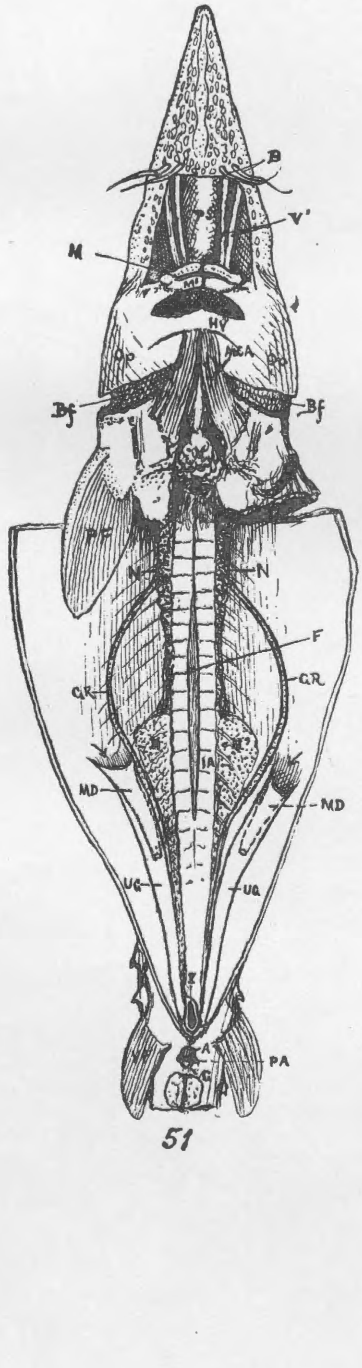
EXPLANATION OF PLATE LVIII.

Fig. 51. Young individual of the common species of the sturgeon, 9 inches long, opened from below with the viscera removed to show the relations of the Wolffian bodies *N*, genital ridges *GR*, to the outgoing ducts *MD*, *UG*, in the sexually immature animal. Also the nerve supply to the barbels and the sensory areolæ of the under side of the snout in front of the mouth. Natural size.

Fig. 52. The same from below, to show the relations of the viscera to the abdominal walls and outlets, the internal openings of the genital canals are indicated by the arrows. Arrows within the dotted outlines of the portions of the alimentary canal, not visible from below in this figure, indicate the course of the food through the intestine. Natural size.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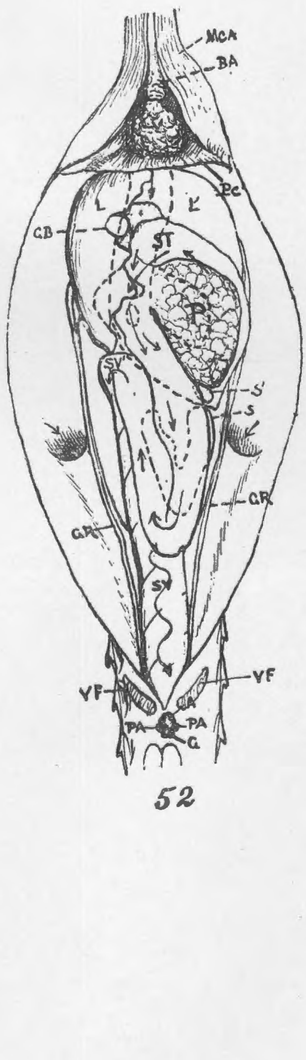
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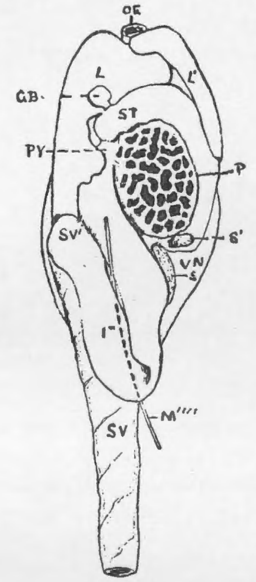
EXPLANATION OF PLATE LIX.

Fig. 53 Abdominal viscera of young sturgeon, viewed from below, showing a bristle, M'''', passing through opening in mesentery of second loop of intestine, and with the under wall of pancreas, *P*, removed to show its glandular cavities, which are much less numerous in the young Sturgeon than in the adult. Natural size.

Fig. 54. Viscera of young sturgeon, viewed from above; swim-bladder, *VN*, intact. Natural size.

Fig. 55. Viscera of young sturgeon, viewed from above, with spiral valve laid open to show its seven turns and with the swim-bladder *VN* cut open and laid to one side to show the wide pneumatic duct *PN* joining the alimentary canal just at the beginning of the first or gastric loop of the latter. The spleen *S* and *S'* is also exposed. Natural size.

Fig. 56. Viscera of young sturgeon, viewed from above, with upper wall of swim-bladder cut away to show the cleft-like opening of the pneumatic duct into its anterior end, with the muscular fibers radiating from it into the floor of the pneumatocyst or swim-bladder. Natural size.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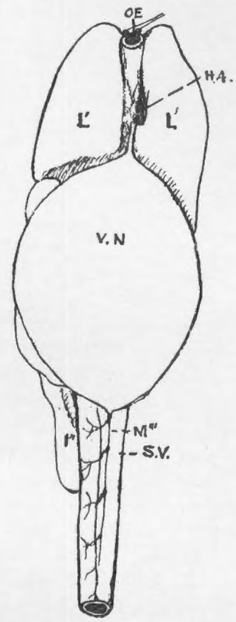
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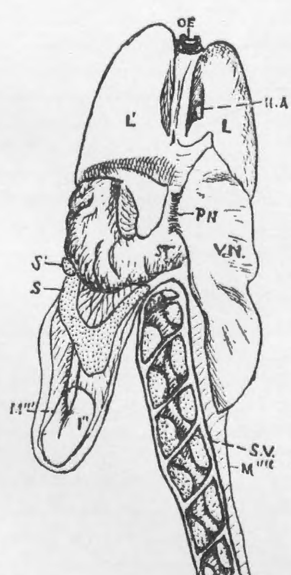
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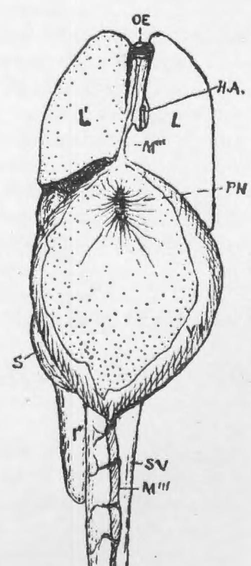
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INDEX.

9.—A REVIEW OF THE GENERA AND SPECIES OF SERRANIDÆ FOUND IN THE WATERS OF AMERICA AND EUROPE.

BY DAVID STARR JORDAN AND CARL H. EIGENMANN.

The family of *Serranidæ* includes many of our most important food fishes. The group comprises the various species popularly recognized as salt-water p rch and bass, the groupers, garrupas, hinds, cabrillas, jew-fishes, together with the striped bass of different species which inhabit or ascend our rivers. Nearly a hundred species are found in North American waters, and of these every one, according to its size, is valuable as food. Some of them, popularly known as "jew-fishes," are among the very largest of spiny-rayed fishes, and many of the smaller forms are remarkable for the brilliancy of their coloration.

This present paper contains an enumeration of the genera and species belonging to the family of *Serranidæ* found in the waters of America and Europe, together with the synonymy of each, and analytical keys by which the different groups may be distinguished.

An earlier paper by Professors Jordan and Swain (Proc. U. S. Nat. Mus., 1884, p. 358–411) has served as the basis of our studies of the *Epinephelinæ*, but this paper has been supplemented by the study of a very much larger amount of material, and the whole group of *Serranidæ* has been brought under consideration.

We have examined all the specimens of *Serranidæ* now contained in the Museum of Comparative Zoology at Cambridge, Massachusetts,* and all that are in the museum of the Indiana University. A large part of the material in the U. S. National Museum we have also studied, and also most of the original types contained in the museum at Paris and in the British Museum.

We have been indebted to Prof. Alexander Agassiz and to Mr. Samuel Garman for the free use of the specimens in the Museum of Comparative Zoology. We are also indebted to Miss Elizabeth G. Hughes for help in the compilation of synonymy and in the preparation of skulls.

For all statements regarding South American specimens the senior author is alone responsible.

From the family *Serranidæ*, as understood by us, we exclude *Centropomus*, which, although certainly allied to the *Latinæ*, should, according to Dr. Gill, stand as a separate family. The *Lobotidæ* (*Lobotes*) stand nearer, but having no teeth on vomer or palatines, they may be kept in a separate group. The *Priacanthidæ* (*Priacanthus* and

*Excepting the sub-family *Latinæ*.

Pseudopriacanthus) should certainly be omitted from the *Serranidæ*, as should *Apogon* and its allies, among which are apparently the two aberrant Cuban genera, *Liopropoma* and *Chorististium*. We are not quite sure that *Rypticus*, *Percichthys* or even *Morone* should be retained among the *Serranidæ*, but we prefer for the present to regard the three groups typified by these genera as sub-families of *Serranidæ*, rather than to attempt to define them as distinct families.

The *Percidæ* (*Perca*, *Stizostedion*, *Aspro*, *Etheostoma*) stand near *Morone* and *Percichthys*, but they are fairly well defined by the greatly increased number of vertebræ, a character associated with their fresh-water life and northern distribution. From all *Serranidæ* they further differ in having two anal spines. Near also to the *Serranidæ* is the singular group of North American sun-fishes or *Centrarchidæ*. In these, however, the pseudo-branchiæ are obsolete and the general form of the body is notably different.

The American genera of *Serranidæ* fall naturally into six groups, which we may call sub-families, although the relation of two of these groups (*Serraninæ* and *Epinephelinæ*) is almost too close for such designation. These six groups, *Grammistinæ*, *Epinephelinæ*, *Serraninæ*, *Anthiinæ*, *Latinæ*, and *Percichthyinæ*, are typified respectively by the genera *Rypticus*, *Epinephelus*, *Serranus*, *Anthias*, *Morone*, and *Percichthys*. They are easily recognized, and in most cases readily defined, notwithstanding the fact that most European naturalists have confounded *Epinephelus* with *Serranus*, while some have placed in the genus *Anthias* not only genuine *Serraninæ*, but also species of the *Sparoid* group of *Lutjaninæ*.

The American *Grammistinæ* all belong to a single genus *Rypticus*, *Grammistes* having no American representatives.

The recognized genera of *Epinephelinæ* are fairly well defined, and although most of them are closely allied to each other, there is no evidence of any intergradation of such a character as to efface our lines of generic division.

The *Serraninæ* are equally varied among themselves, but the lines of division are less sharply marked, and certain species form connecting links between one genus and another. Authors have divided the group or sub-family into numerous genera, but these genera are not separated by strongly marked characters, and most of them might well be placed as sub-genera under *Serranus*.

The species of *Anthiinæ* are not numerous, but the generic differences in this group are more marked than those separating the genera of the two groups just named. The representation of this group in our fauna is not extensive enough to give us a clear idea of the mutual relations of the forms included in it.

We unite under the sub family name of *Latinæ* (the more usual name *Labracinæ* not being available, as the name *Labrax* properly belongs to the genus *Hexagrammus*, of which name it is a later synonym) certain *Serranidæ*, which show more marked resemblances to the genus *Perca*. These are characterized in general by the divided dorsal, the villiform teeth, and by the absence of a supplementary bone to the maxillary. A majority of the species are Asiatic, and but few of these have been studied by us. Some of them (*Cnidon*) are said to lack the pseudo-branchiæ, but this is probably not true. Some of the *Latinæ* (*Lateolabrax*) approach the *Percidæ* in the increased number (35) of the vertebræ, which are about 25 in most of the others, but they differ from the *Percidæ* in this, at least, that none of the latter (*Perca*, *Stizostedion*, *Etheostoma*, *Acerina*, *Aspro*, etc.), have more than two spines in the anal fin, while all the *Latinæ* have three. Most of the species of *Latinæ* found in Europe and North America are closely related, and might well be referred to a single genus—*Morone*. *Lates* and *Kuhlia* are, however, quite unlike *Morone*, and perhaps should be placed in different groups.

The sixth sub-family, *Percichthyinæ*, is still closer to the *Percidæ*, agreeing with the perch in the general form of the head and body, in the increased number (36) of the vertebræ, and in the armature of the head. The species have, however, *three* anal spines, there is a large supplemental maxillary, the scales are scarcely ctenoid, and the spinous dorsal is short. If a division is to be made between *Percidæ* and *Serranidæ*, certainly *Percichthys* should be placed in the latter family.

Of the 119 species here admitted, the following (32 in number) have not been studied by us:

Rypticus nigromaculatus.
Rypticus arenatus.
Rypticus bicolor.
Polyprion oxygeneios.
Hemilutjanus paytensis.
Alphestes pictus.
Epinephelus aspersus.
Epinephelus caninus.
Epinephelus goreensis.
Epinephelus æneus.
Epinephelus alexandrianus.
Epinephelus chrysotænia.
Dermatolepis angustifrons.
Bodianus panamensis.
Bodianus tæniops.
Hypoplectrus gemma.
Hypoplectrus crocotus.
Diplectrum conceptione.
Serranus annularis.
Serranus flavescens.
Serranus peruanus.
Serranus castelnaui.
Odontanthias asperilinguis.
Odontanthias tonsor.
Bathyanthias roseus.
Dicentrarchus orientalis.
Dicentrarchus punctatus.
Lates nilotica.
Percichthys lævis.
Percichthys melanops.
Percilia gillissi.
Percilia gracilis.

ANALYSIS OF SUBFAMILIES OF SERRANIDÆ.

COMMON CHARACTERS.—Body oblong, more or less compressed, covered with adherent scales of moderate or small size, which are usually but not always ctenoid. Mouth moderate or large, not very oblique, the premaxillary protractile and the broad maxillary not slipping for its whole length into the sheath formed by the preorbital, which is usually narrow. Teeth all conical or pointed, in bands, present on jaws, vomer and palatines.* Gill-rakers long or short, usually stiff, armed with teeth. Gills 4, a long slit behind the fourth. Pseudo-branchiæ present, usually large. Lower pharyngeals rather narrow, separate, with pointed teeth. Gill-membranes separate, free from the isthmus. Branchiostegals normally 7 (occasionally 6). Cheeks and opercles always scaly; preopercle with its margin more or less serrate, the opercles usually ending in one or two flat spine-like points. Nostrils double. Lateral line single, not extending on the caudal fin. Skull without cranial spines and usually without well-developed cavernous structure. No suborbital stay. Dorsal spines usually stiff, 2 to 15 in number; soft dorsal with 10 to 20 rays. Anal fin rather short, its soft rays 7 to 12, its spines three (obsolete in one subfamily). Ventrals thoracic, I, 5, normally developed. Pectorals well developed. Caudal peduncle stout, the fin variously formed. Vertebræ usually about 10 + 15 (more in some of the *Latinæ* and *Percichthyinæ*; 16 + 19 in *Lateolabrax*; 16 + 20 in *Percichthys*). Air bladder present, usually small, and adherent to the walls of the abdomen. Stomach cæcal, with few or many pyloric appendages; intestines short, as usual in carnivorous fishes.

* Except in *Percilia*, which has blunt teeth, and none on the palatines.

a. Anal spines obsolete; dorsal spines 2 to 8; scales very small, smooth; teeth all villiform; maxillary with a supplemental bone; head scaly; lateral line normal; gill-rakers rather few and short; caudal rounded; preopercle without angle or serrations, but with two or three spinous teeth above .... GRAMMISTINÆ, I.

aa. Anal spines 3; dorsal spines 8 to 14.

b Dorsal fin continuous or nearly so, not divided nearly to the base.

c. Maxillary with a supplemental bone (usually distinct, but sometimes hidden in the skin); canine teeth usually present, at least in front of jaws; inner teeth in both jaws usually depressible; scales small, firm, the top of head more or less scaly; lateral line running low (except in *Gonioplectrus*, etc.); supraoccipital crest usually more or less encroaching on the top of the skull, so as to leave no distinct smooth area at the vertex (except in *Variola*); temporal crests usually distinct; gill-rakers various, generally small and short. Dorsal rays VIII to XIV–12 to 20, the number of spines usually not ten; anal rays III, 7 to III, 12; vertebræ about 10 + 14 = 24. Chiefly shore-fishes, often of large size; all of them, so far as known, bisexual .... EPINEPHELINÆ, II.

cc. Maxillary without supplemental bone; canine teeth, if present, usually developed on the side of the lower jaw as well as in front; no depressible teeth; scales mostly ctenoid, including those of the lateral line; temporal crests on cranium almost obsolete.

d. Gill-rakers comparatively short and wide apart; lateral line not running close to the back (except in one species); dorsal rays X, 11 to 15; anal rays usually III, 7; supraoccipital crest not extending far forward on top of skull, a more or less distinct convex smooth area being left on the vertex between the supraoccipital and the interorbital area; mouth less oblique than in the *Anthiinæ;* vertebræ about 10 + 14 = 24. Chiefly shore-fishes of olivaceous colors; some of them—possibly all—hermaphrodite ..... SERRANINÆ, III.

dd. Gill-rakers (in all species known to us) very long, slender and close-set; lateral line running close to the back; dorsal rays IX to XII, 9 to 20. Anal rays III, 7 to 10; supraoccipital crest very high, not encroaching on the short, convex, smooth area at the vertex, which is considerably depressed; canines usually strong; preorbital very narrow. Deep-water fishes, usually bright red in life...................... ANTHIINÆ, IV.

bb. Dorsal fins separate, or joined at base only, the rays VII to XI–I, 12 to 14.

e. Maxillary without supplemental bone;* teeth all alike, usually villiform, without canines; preorbital narrow; lateral line normal, straight, or bent upward at base; preopercle serrate; gill-rakers moderately long and slender; vertebræ 10+14=24 to 16+19=35, the number usually more than 24. Species of generally large size, and silvery-olive coloration, mostly inhabiting fresh or brackish waters .... LATINÆ, V.

ee. Maxillary with a large supplemental bone; membrane bones of head extensively cavernous; vertebræ in increased number, 16+20=36 in *Percichthys;* lateral line normal; dorsal rays about X-11; gill-rakers rather short and thick. Species of moderate size and dull olive coloration, inhabiting the fresh waters of Chili .... PERCICHTHYINÆ, VI.

ANALYSIS OF AMERICAN AND EUROPEAN GENERA OF SERRANIDÆ.

Subfamily I.—GRAMMISTINÆ.

(*Serranidæ* with the anal spines obsolete, the dorsal spines in small number, maxillary with a supplemental bone; the preopercle with two or three spine-like hooks posteriorly, the scales small and imbedded, the teeth all villiform.)

a. Dorsal spines two to four; preorbital narrow; no canine teeth; preopercle without angle or serratures, its margin with 2 or 3 spinous teeth above; caudal fin rounded; scales small, smooth, embedded; smooth area on top of head very large, transversely convex, much longer than the low supraoccipital crest; interorbital area very narrow; temporal ridges strong... RYPTICUS, 1.

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* In *Morone*, *Lateolabrax*, etc. We have not examined *Lates*.

Subfamily II.—EPINEPHELINÆ.

(*Serranidæ* with the dorsal fin continuous, the dorsal and anal spines developed, and with a supplemental bone to the maxillary.)

a. Soft dorsal with 10 to 12 rays; teeth all villiform, without canines.

b. Head armed with rough spinigerous crests, there being spinous projections above the eyes and a rough, bony ridge on the opercle, with others on the post-temporal; dorsal fin low, continuous; tongue with teeth; dorsal spines 11 or 12; soft dorsal scaly; caudal rounded; pyloric cœca numerous (about 70).....POLYPRION, 2.

bb. Head not armed with spinigerous ridges; preopercle moderately serrate, sometimes becoming entire with age.

c. Dorsal fin deeply notched, the last spines much shorter than the middle ones; scales rugose; soft dorsal scaly; dorsal spines 11; tongue toothless; forehead broad, flattish; snout, preorbital, and jaws naked; caudal subtruncate; preopercle finely serrate, becoming entire with age; gill-rakers very strong; pyloric cœca few (about 7)..........STEREOLEPIS, 3.

cc. Dorsal fin low, its outline not deeply notched; scales small, ctenoid; soft dorsal naked; dorsal spines 10; forehead broad, concave near the orbital ridges, then transversely convex; preopercle subrectangular, with fine serræ above, larger, radiating teeth on angle, and many small teeth directed downward on lower limb; snout, preorbital and jaws densely scaly; eyes very large; preorbital very narrow; caudal lunate, with rounded angles; gill-rakers long and slender; lateral line black..........HEMILUTJANUS, 4.

aa. Soft dorsal, with 13 to 20 rays; head unarmed, except for the opercular spines and the serræ on the preopercle; soft dorsal scaly; scales of lateral line usually triangular and cycloid.

d. Preopercle with one or more large, conspicuous, hook-like teeth, directed downward and forward, on its lower limb.

e. Dorsal spines, 8; plectroid spine on preopercle single, very strong; a strong canine on middle of side of lower jaw; opercle with a long, knife-shaped spine; body rather deep; lateral line running high; jaws naked; scales small, firm, and rough; caudal rounded; soft dorsal rather short, of 12 to 13 rays..GONIOPLECTRUS, 5.

ee. Dorsal spines, 10; plectroid spines on preopercle two to four, rather small; a stout canine on middle of side of lower jaw; opercle with small spines; jaws naked; scales rather large; soft dorsal long, with 17 to 20 rays; caudal rounded..GILBERTIA, 6.

eee. Dorsal spines, 13 (12 to 14); plectroid spines two or three in number; usually one or more strong canines present on side of lower jaw; body short and deep ..........ACANTHISTIUS, 7.

eeee. Dorsal spines, 11; plectroid spine on preopercle single; no lateral canine in lower jaw; (otherwise as in *Epinephelus*)..........ALPHESTES, 8.

dd. Preopercle without distinct antrorse spinous hooks on its lower limb; sides of lower jaw without distinct canines.

f. Dorsal spines, 11 (10 in one species of *Epinephelus*).

g. Scales, some or all of them, more or less ctenoid; canines distinct, in front of one or both jaws; body oblong or elongate, not greatly compressed, the interorbital width more than twice diameter of the eye, in the adult; preopercle finely serrate.

h. Anal fin short, its rays III, 8, or III, 9; cranium with the median crest much more developed than lateral crests, which do not extend as far forward as the former and are not parallel with them; scales nearly all ctenoid; spines strong.

i. Scales of the lateral line normal, not marked by radiating ridges...EPINEPHELUS, 9.

ii. Scales of the lateral line each with 4 to 6 strong radiating ridges; cranium short, extremely broad, and depressed between the eyes; the anterior profile of head a little concave; dorsal spines low; dorsal rays XI, 16 ......PROMICROPS, 10.

hh. Anal fin elongate, its rays III, 11 or III, 12; caudal fin lunate or truncate; spines slender, those of the anal fin graduated; lower jaws strongly projecting; cranium rather broad and transversely concave between the eyes, its lateral crests very strong, nearly parallel with the supraoccipital crest and extending farther forward than the latter, joining the supraocular crest above the eye; scales small, largely cycloid, those of the lateral line simple; pyloric cæca few (12 to 20); dorsal rays XI, 16 to 18.................. MYCTEROPERCA, 11.

gg. Scales all smooth (said to be ciliated in *D. angustifrons*); canine teeth small or obsolete; head small, much compressed, the interorbital area in the adult not broader than the eye; supraoccipital crest low; soft dorsal unusually long, the rays XI, 17 to 20; dorsal spines low; vertical fins all rounded posteriorly.. DERMATOLEPIS, 12.

ff. Dorsal spines, 9.

j. Soft dorsal of moderate length and height; dorsal rays IX, 13 to 15; anal rays III, 7 or 8; caudal fin rounded or lunate; skull and head essentially as in *Epinephelus*, the snout not very short, the frontal region flat or convex, the supraoccipital crest continued forward over it, the lateral crests short, low and diverging; mouth and teeth as in *Epinephelus*................ BODIANUS, 13.

jj. Soft dorsal long and very low; dorsal rays IX, 18 or 19; caudal fin deeply forked, the lobes attenuate; snout very short, convex in profile; frontal region flattish or transversely concave, the median crest very prominent; mouth small, the teeth slender.. PARANTHIAS, 14.

Subfamily III.—SERRANINÆ.

(*Serranidæ* without supplemental bone to the maxillary, with no depressible teeth and with more or less distinct lateral canines in the lower jaw; the gill-rakers comparatively short and few in number; the dorsal fin continuous, its number of spines normally 10, and the lateral line usually normal in direction.)

a. Body short and deep, with elevated back, the depth more than two-fifths the length, usually nearly half; preopercle with a few antrorse serræ on its lower limb; top of supraoccipital crest very high, about as long as the smooth area on vertex of cranium; top of head naked; dorsal rays usually X, 14............... HYPOPLECTRUS, 15.

aa. Body comparatively elongate, the depth one-third to one-fourth the length; no hooked spinules on lower limb of preopercle.

b. Smooth area on top of cranium, very short and small; the long supraoccipital crest encroaching on the posterior border of cranium so that the latter in profile is not nearly vertical along the occipital region.

c. Caudal fin more or less distinctly lunate or concave, the middle rays shortest; dorsal spines strong, very unequal, the third or fourth more or less elevated; (scales small; dorsal rays X, 14; top of head usually more or less scaly.).... PARALABRAX, 16.

cc. Caudal fin not lunate, ending in three points, the middle rays produced like the outer ones; dorsal spines slender, the third little elevated, some of them with dermal appendages or filaments; (teeth small, in broad bands; top of head naked; scales large; dorsal rays X, 11.)............................ CENTROPRISTIS, 17.

bb. Smooth area on top of cranium very large, longer than the low supraoccipital crest, which is low and short; posterior border of cranium at occipital region nearly vertical in profile.

d. Dorsal spines very unequal, one or more much produced; dorsal rays, X, 12, or X, 13; preopercle evenly serrate; preorbital comparatively broad.

e. Dorsal spines most of them produced in long filaments; branchiostegals 7; top of head, cheeks and preorbital finely and closely scaled; snout long and low, the lower jaw much projecting; caudal lunate; scales rather small .... CRATINUS, 18.

ee. Dorsal with the third spine only produced in a long filament; branchiostegals 6, the first being obsolete; top of head naked; scales large; caudal subtruncate.. DULES, 19.

dd. Dorsal spines subequal; none of them much produced.

f. Top of head closely scaled; scales large; soft dorsal scaly, its rays about X, 12. PARACENTROPRISTIS, 20.

ff. Top of head from the occiput forward naked.

g. Preopercle with numerous strong diverging spines at its angle, these spines diverging from one or two centers; (profile of head arched; preorbital broader than maxillary, which is widest near its middle; scales rather large)..DIPLECTRUM, 21.

gg. Preopercle simply and rather finely serrate; scales large or small; preorbital narrow; canine teeth various; dorsal rays X, 11, to X, 15..............SERRANUS, 22.

Subfamily IV.—ANTHIINÆ.

(*Serranidæ* with the maxillary destitute of supplemental bone and with the lateral line running very high, close to the dorsal fin; the gill-rakers numerous, long and slender; the mouth oblique, with broad, short maxillary.)

a. Lateral line complete, extending from gill-opening to base of caudal.

b. Caudal-fin very deeply forked, the lobes produced; dorsal spines, 10; preopercle angular, with salient teeth at its angle; one or more of the dorsal spines filamentous; ventral fins produced.

c. Maxillary and frontal region naked; tongue toothless................. PRONOTOGRAMMUS, 23.

cc. Maxillary scaly; top of head scaled to the snout; third dorsal spine produced; body compressed.

d. Tongue without teeth..ANTHIAS, 24.

dd. Tongue with a large patch of villiform teeth.............................ODONTANTHIAS, 25.

bb. Caudal fin subtruncate; dorsal spines, 9; preopercle evenly rounded, its edge very finely serrate; none of the dorsal spines produced, the fins all low; no canines; no opercular spine; jaws scaleless..BATHYANTHIAS, 26.

aa. Lateral line ceasing under last rays of soft dorsal; preopercle entire; dorsal spines 11; jaws scaly; canines present; dorsal spines and ventral fins not produced; caudal deeply forked, its lobes elongate...CALLANTHIAS, 27.

Subfamily V.—LATINÆ.

(*Serranidæ* with the dorsal fins more or less distinctly separated; the lateral line straight or slightly curved upwards in front; no supplementary maxillary bone, and the teeth all alike, without canines; vertebræ 24 to 35; membrane bones of head not especially cavernous. Fishes often entering or inhabiting rivers.)

a. Caudal fin rounded behind; pseudobranchiæ small; tongue toothless; form elliptical, with pointed snout and projecting lower jaw; preorbital, post-temporal, and clavicular bones serrate; angle of preopercle with a strong spine directed backward, the spinules on the lower limb directed somewhat forward; dorsal spines strong, eight in number, the third elevated; anal spines small...LATES, 28.

aa. Caudal fin lunate or forked; pseudobranchiæ large; angle of preopercle with no large horizontal spine; dorsal spines ten.

d. Top of head naked; lateral line distinctly arched in front; body much compressed; preorbital sharply serrate; dorsal fins joined, the spines moderate; anal spines graduated; mouth oblique, the lower jaw projecting; gill-rakers slender; teeth on tongue minute or wanting..KUHLIA, 29.

dd. Top of head scaly; lateral line nearly straight; teeth on tongue in one or more patches.

e. Preopercle without antrorse spines on its lower limb.

f. Dorsal fins joined; spines of fins strong; anal rays III, 9, the spines not graduated; jaws subequal; base of tongue toothless.......................................MORONE, 30.

ff. Dorsal fins separate; spines of fins weak; anal rays III, 12, the spines graduated; lower jaw projecting; base of tongue with teeth .... ROCCUS, 31.

ee. Preopercle with about 3 antrorse spines on its lower limb; dorsals separate; spines slender; anal rays III, 11, the spines graduated; lower jaw slightly projecting. .... DICENTRARCHUS, 32.

Subfamily VI.—PERCICHTHYINÆ.

(*Serranidæ* approaching the *Percidæ*, having the general form of the true Perch (*Perca*); the dorsal fins separated; the maxillary with a large supplemental bone, and the teeth subequal without canines; vertebræ in increased number (about 36); lower jaw, preorbital, suborbital and preopercle extensively cavernous; fresh water fishes of Chili.)

a. Palatine teeth present; preorbital retrorse-serrate; snout bluntish in profile; top of head scaly as far forward as anterior nostril; teeth villiform or cardiform; end of supra-clavicle projecting backward, coarsely serrate; lateral line little curved, concurrent with the back; pseudobranchiæ small; dorsal and anal naked; opercle with spines; preopercle serrate, the serræ on lower limb antrorse; scales moderate, little ctenoid; supraoccipital crest rather long and low; top of cranium anteriorly as far as eyes perfectly smooth, without ridges, and very convex in section; interorbital area with a groove between the orbital ridges .... PERCICHTHYS, 33.

aa. Palatine teeth obsolete; teeth in jaws subcylindrical, blunt; opercular spine obsolete; preopercle with a few minute serræ; snout bluntish; scales large, rough; forehead naked; lateral line bent under second dorsal .... PERCILIA, 34.

Genus I.—RYPTICUS.

Rypticus Cuvier, Règne Animal, ed. II, 1829 (*saponaceus*).
Smecticus Valenciennes, Voyage de la Venus, 1855, 305 (*bicolor*).
Rhypticus Günther, I, 171, 1859 (corrected orthography).
Promicropterus Gill, Proc. Ac. Nat. Sci., Phila., 1861, 53 (*maculatus*).
Eleutheractis Cope, Trans. Am. Phil. Soc., 1870, 467 (*coriaceus*).

TYPE: *Anthias saponaceus*, Bloch and Schneider.
Etymology.—ῥυπτικός, washing, from the "soapy" skin.

The species of this genus are all American, representing in our fauna the genus *Grammistes* of the coasts of Asia. The two genera agree in many particulars, differing chiefly in the fin formula, *Grammistes* having D. VII–I, 13, A. 0, 8, while *Rypticus* has D. II to IV, 21 to 26, A. 0, 14 to 17.

One of the species of *Rypticus* (*bicolor*) has been detached from the others to form a distinct genus, *Smecticus*, said to be characterized by a different number of fin-rays. (D. X, 21, A. II, 15.) Judging from the figure which Valenciennes has given of his *Smecticus bicolor* the species is a genuine *Rypticus*. Apparently some of the rudimentary or "stub" rays of the dorsal and anal have been taken for spines and enumerated accordingly. Another species has been taken to form still another genus, *Eleutheractis*, because the anterior dorsal is wholly separated from the other, not joined by a low membrane as usual in the genus. This character has but slight value, its presence depending to some extent on the condition of preservation of the specimen. *Promicropterus*, based on the species with two dorsal spines, may be regarded as a valid subgenus, but as no other character of importance goes with this one the value of the distinction is not great.

We revert to the original spelling of the name *Rypticus*, although the later *Rhypticus* is the correct form of the word.

The species of *Rypticus* are, with two exceptions, not well known. The various nominal species are probably reducible to six, *R. bistrispinus*, *nigripinnis*, *saponaceus*, *coriaceus*, *arenatus*, and *bicolor*, but we have not the material to demonstrate this.

ANALYSIS OF SPECIES OF RYPTICUS.

a. Dorsal spines, two. (*Promicropterus* Gill.)

b. Body comparatively deep, the depth more than length of head and more than one-third the length in the adult (less in the young); back considerably elevated; preopercle with two developed spines, only the uppermost usually obsolete; maxillary reaching to below posterior margin of eye, 2¼ in head; a depression before eye, the sharp snout abruptly projecting; eye nearly as long as snout, 5½ in head; lower jaw much projecting; upper (median) spine on preopercle often divided, the lowermost larger, directed partly downward; opercular spines small; first dorsal spine a little longer than second, which is nearly or quite free from the soft rays; gill-rakers very short and thick, close set, about 8 or 10 developed; color dusky olive brown, somewhat clouded; sides with a few small irregular whitish spots; young with brownish spots; fins dusky, edge of caudal pale; head 3 in length; depth, 2¼ to 2⅝. D. II, 25, A. 14 or 15..BISTRISPINUS, 1.

bb. Body more slender, the depth about equal to length of head and less than one-third the length, even in the adult; back little elevated; preopercle with three distinct spines; maxillary 2⅝ in head, not quite reaching posterior border of eye; depression before eye slight, the profile not very uneven, slightly convex above eye; eye as long as snout, 5½ in head; lower jaw much projecting; preopercle with three distinct spines, the upper one small, the middle one largest, rarely divided; opercular spines, three, rather strong, the middle one largest; first dorsal spine slightly longer than second, which is nearly or quite free from the soft rays; gill-rakers short and thick, about 8 developed. Color brownish, irregularly mottled with whitish spots as large as the pupil, some of them with a darker center, these spots extending on all the vertical fins, sometimes wanting in the young, vertical fins and pectorals edged with dusky; head 3⅛ in length; depth about 3¼. D. II, 26, A. 16........NIGRIPINNIS, 2.

aa. Dorsal spines three (or four) (*Rypticus*).

c. Dorsal spines three only.

d. Preopercle with three spines, the uppermost blunt, and sometimes obsolete, the lower the largest; opercle with three strong spines, the middle one largest; body rather deep, the depth about equal to length of head and 3¼ in length to base of caudal; back moderately elevated; snout short, not very acute, the lower jaw much projecting; anterior profile steep and almost straight; eye 5½ in head; maxillary reaching beyond pupil, 2¼ in head; first dorsal spine longest; dorsals slightly connected; ventral fins moderate, nearly twice as long as eye; pectorals rounded; gill-rakers short and thick. Color very dark olive brown, the fins all blackish; sides with vague blotches of light brown. Head, 3¼; depth, 3¼; D. III, 24; A. 16....................XANTI, 3.

dd. Preopercle with two spines only, the lower scarcely the longer.

e. Opercular spines three, all well developed.

f. (Color red, with darker cross-shades on sides of back; fins all dusky; dorsal fins well separated; body rather elongate. Head 3⅜ in length; depth 3⅞.) (*Valenciennes*) ....BICOLOR, 4.

ff. Color not red, chiefly olivaceous; dorsal fins distinctly connected by membrane.

g. Body comparatively deep, the depth in the adult about equal to length of head and 3 to 3⅓ in length to base of caudal; young more slender; back elevated; snout rather pointed; lower jaw much projecting; anterior profile before eye a little concave; eye 4½ to 5 in head; maxillary reaching posterior edge of eye, 2⅛ in head; preopercle with two straight spines behind; opercle with three spines, the middle one largest;

first and second dorsal spines subequal, the third smallest; dorsals slightly connected; ventrals very small, not half longer than eye; pectorals rounded; gill-rakers very small and short, about eight developed; color dusky brown, fins marked with blackish and usually with a narrow pale edge; sides generally with irregular pale spots; back and head usually immaculate. Head $3\frac{1}{2}$ in length; depth $3\frac{1}{2}$. D. III, 25, A. 16 .... SAPONACEUS, 5.

gg. [Body comparatively slender, the depth less than length of head. Color dark-brown, the head, throat, anal, dorsal, caudal, and base of pectoral thickly covered with small oblong or roundish dusky spots; these sometimes few and scattered or wholly wanting; vertical fins dark, narrowly edged with paler. Head $3\frac{1}{3}$ in length with caudal; depth $4\frac{1}{2}$; eye $5\frac{1}{2}$ in head. D. III, 23 to 25, A. 16.] (*Steindachner*). ARENATUS, 6.

ee. Opercular spines two, small, the uppermost the smaller (the lowermost being obsolete); dorsal fins separated; body moderately elongate, the back elevated, the head low, slender, and pointed, the anterior profile almost straight; lower jaw much projecting; eye small, smaller than in *R. saponaceus*, 5 to $5\frac{1}{2}$ in head; about equal to the short snout; maxillary reaching posterior edge of eye, $2\frac{2}{3}$ in head, preopercular spines short, bluntish, close together, the uppermost the smaller; first dorsal spine longest, the two fins well separated; ventrals moderate, nearly twice as long as eye; gill-rakers small and short; color (in our specimen) nearly plain brown, the edges of the scales darker with dark points; sides with some faint paler spots; edges of vertical fins dusky; head $3\frac{1}{4}$; depth $3\frac{1}{2}$. D. III, 25, A. 15 .... CORIACEUS, 7.

cc. [Dorsal spines four; spines not described, probably as in *R. arenatus;* color brown; body and base of dorsal covered with round, jet-black spots, each surrounded by a clear ring; these spots lie in five longitudinal rows, those of the middle row much larger than the others; a sixth row on base of dorsal and 2 or 3 spots on base of anal; fins dusky, without paler margin; head $3\frac{1}{3}$ in length (with caudal), depth $4\frac{1}{2}$, D. IV, 22 or 23, A. about 12.] (*Steindachner*.) .... NIGROMACULATUS, 8.

1. RYPTICUS BISTRISPINUS.

SOAP-FISH.

Bodianus bistrispinus Mitchill, Am. Monthly Magazine and Crit. Review, 247, Feb., 1818 (Straits of Bahama).

Rhypticus bistrispinus Jordan, Cat. Fishes of N. A., 86, 1885.

Rhypticus maculatus Holbrook, Ichth. S. Car., Ed. 1, 1856, 39, and Ed. 2, 1860, 42 (Cape Romain, South Carolina); Günther, I, 173, 1859 (copied); Jordan and Gilbert, Syn. Fishes of N. A., 543, 1883; Jordan, Proc. U. S. Nat. Mus., p. 35, 1884 (Pensacola.)

Rhypticus pituitosus Goode & Bean, Proc. U. S. Nat. Mus., 1879, 341 (Key West); Jordan and Gilbert, Syn. Fishes of N. A., 543, 1883.

Rhypticus bistrispinosus Jordan, Proc., U. S. Nat. Mus., 1884, p. 149 (Key West); Jordan, *op. cit.*, 546, (Newport); Jordan, Proc. U. S. Nat. Mus., 1886, 581 (*lapsus calami* for *bistrispinus*).

Promicropterus decoratus Cope, Proc. Ac. Nat. Sci., Phila., 118, 1870 (Newport, R. I.) (not of Gill).

Rhypticus decoratus Jordan & Gilbert, Syn. Fishes of N. A., 543, 1883 (copied).

Habitat.—South Atlantic coast of United States.

Etymology.—*Bistrispinus*, twice three spines.

Our specimens of this species are from Pensacola.

All the two-spined soap-fishes which we have seen from the Atlantic seem to belong to a single species, for which the oldest specific name is the long-neglected one of *bistrispinus* Mitchill. It is not uncommon in rather deep water off our South Atlantic coast.

2. RYPTICUS NIGRIPINNIS.

Rhypticus nigripinnis Gill, Proc. Ac. Nat. Sci., Phila., 1861, 53 (Panama); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 359 (Cape San Lucas); Jordan and Gilbert, *op. cit.*, 375 (Panama); Jordan and Gilbert, *op. cit.*, 381 (Panama); Jordan and Gilbert, *op. cit.*, 110 (Panama); Jordan, Proc. U. S. Nat. Mus., 1885, 378 (Cape San Lucas, Panama); Jordan, Cat. Fishes of N. A., 86, 1885; Jordan, Proc. U. S. Nat. Mus., 1889, 180 (Panama).

Rhypticus maculatus Gill, Proc. Ac. Nat. Sci., Phil., 1862, 251 (Cape San Lucas) (not of Holbrook).

Promicropterus decoratus Gill, Proc. Ac. Nat. Sci., Phila., 1863, 164 (Panama).

Rhypticus decoratus Günther, Fishes Cen. Am., 412, 1869 (Panama).

Habitat.—Pacific coast of tropical America, Cape San Lucas to Panama.

Etymology.—*Niger*, black; *pinna*, fin.

We have examined numerous specimens of this species, including the original types of *nigripinnis*, *maculatus*, and *decoratus*. There is no doubt whatever of the identity of these three. *Rh maculatus* Gill is said to have three dorsal spines, but this is an error, the first (broken) soft ray on the type having been counted as a spine. We have compared *R. nigripinnis* with *R. bistrispinus*, and find the two different, although very nearly related.

The chief distinctions are to be drawn from the slenderer body of *R. nigripinnis*, and from the presence of three distinct opercular spines, there being usually but two in *R. bistrispinus*, although the original meaning of the specific name of the latter implies the presence of three.

Our description is drawn from No. 29277, U. S. National Museum, taken by Professor Gilbert at Panama.

3. RYPTICUS XANTI.

Rhypticus xanti Gill, Proc. Ac. Nat. Sci., Phila., 1862, 250 (Cape San Lucas); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 359 (Cape San Lucas); Jordan and Gilbert, *op. cit.*, 371 (Colima); Jordan and Gilbert, *op. cit.*, 106 (Mazatlan); Jordan, Proc. U. S. Nat. Mus., 1885, 377 (Cape San Lucas).

Habitat.—Pacific coast of Mexico.

Etymology.—Named for John Xantus, the discoverer of the species.

This species differs from *R. saponaceus* of the Atlantic chiefly in the armature of the head. We have examined the original type, and also specimens from Colima and Mazatlan. Our description is drawn from No. 7740, U. S. Nat. Mus., collected by Mr. John Xantus, at Colima.

4. RYPTICUS BICOLOR.

Smecticus bicolor Valenciennes, Voyage de la Venus, Poissons, 307, Pl. ii, f. 2, 1855 (Galapagos Archip.).

Rhypticus bicolor Günther, I, 173, 1859 (copied).

Habitat.—Galapagos Archipelago.

Etymology.—*Bicolor*, two colored.

This species is known from the description and figure given by Valenciennes. The description speaks of ten dorsal and two anal spines, but it is evident from the figure that this is an ordinary *Rypticus*, the short or rudimentary rays of the dorsal and anal having been taken by Valenciennes for spines. The red coloration, as shown on the figure, is exceptional in this genus, and its correctness may be doubted. It is not unlikely that the species is identical with *Rypticus xanti*. Possibly it is a deeper-water form, analogous to the red forms of certain species of *Mycteroperca*. The plate of this species (issued in 1846) is named "*Rypticus bicolor*," the name *Smecticus* appearing in the later text (1855).

5. RYPTICUS SAPONACEUS.

SOAP-FISH; JABON; JABONCILLO.

Jaboncillo Parra, Difer. Piezas de Hist. Nat., 51, lam. 24, f. 2, 1787 (Havana).

Anthias saponaceus Bloch and Schneider, Syst. Ichth., 310, 1801 (after Parra).

Rhypticus saponaceus Cuv. and Val., Hist. Nat. des Poissons, III, 63, 1829 (Brazil; Cape Verde); Storer, Syn. Fishes N. A., 289, 1846 (copied); Günther, I, 172, 1859 (Cape of Good Hope; St. Hélena; West Indies; St. Vincent's, Jamaica); Gill, Proc. Ac. Nat. Sci., Phila., 1869, 52; Günther, Proc. Zool. Soc., Lond., 225, 1868 (St. Helena); Poey, Syn. Pisc. Cubensium, 297, 1868 (Havana); Cope, Trans. Am. Phil. Soc., 1870, 467 (St. Croix); Peters, Berliner Monatsberichte, 245, 1876 (Victoria, West Africa); Poey, Enumeratio, 34, 1875 (Havana); Poey, Fauna Puerto Riqueña, 322, 1881 (Porto Rico); Jordan, Proc. U. S. Nat. Mus., 35, 1884 (Pensacola); Jordan, Cat. Fishes N. A., 85, 1885; Jordan, Proc. U. S. Nat. Mus., 1886, 581; Jordan, *op. cit.*, 41 (Havana).

Rhypticus microps Castelnau, Anim. Nouv. ou Rares de l'Amer. du Sud, 6, 1855 (Bahia), (after *Perca microps* Broussonet, a MSS. name ?).

Habitat.—West Indian fauna, Pensacola to West Africa and Brazil.

Etymology.—*Saponaceus*, soapy.

This species is the best known and most widely distributed of the soap-fishes. Our specimens are from Havana, Pensacola, and Bahia. The young specimens are much slenderer in form and more uniform in color than the adult, but we think that all belong to the same species.

The name *Rypticus microps* has been adopted for this species by Castelnau, on account of the early name *Perca microps* of Broussonet. We find, however, no published reference to this name except the statement by Cuvier, that a specimen bearing this MSS. name is in the museum at Paris. We doubt whether it has priority of publication over *Anthias saponaceus*.

6. RYPTICUS ARENATUS.

Rypticus arenatus Cuv. and Val., III, 65, pl. 45, 1829 (Brazil); Günther, Cat. Fish, Brit. Mus., I, 1859, p. 173. (Jamaica, Trinidad); Steindachner, Ichth. Notiz., VI, 41, 1867 (Barbadoes); Jordan Proc. U. S. Nat. Mus., 1886, 581.

? *Rhypticus subbifrenatus* Gill, Proc. Acad. Nat. Sci., Phila., 1861, 53 (St. Thomas).

Habitat.—West Indian Fauna.

Etymology.—*Arenatus*, sanded, from the speckled coloration.

We have not seen this species, and take our account of it chiefly from Dr. Steindachner.

The scanty description of a young example published by Gill, under the name of *Rhypticus subbifrenatus*, seems to approach very closely to *R. arenatus*. The following is the substance of Dr. Gill's account of *R. subbifrenatus*.

Color dusky, with remote dark spots; head with two series of spots; one series of four between orbit and opercular spine; the other of three smaller spots between eye and suprascapula; head $2\frac{2}{3}$ in length ($3\frac{1}{2}$ with caudal); depth $3\frac{3}{4}$ ($4\frac{1}{2}$ with caudal). D. III, 23. A. 15.

7. RYPTICUS CORIACEUS.

Eleutheractis coriaceus Cope, Trans. Am. Phil. Soc., 467, 1870 (St. Martin's).
Rhypticus arenatus Bean and Dresel, Proc. U. S. Nat. Mus., 1884, 163 (Jamaica).

Habitat.—West Indian Fauna.
Etymology.—Latin, *coriaceus*, leathery.

A specimen before us (30130, U. S. Nat. Mus.) from Kingston, Jamaica, seems to be identical with *Eleutheractis coriaceus* Cope. It seems to us to represent a valid species, distinguished from *R. saponaceus* by the weak armature of the head, and by the greater distance between the dorsal fins.

8. RYPTICUS NIGROMACULATUS.

Rhypticus nigromaculatus Steindachner, Ichth. Notiz., VI, 42, 1867. (Barbadoes.)

Habitat.—West Indian Fauna.
Etymology.—*Niger*, black; *maculatus*, spotted, from the black spots on body.

This species is based on a single specimen 1¾ inches long. Except that it is said to have four dorsal spines, the description agrees with that of *R. arenatus*, and *R. nigromaculatus* may prove to be simply an accidental variation of the latter.

Genus II.—POLYPRION.

Polyprion (Cuvier), Valenciennes, Mémoires du Muséum, XI, 265, 1824 (*cernium*).
Hectoria Castelnau, Proc. Zool. Soc. Vict., II, 1873, 1851 (*gigas=oxygeneios*).

TYPE.—*Polyprion cernium* Valenciennes.
Etymology.—Πολὺς, many; πρίων, saw, from the numerous serrations on head and fins.

This genus seems to be somewhat allied to *Epinephelus*, but it is readily distinguished from all the other *Serranidæ* by the armature of its head. The two known species inhabit the warm seas and reach a very great size.

ANALYSIS OF THE SPECIES OF POLYPRION.

a. Body robust, moderately elevated, the depth 3 in length; head, 2½; mouth large, the maxillary reaching posterior border of eyes; teeth in villiform bands on jaws, vomer, palatines and tongue; supraocular region, supraclavicle, post temporal, preopercle, and a ridge on the opercle spinigerous; dorsal fin low, with 11 strong spines; caudal rounded; anal spines short, serrate anteriorly, the third much the longest; ventrals large; pectoral short; color grayish-brown, the caudal edged with white; young clouded with light and dark. D. XI, 12, A. III, 8........CERNIUM, 9.

aa. [Body more elongate; the depth 3½ in length; head 2½; armature of the head less developed than in *P. cernium;* dorsal spines 12; color, dark gray above, paler below. D. XII, 11, A, III 8,] (*Steindachner*)..OXYGENEIOS, 10.

9. POLYPRION CERNIUM.

(THE WRECK-FISH; STONE BASS; CERNIER.)

Polyprion cernium (Cuvier), Valenciennes, Mém. du Muséum, XI, 265, 1824; Cuv. and Val., Hist. Nat. Poiss. III, 21, pl. 42, 1829 (France; Italy); Günther I, 169, 1859 (Mediterranean); Day, Fish. Great Britain, 17, 1865, and of authors generally.
Holocentrus gulo Risso, Europe Méridionale, III, 367, 1826 (Nice).
Serranus couchi Yarrell, British Fishes, Ed. 1, 12, 1836.

Polyprion oxygenius Jordan and Gilbert, Syn. Fish. N. A., 532, 1883 (Deep water, off U. S. coast), not *Epinephelus oxygeneios* Bloch and Schneider.

Polyprion americanus Jordan, Cat. Fish. N. A., 83, 1885 (probably not *Amphiprion americanus* Bloch and Schneider).

Habitat.—Southern Europe, north to Norway and south to Cape of Good Hope, once taken in the Gulf Stream off the United States coast.

Etymology.—*Cernier*, French name for the species.

This large fish is not uncommon in the deep waters off the coast of Europe, especially southward. It is said to live most abunduntly about wrecks; hence the common name of wreck-fish. It reaches a length of five or six feet. A single young specimen has been taken in the deep waters of the Gulf Stream by the United States Fish Commission.

10. POLYPRION OXYGENEIOS.

(HAPUKU.)

? *Amphiprion americanus* Bloch and Schneider, Syst. Ichth., 205, 1801, pl. XLVII (based on a drawing sent from Latham to Schneider of some fish called "*girom*" in America; called *Amphiprion australis* in the plate), (may have been based on a young example of *P. cernium*).

Epinephelus oxygeneios Bloch and Schneider, Syst. Ichth., 301, 1801 (based on Forster's MSS., Queen Charlotte's Island, near New Zealand).

Perca prognathus Forster, MSS. Lichtenstein Cat. Anim., 1844, 309 (Queen Charlotte's Island).

Polyprion prognathus Günther, Ann. Mag. Nat. Hist., 1887, 236 (discussion of synonymy).

Centropristis gigas Owen, Osteol. Cat. College Surgeons, I, 51. (Skeleton.)

Oligorus gigas Günther, I, 251, 1859.

Hectoria gigas Castelnau, Proc. Zool. Soc. Vict., II, 1873, 151.

Polyprion kneri Steindachner, Ichth. Beitr., II, 1, 1875 (Juan Fernandez Island). Günther, Shore Fishes, Challenger, 1880, 24 (Juan Fernandez).

Polyprion sp. Kner, Novara Fische, I, 28, 1865 (St. Paul Island).

Habitat.—South Pacific; coasts of South America and New Zealand.

Etymology.—ὀξύς sharp, γένειον-chin.

We have not seen this species and know it only from the accounts given by Kner, Steindachner, and others.

It seems to us that the figure given by Bloch and Schneider of *Amphiprion americanus* is quite as likely to have been based on this species, which is really American, as on the European *Polyprion cernium.* The species is represented as more slender than the European fish, and the rough ridges on the head, very conspicuous in the European species, are not shown in this picture. Latham's drawing, on which Schneider's species was based, was said to have been made in America, where the fish is called "*Girom.*" As there is no certainty in the identification of this figure, we have adopted the name *oxygeneios*, rather than *americanus.*

Dr. Günther has lately published a note on the synonymy of this species, which throws much light on its history. He adopts for it the specific name of *prognathus*, a name which although proposed by Forster when the species was discovered has lain in MSS. until the year 1844. If, however, the name occurs in any prior works of Forster, Parkinson, or Captain Cook, it should be adopted in preference to *oxygeneios.* We quote Dr. Günther's note in full:

[From the Annals and Magazine of Natural History for September, 1887.]

NOTE ON THE HAPUKU OF NEW ZEALAND (POLYPRION PROGNATHUS).

The Hapuku of New Zealand, one of the most highly esteemed food-fishes of the southern hemisphere, and attaining to a weight of 100 pounds, has been known to naturalists since Cook's visits to that country, as has been shown by Mr. Hutton (Trans. N. Z. Instit. v. p. 259). It was figured by Forster as well as by Parkinson, the former naming it *Perca prognathus*, a very appropriate term, to which I give preference before all others, although Schneider (Bl. Schn. p. 301) arbitrarily changed it into the less expressive *Epinephelus oxygeneios*. Forster's original description is published in "Descript. Animal. ed. Lichtenstein," p. 309, and referred to by Cuvier (Cuv. & Val. Hist. Nat. Poiss. III. p. 29), who, with his perfect knowledge of fishes, recognized its relation to *Polyprion*, not doubting that it was the same species as the Atlantic *P. cernium*.

The figure left by Parkinson bears the name *Sciœna gadoides*, probably in Broussonet's handwriting; but this name seems to have remained always a MS. name.

The second period of the history of this fish begins with Owen, who, in the "Osteological Catalogue of the College of Surgeons," I. p. 51, described the skeleton of a New Zealand Percoid under the name of *Centropristis gigas*. In the "Catalogue of Fishes," I. p. 251, I stated the reasons which prevented me from adopting Professor Owen's view as to the generic affinity of this fish, which I thought, in the absence of specimens preserved entire, would prove to be rather with the Murray cod, *Oligorus*; and thus the fish appeared in nearly all subsequent publications as *Oligorus gigas*. Castelnau, however, ("Notes on the Edible Fishes of Victoria," 1873, p. 8, and Proc. Zool. Soc. Vict. II. 1873, p. 151), proposed to form a new genus for it, *Hectoria*, "on account of its armed tongue, double-pointed operculum, etc."

In more recent years the same fish has been found far from the place of its first discovery, viz., off the island of Juan Fernandez, and described by Steindachner as *Polyprion kneri* (Sitzungsb. Wien. Acad. lxxi. p. 443); also the *Challenger* obtained it off the same island (Chall. Shore Fish. p. 24).

Finally, the British Museum obtained from the Fisheries and Indo-Colonial Exhibitions specimens (in spirit as well as mounted) from New Zealand and Juan Fernandez*; and a direct comparison of these specimens can leave no doubt that all belong to the same species, which is antipodal to the only other species known, *Polyprion cernium*.

Lowe (Fish. Madeira, p. 185) has shown that *P. cernium* is a deep-sea fish, swimming near the surface when young, but living habitually at a depth of 300 and more fathoms when adult. The wide range of this genus is therefore not surprising; in fact we may well expect that *P. cernium* will be met with far beyond the limits of the northeastern Atlantic.

Genus III.—STEREOLEPIS.

Stereolepis Ayres Proc. Cal. Ac. Nat. Sci., 1859, 28. (*gigas*).

TYPE.—*Stereolepis gigas* Ayres.

Etymology.—Στερεός, firm; λεπίς, scale.

This genus contains a single species, one of the gigantic Serranoids known as "jew-fishes," rivaling in size *Polyprion cernium*, *Epinephelus nigritus*, and *Promicrops guttatus*.

The Australian genus *Oligorus* Günther is closely allied to *Stereolepis*, differing apparently in the greater number of soft rays in the dorsal and anal fins (D. XII, 14 to 16: A. III, 12).

ANALYSIS OF SPECIES OF STEREOLEPIS.

a. Body oblong, somewhat elevated, little compressed; head robust, the profile steeply elevated, the forehead broad and flattish; edges of preopercle and interopercle serrate, becoming nearly entire with age; crown, cheeks, and opercles scaly; snout, preorbital, and jaws naked; scales small,

*Those exhibited by the Chilian Government, and presented by them to the British Museum, bore the MS. name "*Perca fernandeziana*."

not strongly ctenoid, the surface rugose with radiating striæ; mouth large, lower jaw prominent; maxillary, with a well-developed supplemental bone, extending to below the eye; preorbital wide; teeth all villiform, in broad bands, on jaws, vomer, and palatines; dorsal spines stout, the last spines very much shorter than the middle ones, and all depressible in a deep groove; anal fin similar to soft dorsal, with three low stout spines; caudal fin broad, nearly truncate; pectorals moderate; ventrals long, reaching vent; color brownish with large black blotches, becoming with age nearly uniform greenish black; vertical fins in the young with a conspicuous pale edge; ventrals black. Head 3 in length; depth 3. D. XI, 10: A. III, 8; scales 115 .... GIGAS, 11.

11. STEREOLEPIS GIGAS.

(THE CALIFORNIA JEW-FISH.)

Stereolepis gigas Ayres, Proc. Cal. Acad. Sci. 28, 1859; (Southern California) Jordan & Gilbert, Proc. U. S. Nat. Mus., 27, 1880, (San Diego); Jordan & Gilbert, Proc. U. S. Nat. Mus., 456, 1880; (Monterey Bay; Santa Barbara; San Diego); Jordan & Gilbert, Synopsis Fish, N. Am., 531, 1883; Jordan Cat. Fish. N. Am. 83, 1885.

Stereolepis californicus Gill, Proc. Acad. Nat. Sci. Phil., 330, 1863, (California) substitute for *gigas*, supposed to be preoccupied, but the *Centropristis gigas* of Owen is a *Polyprion*.

Habitat.—Coast of California, north to the Farallones.

Etymology: *gigas*, giant.

This huge fish is rather common about rocks on the California coast, from the Farallones southward to beyond San Diego. It reaches a weight of 400 to 500 pounds.

As it was thought likely that *Centropristis gigas* Owen (Osteol. Cat. 1853, 1, 51) from New Zealand might prove to be a species of *Stereolepis*, Dr. Gill has proposed to change the name of this species to *Stereolepis californicus*. This species of Owen, is now regarded as identical with *Polyprion oxygeneios*.

Genus IV.—HEMILUTJANUS.

Hemilutjanus Bleeker, Systema Percarum Revisum, Archives Neèrlandaises, XI, 1875,277. (Type *Plectropoma macrophthalmos* Tschudi).

TYPE—*Plectropoma macrophthalmos* Tschudi.

Etymology—ἡμι, half; *Lutjanus*, a genus of *sparoid* fishes, to which these fishes are in no way allied.

This is one of the most strongly marked of the Serranoid genera, showing resemblances at once with *Stereolepis*, *Plectropoma*, *Anthias*, and *Priacanthus*. But a single species is definitely known.

The name selected by Dr. Bleeker for this genus is peculiarly unfortunate, for besides the lack of euphony in the name, the genus has neither resemblance to nor affinity with the genus *Lutjanus*.

ANALYSIS OF SPECIES OF HEMILUTJANUS.

a. Color nearly uniform grayish, lateral line black; caudal lunate; body rather short, deep, compressed; anterior profile rather steep; snout sharp; profile with a concavity before and above eye, the nape convex; occipital keel sharp; interorbital space broad, concave next the sharp orbital ridges, the middle transversely convex; interorbital width 4½ in head, snout 4; nostrils roundish, close together, the posterior the larger; eye very large, 3¼ in head; preorbital extremely narrow, about one-fourth width of pupil; mouth large, the lower jaw projecting; maxillary very broad and scaly, reaching posterior edge of pupil, $1\frac{9}{10}$ in head; supplemental maxillary very broad, broader than in any other of the *Serranidæ*, scaly, its width scarcely less than that of the preorbital; teeth very small, in villiform bands; no canines; the outer teeth above very slightly enlarged; preopercle subrectangular, the perpendicular limb straight, vertical and finely serrate; angle with larger, radiating teeth; about ten small sharp teeth on the lower limb directed downward, the anterior directed slightly forward; top of head, maxillary, mandible, opercular bones, all parts of the head except the eye and lips closely covered with small rough scales, much as in the genus *Priacanthus;* scales on opercle small, like those on the cheeks; gill-rakers very long, about x+20, the longest 1⅗ in eye; opercular spines very weak; lateral line bent upward anteriorly, but not running high, the scales above it smaller than those below; dorsal and anal fins naked, but with a scaly sheath at base; dorsal spines low, the fifth highest, 3⅓ in head; soft dorsal rays few and rather long, their height not twice that of last spine, 3 in head; anal fin low, the spines strong, graduated; second anal spine 4 in head; caudal lunate, with rounded lobes; pectoral pointed, rather short, 1⅔ in head. Color dusky-silvery, the fins blackish; lateral line black, conspicuous, much as in *Centropomus undecimalis*. Head, 2⅔ in length; depth, 2⅗. D. X, 11; A. III, 9. Scales, 66 (pores); 70 rows above lateral line, 100 below; 18 between first dorsal spine and lateral line .... MACROPHTHALMOS, 12.

aa. [Color reddish gray, with five large yellow spots on the side; caudal fin forked. D. X, 12; A. III, 7.] (*Günther*) .... PAYTENSIS, 13.

12. HEMILUTJANUS MACROPHTHALMOS.

Plectropoma macrophthalmos Tschudi, Fauna Peruana, Ichth., 1845, 6. (Lurin, Callao.) Günther, I, 165, 1859; (copied). Kner, Neue Fische aus Museum Godeffroy, 1867, 3, plate. (Iquique).

Hemilutjanus (macrophthalmus) Bleeker, Systema Percarum Revisum, 1875, 277 (generic diagnosis).

Habitat.—Coasts of Peru and Chili.

Etymology.—*Μακρός*, large; *οφθαλμός*, eye.

We have examined specimens of this species in the museum at Cambridge from Peru and from Caldera, Chili. The specimen from which our account is taken (21716 M. C. Z.) is from the coast of Peru; E. G. Squire. It is about 11 inches in length. The species is well represented in the figure published by Dr. Kner.

13. HEMILUTJANUS PAYTENSIS.

Plectropoma paytensis Lesson, "Voyage de la Coquille, Zool. 233, 1828" (Payta.); Günther, I, 165, 1859. (Copied).

Habitat.—Coast of Peru.

Etymology.—Named from Payta, where it was first found.

We know nothing of this species except what is contained in the few words quoted by Dr. Günther from Lesson. It may not belong to *Hemilutjanus*, though, so far as it goes, the description accords with this genus. Possibly it is simply the young of *H. macrophthalmos*.

GENUS V.—GONIOPLECTRUS.

Gonioplectrus Gill, Proc. Ac. Nat. Sci., Phila., 1862, 236, 237 (*hispanum*).

TYPE.—*Plectropoma hispanum* Cuv. and Val.

Etymology.—*Γωνία*, angle; *πλῆκτρον*, spur.

This well-marked genus contains a single species allied to *Plectropoma* and *Alphestes*, but with a stronger opercular armature than is found in any other genus. According to Poey, the skull "shows a great affinity with *Hypoplectrus*. Thus it is rounded above, the supraoccipital crest is below the level of the frontals; the other crests are low." In some respects *Gonioplectrus* resembles *Anthias*.

ANALYSIS OF SPECIES OF GONIOPLECTRUS.

a. Body short and deep, with very short, deep tail; interorbital region narrow, the bones rugose; snout $3\frac{3}{5}$ in head; maxillary reaching middle of orbit, 2 in head, naked, its supplemental bone well developed; preorbital narrow; lower jaw projecting; teeth very small, in narrow, villiform bands, the depressible teeth very few; a stout canine on each side, in front of each jaw, and one or two similar canines in middle of side of lower jaw; eye $4\frac{1}{2}$ in head (exclusive of opercular spine); preopercle finely serrate, with a single very large antrorse hook at its angle; opercle ending in four spines, the second of which is long, straight, compressed and knife-shaped, as long as eye; nostrils small, round, separated, the posterior the larger; suborbital serrate on its edge; gill rakers rather long and slender, x + 15; scales small, firm, and rough; lateral line arched, running high, close to middle of spinous dorsal, and then bent abruptly downward; dorsal spines low and stout, the fin notched; soft dorsal short and rather high; longest dorsal spine 3 in head; second anal spine $2\frac{2}{3}$, very strong, longer than third, the soft rays high and rather short, scaly; pectorals moderate, rounded at tip, longer than ventrals, $1\frac{1}{2}$ in head; caudal truncate, its peduncle as deep as long; color rose-colored, with yellow stripes along head and back; top of head with orange spots; a pale bar before vent; caudal fins sometimes with dark spots; fins otherwise plain; head $2\frac{1}{2}$ in length; depth $2\frac{3}{5}$. D. VIII, 13. A. III, 7, scales 70.
HISPANUS, 14.

14. GONIOPLECTRUS HISPANUS.

("SPANISH FLAG"; OUATILIBI ESPAGNOL; BIAJAIBA DE LO ALTO.)

Plectropoma hispanum Cuv. & Val., Hist. Nat. Poiss., II, 396, 1828, (Martinique); Storer, Synopsis Fish. N. Am., 282, 1846 (copied); Poey, Memor. Cuba, I, 72, plate 4, fig 1, 1851 (Havana); Günther, Cat. Fish Brit. Mus., I, 165, 1859 (copied).

Gonioplectrus hispanus Poey, Synopsis Pisc. Cubens., 289, 1868 (Havana); Poey, Enumeratio, 24, 1875 (Martinique).

Habitat.—West Indian fauna.

Etymology.—*Hispanus*, Spanish, its colors resembling those of the Spanish flag.

This species is known to us from specimens in the museum at Cambridge, sent from Cuba by Professor Poey.

Genus VI.—GILBERTIA.

Gilbertia Jordan, Genus nova.

TYPE.—*Plectropoma semicinctum* Cuv. & Val.

Etymology.—Named for Dr. Charles Henry Gilbert, of the University of Indiana.

The group of species of which *Plectropoma semicinctum* is the type seems to us to form a genus sufficiently distinct from *Plectropoma.* The latter genus (taking *Bodianus cyclostomus* Lac. (=*B. melanoleucus* Lac.) as its type,* has a much shorter dorsal fin (D., VIII, 11 or 12) and small scales. Both genera have lateral canines in the lower jaw. There are no American species in *Plectropoma* as now restricted.

Besides the typical species, *semicincta*, the three following, none of them examined by us, appear to belong to *Gilbertia*:

Plectropoma nigrorubrum Cuv. & Val. (Australia).

Plectropoma annulatum Günther (locality unknown) and *Plectropoma armatum* Castelnau (=*P. huntii* Hector), from Australia.

*This arrangement accords with the earliest restriction of *Plectropoma*, that made by Gill in 1862. Bleeker has since transferred the name *Plectropoma* to *Lates*, because of the three species placed by Cuvier in *Plectropoma*, the one standing first in the list was *Lates calcarifer*. To the genus called *Plectropoma* by Gill he has given the new name of *Paracanthistius.*

Plectropoma dentex Cuv. & Val., also from Australia, seems to belong to a different genus (*Colpognathus* Klunzinger, Sitzber. Akad. Wiss. Wien, 1879, LXXX, 339), having both jaws well scaled and three to six large canines on the side of the lower jaw. *Colpognathus dentex* has also the dorsal rays X, 18, and the antrorse teeth of the preorbital quite small.

[1] I have taken pleasure in naming this genus for my friend and associate, Dr. Charles H. Gilbert.

ANALYSIS OF AMERICAN SPECIES OF GILBERTIA.

a. Body compressed, moderately elongate; head rather pointed, the profile straightish and not very steep; eye small, 5 in head; maxillary 2 in head; preorbital narrow, two-thirds diameter of eye; teeth quite small, in very narrow bands, the inner depressible; a stout canine on each side in front of each jaw, and a stout curved canine on each side of lower jaw; supplemental maxillary evident; jaws naked; top of head very narrow, transversely convex, scaly; interorbital width $10\frac{1}{2}$ in head; snout $3\frac{1}{2}$; preopercle rounded, arciform, rather finely and sharply serrate; two moderate teeth, hooked forward on its lower limb; opercular spines small; scales on opercles much smaller than those on cheeks, the latter in 15 rows; gill rakers short and slender, x+10, as long as pupil; scales rather large, ctenoid, those on breast small; lateral line running rather high; dorsal spines low, slender, the fifth longest, $2\frac{3}{4}$ in head; the last spine not half the height of the first soft ray, which is rather high, $2\frac{2}{3}$ in head; caudal rounded; anal rather low, the second spine high and strong, $2\frac{1}{3}$ in head; pectoral long, $1\frac{3}{4}$ in head. Color in spirits: body and fins pale, the fins nearly plain, the spinous dorsal and anal with dark edging; upper half of body with seven or eight broad black cross-bands wider than the interspaces, these somewhat irregularly confluent along sides, and not quite meeting below; top and sides of head with dark streaks; breast with dark longitudinal clouds. Head $2\frac{4}{5}$ in length; depth $2\frac{2}{3}$. D. X, 20. A. III, 8. Scales 52 (51 pores) .... SEMICINCTA, 15.

15. GILBERTIA SEMICINCTA.

Plectropoma semicinctum Cuvier & Valenciennes, Hist. Nat. Poiss. IX, 442, 1833 (Juan Fernandez); Gay, "Chile.. Zool. II, 153, pl. 2, f. 1" (Chili).

?*Plectropoma semicinctum* Günther I, 160, 1859 (Australia); Steindachner, Zur Fisch-fauna, Port Jackson, 1866, 2 (Australia).

Habitat.—Coasts of Chili.

Etymology.—*Semi*, half; *cinctus*, belted.

We have examined two specimens of this species (4829 M. C. Z.), each about 6 inches in length, collected on the island of Juan Fernandez by Dr. Steindachner.

The coloration, the large scales, and the naked jaws give this fish a resemblance to the species of *Serranus*, but its real affinities are with *Epinephelus* and *Plectropoma*.

The Australian specimens referred by Günther and Steindachner to this species perhaps belong to some other.

GENUS VII.—ACANTHISTIUS.

Acanthistius Gill, Proc. Ac. Nat. Sci., Phila., 1862, 236 (*serratus*).

TYPE.—*Plectropoma serratum* Cuv. and Val.

Etymology.—ἄκανθα, spine; ἱστίον, sail or dorsal fin.

This genus is allied to *Plectropoma*, as restricted by Gill, a chief difference being the presence of thirteen dorsal spines instead of eight, as in *Plectropoma*. This character of having the spines in increased number seems to accord with the facts of its geographical distribution, the species of *Plectropoma* and of its allies with few dorsal spines, *Gilbertia* and *Alphestes*, belonging to tropical waters, while *Acanthistius* is characteristic of the south temperate zone. Our species of *Acanthistius* differ from the type of the genus in the presence of lateral canines, which are undeveloped in *Acanthistius serratus*. Less closely allied to *Plectropoma* are *Gonioplectrus* and *Hemilutjanus* while *Hypoplectrus*, usually associated with these, is a genuine ally of *Serranus*, having little except its plectroid armature in common with these grouper-like fishes.

ANALYSIS OF AMERICAN SPECIES OF ACANTHISTIUS.

a. Sides of lower jaw with small canines.

b. Body very short and deep, the depth 2⅓ in length; preopercular spines moderate, 3 on lower limb; color plain dark brown or with paler cross shades; back elevated; anterior profile steep and straight; jaws subequal; mouth moderate, the maxillary reaching posterior border of eye, 2 in head; snout 4⅓ in head; eye 4½; preorbital narrow; interorbital space narrow, transversely convex; teeth small, about as in *Epinephelus*; canines small; lateral canines of lower jaw as large as upper anterior canines, and larger than anterior canines of lower jaw; nostrils small, round, not close together; preopercle rounded with moderate serræ above, these increasing in size downward; three serræ turned downward and forward on lower limb, besides two near angle also turned downward; opercular spines small; scales larger and rougher than in *patachonicus*; gill-rakers moderate, slender, x+14; lateral line normal in direction; dorsal spines rather slender, the longest 2⅔ in head; dorsal deeply notched, the soft rays low; caudal peduncle short, compressed; caudal rounded; anal rounded, short and high, the second spine strongest, 2⅔ in head; pectoral rather long, 1⅔ in head. Color brown, nearly plain; fins dusky; young with paler cross-bands. Head 2⅔ in length; depth, 2⅓; D. XIII, 15; A. III, 8; scales 60 (pores), 86 in a longitudinal series .... BRASILIANUS, 16.

bb. Body less deep; the depth 2⅔ in length; preopercular spines very strong, 2 on lower limb; color brown, covered with darker reticulations. Body short and deep, the back elevated, the profile straight and rather steep; preorbital and teeth essentially as in *A. brasilianus*; jaws subequal; maxillary broad, scaleless, with well-developed supplemental bone; maxillary reaching posterior edge of pupil, 2½ in head; eye large, 4½ in head; snout short, 4⅔; nostrils round, the posterior rather the larger; preopercle strongly and sharply serrate above, the teeth larger below; a strong tooth downward and backward at angle, with two strong antrorse hooks before it; opercular spines small, but distinct; gill-rakers long and slender, 1⅓ in eye, x+13 in number. Scales small, roughish; lateral line normal in direction; scales below lateral line larger than those above; dorsal and anal fins low; longest dorsal spine, 2½ in head; second anal spine 2⅔; fourth soft ray of anal longest, 1½ in head; caudal truncate, its peduncle moderate, compressed; pectoral rather long, 1⅔ in head. Color brown, the body covered with a network of dark lines, which form sharply defined reticulations or vermiculations everywhere; these extending on scaly part of soft dorsal and anal, but not on head or on other fins; fins mostly dusky; young with about 4 dark cross-bars. Head 2½ in length; depth 2⅔. D. XIII, 15; A. III, 7 or 8; scales, 68 (pores) (the number in a longitudinal series above lateral line nearly 100)... PATACHONICUS, 17.

16. ACANTHISTIUS BRASILIANUS.

Plectropoma brasilianum Cuv. and Val., Hist. Nat. Poiss. II, 1828, 397 (Brazil): Günther, I, 164 (copied).
?? *Plectropoma aculeatum* Cuv. and Val., VI, 523, 1830 (Banc des Aiguilles). (Günther, I, 163 (copied).

Habitat.—Coast of Brazil.

Etymology.—*Brasilianus*, Brazilian.

The specimens of this species examined by us (4830 M. C. Z.) were collected at Rio de Janeiro by Dr. Steindachner. The short description of *Plectropoma aculeatum*, from the "Banc des Aiguilles," agrees with *A. brasilianus* in all respects so far as it goes. I am not certain as to the location of this bank, but the Point "des Aiguilles" is in northern New Zealand.

17. ACANTHISTIUS PATACHONICUS.

Plectropoma patachonica Jenyns, Voyage Beagle, Fishes, 1840, 11. (Mouth of the Rio de la Plata; east coast of Patagonia.)

Habitat.—Southeastern coasts of South America, north to Uruguay.

Etymology.—*Patachonicus*, Patagonian.

We have examined specimens of this species (4515 M. C. Z.) collected at Maldonado by Mr. Thomas G. Carey. Numerous specimens were also taken by the *Albatross* at points on the east coast of Patagonia, most of them off Cape San Matios. It is well distinguished from its congener, *A. brasilianus*, by the characters originally noticed by Mr. Jenyns, as well as by its coloration and the small size of its scales.

Genus VIII.—ALPHESTES.

Alphestes Bloch & Schneider, Syst. Ichthyol., 236, 1801 (*afer*).
Prospinus Poey, MSS.; Gill, Proc. Ac. Nat. Sci., Phila., 237, 1862 (*chloropterus* = *afer*).

TYPE.—*Epinephelus afer* Bloch.

Etymology.—Αλφηστής, greedy or incontinent, a name applied to a kind of fish that swims in pairs, one behind the other, possibly *Symphodus tinca.*

This genus contains a few species of small size, intermediate between *Plectropoma* and *Epinephelus.*

For the synonymy of its species see Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 394.

ANALYSIS OF SPECIES OF ALPHESTES.

a. Preopercle with a single strong antrorse spine below its angle; second anal spine longer than third; head small; scales mostly cycloid. D. XI, 17. A. III, 9. Scales 80.
- *b.* Olivaceous, the ground color nearly uniform, the body and fins closely covered with small dark-brown spots; breast plain; snout slender, pointed; lower jaw rather strongly projecting. .... MULTIGUTTATUS, 18.
- *bb.* Olive, clouded with dusky, the body with rather few dark orange spots; breast with pearly spots; a dark mustache above the maxillary; lower jaw little projecting; preorbital very narrow........ AFER, 19.

aa. [Preopercle with two antrorse spines below the angle; second anal spine not longer than third, but stouter; canine teeth thick and blunt; third to fifth dorsal spines highest; caudal truncate, with rounded angles; ventrals reaching tips of pectorals, not to anal fin; scales ctenoid; color iron-gray, paler below; fins, except pectoral, dusky. Head, $2\frac{2}{3}$; depth, $2\frac{1}{3}$. D. XI, 17. A. III, 9. Scales 100.] (*Kner*)........ PICTUS, 20.

18 ALPHESTES MULTIGUTTATUS.

Plectropoma multiguttatum Günther, Proc. Zool. Soc., London, 1866, 600 (Panama).
Alphestes multiguttatus Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 107, 110 (Mazatlan; Panama); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 375.
Epinephelus multiguttatus Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 625 (Panama); Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 395 (Mazatlan; Panama).
Plectropoma afrum Günther, Fishes Centr. Amer., 411, 1869, with plate (Panama).

Habitat.—Pacific coast of tropical America; Mazatlan to Panama.

Etymology.—*Multum*, many; *guttatus*, spotted.

This species is common on the Pacific coast of tropical America, where it represents the closely related *A. afer*.

19. ALPHESTES AFER.

(GUASETA.)

Epinephelus afer Bloch, Ichthyologia, tab. 327, 1793 (Guinea ?).
Alphestes afer Bloch & Schneider, Syst. Ichth., 1801, 236 (copied); Peters, Berliner Monatsber., 1865, 105 (description of Bloch's type); Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 396 (Cuba).
Plectropoma chloropterum Cuv. & Val., Hist. Nat. Poiss., II, 398, 1828 (San Domingo; Martinique); Poey, Memorias Cuba, i, 73, tab. 9, f. 3, 1851 (Havana); Vaillant & Bocourt, Miss. Sci. au Mexique, 107, pl. v, f. 3, 1875; Poey, Repertorio, i, 265, 1867.
Prospinus chloropterus Poey, Syn. Pisc. Cubens., 1868, 289 (Havana); Poey, Enumeratio, 1875, 18.
Plectropoma monacanthus Müller & Troschel, Schomburgk's Hist. Barbadoes, 665, 1848 (Barbadoes), Günther, Cat. Fish Brit. Mus., I, 164, 1859 (copied); Cope, Trans. Am. Phil. Soc., 1871, 467, (St. Martins).

Habitat.—West Indian fauna; Cuba to Brazil.

Etymology.—*Afer*, African.

This small fish is generally common in the West Indies. Our specimens are from Cuba and Bahia.

20. ALPHESTES PICTUS.

Plectropoma pictum Tschudi, Fauna Peruana, 5, 1844; Günther, Cat. Fish Brit. Mus., I, 164, 1859 (copied); Kner, Neue Fische aus. Museum Godeffroy, 1867, 2. (Iquique.)
Alphestes pictus Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 395 (copied).

Habitat.—Coast of Peru; not seen by us.

Etymology.—*Pictus*, painted.

This species may perhaps prove to be the type of a distinct genus. Our account is taken chiefly from the description of Dr. Kner.

Genus IX.—EPINEPHELUS.

Epinephelus Bloch, Ichthyologia, 1793 (in part; not species which suggested the name).
Cerna Bonaparte, Introduzione alla classe Pesci, Fauna Italica, tome III, pt. 1, 1833 (*gigas*).
Cynichthys Swainson, Nat. Hist. Classn. Fishes, II, 1839, 201 (*flavo-purpuratus*).
Cromileptes Swainson, Nat. Hist. Classn. Fishes, II, 1839, 201 (*gigas*, etc).
Epinephelus Bleeker, Gill, 1861, and of most American writers.
Hyporthodus Gill, Proc. Ac. Nat. Sci. Phila., 1861, 237 (*flavicauda* = *niveatus*).
Schistorus Gill, Proc. Ac. Nat. Sci. Phila., 1862, 237 (*mystacinus*).
Labroperca Gill, Proc. Ac. Nat. Sci. Phila., 1863, 80 (*labriformis*).
Merus Poey, Ann. Lyc. Nat. Hist. N. Y., about 1869 (*gigas*, etc).
Priacanthichthys Day, Proc. Zool. Soc. London, 1868 (young).
Cerna Doderlein, Rivista delle Specie del genere *Epinephelus* o *Cerna*, 1873 (*gigas*).
Hyposerranus Klunzinger, Fische des Rothen Meeres, 1884, 3 (*morrhua*).
Garrupa Jordan, subg. nov. (*nigritus*).
Serranus sp., auct. (*nec typus*).

TYPE.—*Epinephelus marginalis* Bloch.

Etymology.—επινεφελος, clouded over, in allusion to the membrane supposed to cover the eye in *E. ruber* (*Mycteroperca*).

This is the largest and most important genus of the *Serranidæ*, and its species are most widely distributed.

Most of the American species of this genus have been already described in detail by Jordan & Swain (Proc. U. S. Nat. Mus., 1884, 379 *et seq.* To this account the reader is referred for description and synonymy. We have, however, in this paper omitted

E. sellicauda, which seems to be identical with *E. labriformis*. We have also added *E. flavolimbatus*, which we now regard as probably a valid species, *E. merus*, a recent addition to the American fauna, and the European species, *E. caninus*, *alexandrinus*, *chrysotænia*, *aspersus*, *æneus*, and *goreensis*.

We retain for this genus the old generic name *Epinephelus*, because, taking the successive restrictions which have followed its use by Bloch, its use by all authors would hold it with the present group.

The species of *Epinephelus* which suggested to Bloch the generic name is, however, a *Mycteroperca*, for the name (meaning clouded over) came from a supposed character of *Mycteroperca rubra* (*Epinephelus ruber* Bloch). Bloch & Schneider say of this species: "Oculi membrana communi quasi nebula ita obducta ut opaci esse videantur; unde nomen genericum." Bloch gives "Blödauge," dim-eye, as the German equivalent of *Epinephelus*. Should we regard the species which suggests the generic name as the type of the genus, the name *Epinephelus* must take the place of *Mycteroperca*, while the present genus would be called *Cerna*.

We think, however, that the restrictions made by different authors should determine the type. The gradual elimination of species would leave the genus as defined by Gill, and *Epinephelus marginalis* Bloch may be regarded as its type. This species is congeneric with *E. catus*, *E. striatus*, and other typical American forms. The name *Cerna* is then a synonym of *Epinephelus*.

We can find no description of the typical species of *Cynichthys* ("*flavopurpuratus*"), and we are not sure whether it belongs to this genus or not.

The genus *Epinephelus* is represented in all warm seas. Even after the removal of the numerous species here placed in other genera, it is by far the largest of all the genera of *Serranidæ*.

ANALYSIS OF SPECIES OF EPINEPHELUS FOUND IN AMERICA AND EUROPE.

a. Interorbital space of moderate width, its breadth more than half diameter of eye and 7 to 10 times in length of head; lateral teeth* of lower jaw in more than two rows, at least in the adult (*Epinephelus*).

b. Dorsal spines ten; caudal rounded; body with faint, dark cross-shades and many round, dark-orange spots, these extending on the fins; vertical fins not edged with black; preopercle without salient angle; lower jaw strongly projecting (in all respects, except the number of spines, almost identical with *E. adscensionis*). ANALOGUS, 21.

bb. Dorsal spines eleven.

c. Second dorsal spine short, lower than third or fourth.

d. Preopercle without distinct spinules on its lower limb; nostrils subequal, the posterior usually not twice diameter of the anterior; pyloric cæca in small number, usually 10 to 25.

f. Body and head covered with red or orange spots (dusky in spirits and always darker than the ground color).

g. Vertical fins without dark edge; their bases spotted like the body; body with large pale spots besides the orange spots; young with large black blotches at base of dorsal; lower jaw strongly projecting; angle of preopercle not salient; form robust. ADSCENSIONIS, 22.

*Lateral teeth of lower jaw in two rows only in the subgenus *Hyposerranus* Klunzinger.

gg. Vertical fins broadly edged with blue-black, their bases unspotted; body without pale spots, the orange spots rather small; lower jaw little projecting; preopercle with salient angle; body rather slender; size small .... CATUS, 23.

ff. Body, head, and fins dark reddish brown, profusely covered with small pearly-white stellate spots; preopercle without salient angle; fins not edged with black; body robust; lower jaw projecting; caudal subtruncate, with sharp angles.

DRUMMOND-HAYI, 24.

fff. Body not covered with round red, orange or stellate white spots; spots, if any, bluish, whitish, or brownish, irregular or diffuse.

i. Preopercle without salient angle, the serræ at the angle scarcely enlarged; caudal fin rounded; (eye not surrounded by dark points; body without traces of longitudinal darker stripes); caudal peduncle with a large, quadrate black blotch above (sometimes obsolete in young or in very old examples); color (in spirits) dark brown, with scattered roundish blotches of pale bluish, these most distinct on breast and lower parts of head; fins pale, spotted like the body, their edges darker; young with large round, whitish spots, regularly arranged.

LABRIFORMIS, 25.

ii. Preopercle with a more or less distinct salient angle, which is armed with larger teeth (these teeth occasionally undeveloped in *E. striatus*, which species may be known by the presence of black points around the eyes).

k. Caudal peduncle with a large quadrate saddle-like black blotch above (sometimes wanting in *E. niveatus*, especially in the young); vertical fins not edged with black.

l. Eye surrounded by conspicuous dark brown points; body with irregular dark cross-bars; angle of preopercle little salient; third dorsal spine highest, 2½ in head; scales moderate, about 100; caudal rounded; lower jaw little projecting; vertical fins in life broadly edged with yellow............ STRIATUS, 26.

ll. Eye not surrounded by dark points; sides brown, marked with large blotches of steel-blue, these more or less regularly arranged and not distinct on the breast; no dark cross-bars; lower jaw strongly projecting; caudal fin subtruncate, its angles rather acute; pyloric cæca rather numerous.. NIVEATUS, 27.

kk. Caudal peduncle without black, saddle-like blotch above.

n. Caudal fin truncate or emarginate when spread open, not convex behind; maxillary usually more or less scaly; vertical fins without broad edging of black.

o. Dorsal fin, or a part of it, distinctly edged with bright yellow.

p. Color of body uniform reddish brown, a clear blue streak from eye to angle of preorbital; a faint dark moustache; no black spots anywhere; whole dorsal with a bright yellow edging; anal and caudal without pale edging; caudal slightly lunate; maxillary scaly; dorsal rays X, 14; lower jaw strongly projecting (as in *Epinephelus niveatus*, with which this species seems to agree very closely in all respects except the color).

FLAVOLIMBATUS, 28.

pp. [Color of body dull greenish, the sides speckled with emerald-green; (dirty whitish in spirits); tips of anal, caudal, soft dorsal and pectoral saffron-yellow; four oblong, dark blotches on back below base of dorsal; body rather elongate; lower jaw projecting; dorsal rays XI, 16; caudal injured] (*Jenyns*).

ASPERSUS, 29.

oo. Dorsal fin without yellow edging.

q. Body without dusky longitudinal streaks.

r. Dorsal rays XI, 15 to 17.

s. [Color brown, with a large quadrate golden blotch on the side of the back, chiefly below the spinous dorsal; fins all low; the dorsal spines subequal; teeth at angle of preopercle strong; caudal fin lunate; body rather slender; the depth 3⅓ in length; maxillary partly scaly; lower jaw much projecting; dorsal rays XI, 16 or 17] (*Doderlein*). CHRYSOTÆNIA, 30.

ss. [Color nearly uniform brown; the dorsal scarcely edged with darker; a black mustache along the maxillary, but no blue bands on cheek; maxillary chiefly naked; caudal fin truncate, with rather sharp angles; dorsal rays XI, 15 or 16; body not very robust, the depth 3½ in length (*Steindachner*). GOREENSIS, 31.

rr. [Dorsal rays XI, 13 or 14; caudal fin truncate, the angles rounded; body robust; the depth 2⅔ in length; mouth large; maxillary scaly; lower jaw projecting; dorsal spines low, subequal; color uniform grayish] (*Doderlein*).....CANINUS, 32.

qq. [Body reddish, with three or four dusky longitudinal streaks along the side of the back; two dark streaks across cheek; caudal truncate, with rounded angles; maxillary nearly naked; dorsal rays XI, 15 or 16; body rather elongate, the depth 3½ in length; serræ at angle of preopercle very strong; fins rather low, the spines subequal] (*Doderlein*). ALEXANDRINUS, 33.

nn. Caudal fin convex behind, the middle rays longest; maxillary naked.

t. [Dorsal rays XI, 13 or 14; vertical fins not edged with black; body rather slender, the depth 3½ in length; mouth moderate; dorsal spines unequal, the third and fourth a little longer than those following. Color olivaceous, three conspicuous, pale-blue streaks across the cheek and opercles] (*Doderlein*) .... ÆNEUS, 34.

tt. Dorsal rays XI, 15 or 16; vertical fins broadly edged with dark brown or black; color reddish brown, the adult nearly plain, the young with darker spots; preopercle with strong teeth at its angle, the lower limb entire; dorsal spines subequal, rather low; interorbital width moderate, about 6½ in head; caudal rounded; maxillary naked; body robust, the depth 3 in length.................................GIGAS, 35.

dd. Preopercle with two or three small irregular teeth below its angle; posterior nostril very large, nearly three times diameter of anterior; head large; pyloric cæca in increased number (*Schistorus*); second and third anal spines about equal in length; color brownish, with about eight darker cross-bands; dark bands radiating from eye; a dark mustache above the maxillary; a dark blotch on back of tail.............................MYSTACINUS, 36.

cc. Second dorsal spine elevated, not lower than third or fourth; caudal fins lunate; preopercular angle little salient, without enlarged teeth; interorbital width 7½ in head; color brown, clouded with whitish; lower parts flushed with orange-red; small dark spots about eye; vertical fins broadly edged with blue-black......MORIO, 37.

aa. Interorbital area very broad, its width 4 to 6 times in length of head; caudal fin rounded; dorsal spines very unequal, the second considerably elevated; body very robust. (*Garrupa* Jordan).

u. Dorsal spines eleven, rarely ten; second dorsal spine longest, 2 to 3 in head, half longer than third spine; preopercle without salient angle, the serræ not much enlarged; canines strong; eye small; color chocolate brown, the distal part of the vertical fins rather darker; depth 2⅓ in length; D. XI, 14; A. III, 9; scales, 107.......NIGRITUS, 38.

uu. Dorsal spines ten; second dorsal spine elevated about 2⅗ in head; preopercle without salient angle, the teeth at and below the angle large and coarse, the lowermost turned downward; canines strong; eye small; color plain dark brown, the fins all darker; depth 2⅗ in length; dorsal rays X, 14; A. III, 9; scales 86. (A variety of preceding?) MERUS. 39.

21. EPINEPHELUS ANALOGUS.

Epinephelus analogus Gill, Proc. Ac. Nat. Sci. Phila., 1863, 163 (Panama); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 232 (Acapulco); Jordan & Gilbert. *op. cit.*, 1882, 376 and 625 (Panama); Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 107, 110 (Mazatlan; Panama); Jordan & Bollman, Proc. U. S. Nat. Mus. 1889, 181 (Chatham Islands; Galapagos); Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 393 (Panama; Mazatlan).

Serranus analogus Günther, Fishes Centr. Amer., 1869, 410 (Panama); Steindachner, Ichth. Beitr., IV, 1871, 5 (Acapulco; Mazatlan; Panama).

Serranus courtadei Bocourt, Ann. Sci. Nat., Paris, 222, 1868 (La Union; San Salvador); Vaillant & Bocourt, Mission Scientifique au Mexique, 1875, 80.

Habitat.—Pacific coast of tropical America.

Etymology.—*Analogus*, similar, its form and coloration resembling those of *Epinephelus adscensionis*.

This species is common on the Pacific coast of Mexico, where it represents *E. adscensionis*.

22. EPINEPHELUS ADSCENSIONIS.

(ROCK HIND; CABRA MORA.)

Pira-pixanga or Gat-visch Marcgrave, Hist. Bras., 152, 1648 (Brazil).

Perca tota maculis, etc. Seba. "Thesaurus, iii, tab. 27."

Trachinus adscensionis Osbeck, Reise in China, etc., 1757, and English edition, 96, 1771 (Ascension Island).

Epinephelus ascensionis Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 391 (Cuba, Key West).

Trachinus punctatus Bonnaterre, Tableau Encycl. Method, 1788, 46 (after Osbeck).

? *Perca stellio* Walbaum, Artedi Piscium, 349, 1792 (after Seba).

Holocentrus punctatus Bloch, Ichthyol. VIII, taf. 241, 1790 (after Marcgrave).

Epinephelus punctatus Poey, Enum. Pisc. Cubens., 1875, 16 (Cuba); Poey, Anales Soc. Hist. Nat. Madrid, 1881, 319.

Perca maculata Bloch, Ichthyol., taf. 313, 1792 (on a figure by Plumier; not *Holocentrus maculatus* Bloch, tafel 242, an East Indian species of *Epinephelus* = *Holocentrus albofuscus* Lac.).

Serranus maculatus Peters, Berliner Monatsber., 1865, 109 (identification of *Perca maculata* Bloch).

Trachinus osbeck Lacépède, Hist. Nat. Poiss. (after Osbeck).

Sparus atlanticus Lacépède, IV, 158, pl. 5, f. i, 1803 (on a copy of a drawing by Plumier).

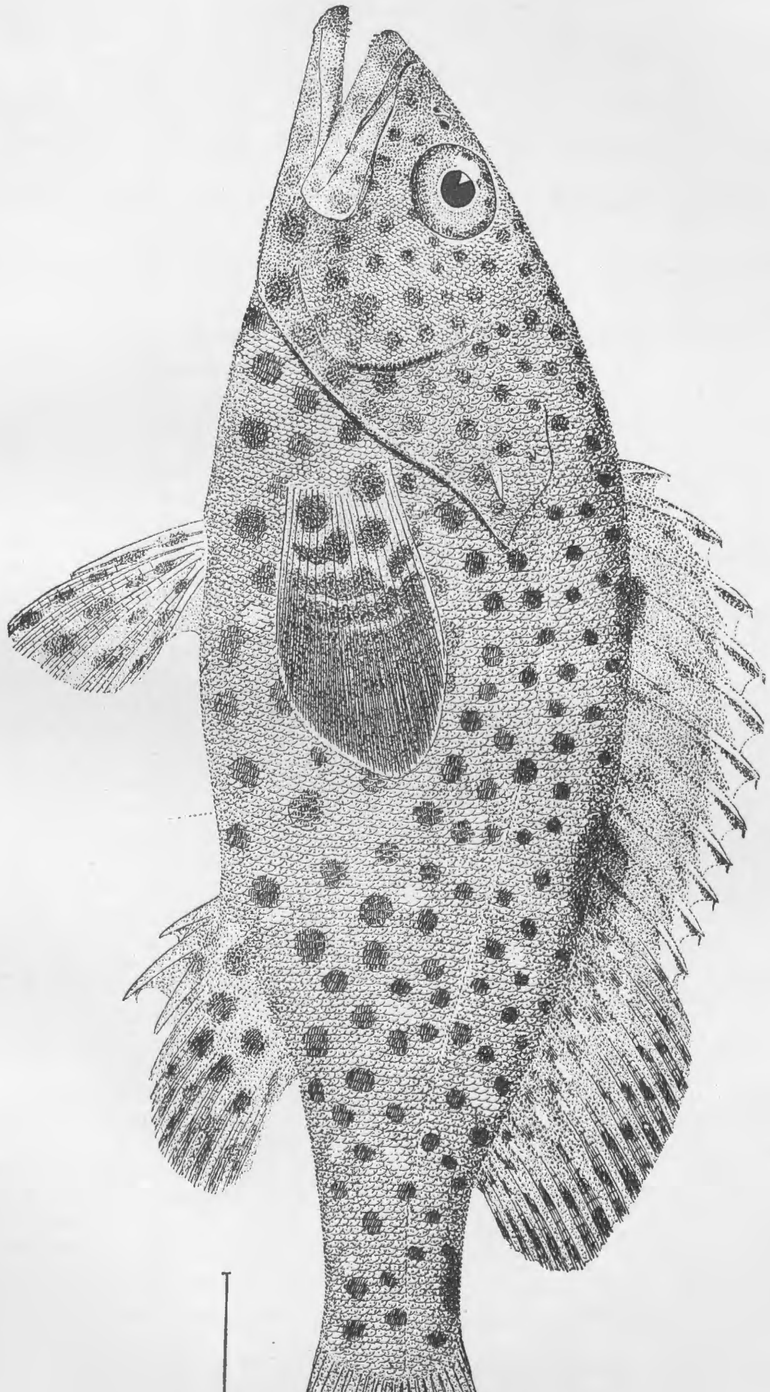
Epinephelus atlanticus Jordan & Gilbert, Syn. Fish. N. A., 1883, 918 and 973.

Serranus nigriculus Cuv. & Val., II, 375, 1828 (Martinique).

Serranus pixanga Cuv. & Val., II, 383, 1828 (on Marcgrave); Poey, Repertorio, I, 203.

Serranus impetiginosus Müller & Troschel, Schomburgk's Hist. Barb., 665, 1848; Günther, I, 142, 1859 (Trinidad); Günther, Proc. Zool. Soc. Lond., 1868, 225 (St. Helena; name only); Günther, Shore Fishes, Challenger, 1880, 5 (Ascension); Steindachner, Ichth. Beitr., V, 127, 1876 (Bahia; Maranhaõ).

PLATE LX.



EPINEPHELUS ADSCENSIONIS (Osbeck). The Rock Hind.
(No. 26574, U. S. National Museum; from Key West, Florida.)

Serranus maculatus var. *impetiginosus* Peters, Berl. Monatsber., 1865, 110.
Epinephelus impetiginosus Poey, Repertorio, I, 201; Poey, Syn. Pisc. Cubens., 286, 1868 (Cuba); Jordan & Gilbert, Syn. Fish. N. A., 1883, 973.
Serranus capreolus Poey, Memorias Cuba, II, 1860, 145 (Cuba); Vaillant & Bocourt, Mission Scientifique au Mexique, 87 (Gulf of Mexico; Brazil; Ascension).
Epinephelus capreolus Jordan & Gilbert, Syn. Fish. N. A., 1883, 539 (specimen from Key West described).
Serranus varius Bocourt, Ann. Sci. Nat. Paris, 1868, 222 (Gulf of Mexico).

Habitat.—West Indian fauna, Florida Keys to Brazil; Ascension and St. Helena Islands.

Etymology.—*Adscensionis*, from Ascension Island, where the species was first taken.

Specimens of this common species from Bahia are in the museum at Cambridge and in the U. S. National Museum.

23. EPINEPHELUS CATUS.

(CABRILLA; RED HIND.)

Cugupuguacu Brazil, the Hind, Catesby, Nat. Hist. Carol., etc., 1743, tab. 14 (Bahamas).
Cabrilla Parra, Dif. Piezas, Hist. Nat. Cuba, 1787 (Havana).
Perca guttata Linnæus, Syst. Nat., X, 1758, 292 (in part, not type; after Marcgrave, Sloane, Willoughby, Ray, and Catesby, the figure of Catesby only belonging to this species).
Epinephelus guttatus Goode, Bull. U. S. Nat. Mus., V, 1876, 58 (Bermudas); Jordan & Gilbert, Syn. Fish. N. A. 1883, 919, 973 (specimens examined from Florida Keys); Bean, Proc. U. S. Nat. Mus., 1880, 99 (Bermuda; Florida).
Serranus apua Cuv. & Val., II, 1828, 287 (Brazil; citing as synonym Piratiapia of Marcgrave, and of authors; not *Bodianus apua* Bloch, Günther, I, 140, 1859 (Jamaica); Steindachner, Ich. Notiz., VI, 43, 1867 (Barbadoes; Surinam); Günther, Shore Fishes, Challenger Exp. 1880, 6 (St. Thomas).
Epinephelus apua Jordan & Gilbert, Syn. Fish N. A., 973 (name only); Jordan & Swain, Proc. U. S. Nat. Mus. 1884, 389 (Havana).
Lutjanus lunulatus (bis) Bloch & Schneider, Syst. Ichthyol., 1801, 329 (after *Cabrilla* Parra; not *Lutjanus lunulatus* Bloch & Schneider).
Serranus lunulatus Cuv. & Val., II, 1828, 379 (after Parra); Steindachner, "Ichthyol. Mittheil., IX, 1866, 15"; Poey, Repertorio, I, 200.
Epinephelus lunulatus Poey, Synopsis Pisc. Cubens., 1868, 286; Poey, Enum. Pisc. Cub., 1875, 16 (Havana); Cope, Trans. Am. Philos. Soc., 1871, 465 (St. Martin's; St. Kitt's; New Providence).
Serranus catus Cuv. & Val., II, 373, 1828 (Martinique); Guichenot, Ramon de la Sagra, Cuba, II, 13, 1850.
Serranus maculatus var. *catus* Peters, Berliner Monatsber., 1865, 110 (Martinique; Barbadoes, Puerto Cabello).
Serranus arara Cuv. & Val., II, 1828, 377 (Havana; erroneously identified with *Bonaci arará* Parra); Poey, Repertorio, I, 200.
Serranus maculatus Günther, I, 1859, 130 (West Indies; not *Perca maculata* Bloch); Vaillant & Bocourt, Mission Scientifique au Mexique, IV, 1875, 83 (Jamaica).
Epinephelus cubanus Poey, Repert. Fis.-Nat. Cuba, I, 1867, 202 (Cuba); Poey, Syn. Pisc. Cub., 1868, 287; Poey, Enumeratio Pisc. Cub., 1875, 17.
Serranus maculatus var. *cubanus* Peters, Berliner Monatsber., 1865, 110 (Cuba).

Habitat.—West Indies; Florida Keys; Bermudas; Brazil.

Etymology.—Low Latin, *catus*, a cat; from Latin *catus*, sly, wary.

We here reject the name *apua* formerly used by us for this species, the original *Bodianus apua* of Bloch being in our opinion based on the red variety of *Mycteroperca venenosa*. The name *guttatus* L. is based chiefly on the Cugupuguacu of Marcgrave, with which Catesby had erroneously identified his "Hind," which is the present species. The oldest tenable name of this fish, so far as we can see, is certainly *Epinephelus catus*. Willoughby's "Cugupuguacu" is certainly identical with Marcgrave's, both as to figure and description.

In the museum at Cambridge are specimens from Charleston, Tortugas, Nassau, St. Thomas, Gonaives, Hayti, and St. Croix.

24. EPINEPHELUS DRUMMOND-HAYI.

(SPECKLED HIND; JOHN PAW.)

Epinephelus drummond-hayi Goode & Bean, Proc. U. S. Nat. Mus., 173, 174, 1878 (Pensacola; Bermuda); Goode & Bean, *op. cit.*, 115, 139, 1879; Jordan & Gilbert, *op. cit.*, 272, 1882; Jordan & Gilbert, Synopsis Fish. N. Am., 340, 1883; Jordan & Swain, *l. c.*, 388 (Pensacola); Jordan & Eigenmann, Proc. U. S. Nat. Mus. 1887, 269 (Charleston).

Habitat.—Bermudas; South Atlantic and Gulf coast of the United States.

Etymology.—Named for "Col. H. M. Drummond Hay, C. M. Z. S., of Leggieden, Perth, Scotland, formerly of the British army, by whom the species was first discovered at the Bermudas in 1854."

We have lately received a specimen of this beautiful species from Charleston.

25. EPINEPHELUS LABRIFORMIS.

Serranus labriformis Jenyns, Zoöl. of Beagle, Fishes, 8, pl. 3, 1840;* Günther, Cat. Fishes Brit. Mus., I, 152, 1859 (Galapagos Islands), Jordan & Swain, *l. c.*, 1884, 387 (copied); Jordan & Bollman, Proc. U. S. Nat. Mus. 1889, 180 (Charles Island and Indefatigable Island, Galapagos).

Epinephelus sellicauda Gill, Proc. Ac. Nat. Sci. Phila., 250, 1862 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. Nat. Mus., 229, 1881 (Socorro Island); Jordan & Gilbert, *op. cit.*, 360, 1882 (Cape San Lucas); Jordan & Gilbert, *op. cit.*, 371, 1882 (Colima); Jordan & Gilbert, *op. cit.*, 625, 1882 (Panama); Jordan & Gilbert, Bull. U. S. Fish Comm., 107, 1882 (Mazatlan); Jordan & Swain, *l. c.*, 385 (Socorro Island; Mazatlan, Colima, Panama, Cape San Lucas).

Epinephelus ordinatus Cope, Trans. Am. Phil. Soc., 466, 1871 (Panama).

Habitat.—Pacific coast of tropical America; Cape San Lucas to Galapagos Islands.

Etymology—*Labrus*, a genus of Wrasse fishes; *forma*, form.

This species is abundant in the Galapagos Islands, from which locality many specimens have been brought to the museum at Cambridge. Although neither Jenyns nor Darwin have noted the saddle-like dark blotch on the tail in the species called by Jenyns *labriformis*, there seems to be little doubt of the identity of *labriformis* and *sellicauda*. This identification has been already suggested by Dr. Steindachner on the labels in the museum at Cambridge.

Specimens are in the museum at Cambridge from Acapulco, and from Albemarle Island, in the Galapagos.

26. EPINEPHELUS STRIATUS.

(NASSAU GROUPER; HAMLET; CHERNA CRIOLLA.)

Cherna Parra, Piezas de Hist. Nat. Cuba, 1787, 50, lam. XXIV (Cuba).

Anthias striatus Bloch, Ichth., IX, 109, tab. 324, 1792 (on a figure by Plumier); Bloch & Schneider, Syst. Ichthyol., 1801, 305 (copied).

Lutjanus striatus Lacépède, Hist. Nat. Poiss., IV, 324, 1803 (copied).

Serranus striatus Cuv. & Val., ii, 1828, 288 (Gulf of Mexico); Storer, Syn. Fish, N. A., 1846, 27 (copied); Guichenot, Ramon de la Sagra's Hist. Cuba, Poiss., 1850, 12 (Cuba); Günther, I, 1859, 110 (Cuba; Mexico; Puerto Cabello; Bahia); Poey, Repertorio, I, 198, 1867; Vaillant & Bocourt, Mission Scientifique au Mexique, 1875–'76 (Cuba; San Domingo; Martinique; Jamaica).

* Not 1842, as usually quoted. This work was issued in parts bearing date of 1840, 1841, and 1842.

Epinephelus striatus Gill, Proc. Ac. Nat. Sci. Phila., 1865, 105 (name only); Poey, Repertorio, II, 285, 1868 (Havana); Poey, Syn. Pisc. Cub., 1868, 310; Poey, Enum. Pisc. Cub., 1875, 15; Goode, Bull. U. S. Nat. Mus., V, 1876, 57 (Bermudas); Cope, Trans. Am. Phil. Soc., 1871, 466 (New Providence; St. Croix); Bean, Proc. U. S. Nat. Mus., 1880, 99 (Bermuda); Poey, Anales Hist. Nat., 319, 1881 (Puerto Rico); Jordan & Gilbert, Syn. Fish. N. A., 1883, 918; Poey, Bull. U. S. Fish Comm., 1882, 118; Jordan, Proc. U. S. Nat. Mus., 1884, 125 (Key West); Jordan & Swain, *l. c.*, 384 (Key West; Havana).

Anthias oherna Bloch & Schneider, Syst. Ichth., 1801, 310 (after Parra).

Sparus chrysomelanurus Lacépède, IV, 1803, 160 (on a copy of Plumier's figure).

Habitat.—West Indian fauna, Key West to Brazil.

Etymology.—*Striatus*, striped.

Specimens of this species are in the museum at Cambridge from Santo Tomas and from Cartagena, besides various more northern localities.

27. EPINEPHELUS NIVEATUS.

Serranus niveatus Cuv. & Val., II, 1828, 380 (Brazil); Castelnau, Anim. nouv. ou rares de l'Amér. du Sud, Poiss., pl. i, f. 2 (coast of Brazil); Günther, I, 130 (copied); Poey, Repertorio, I, 202.

Epinephelus niveatus Poey, Synopsis Pisc. Cubens., 1868, 286 (Havana); Poey, Enum. Pisc. Cubens., 1875, 15; Jordan & Gilbert, Syn. Fish. N. A., 1883, 541; Jordan & Swain, *l. c.*, 386 (Havana).

Serranus margaritifer Günther, Cat. Fish. Brit. Mus., I, 1859, 131 (South America).

Serranus conspersus Poey, Memorias Cuba, II, 139, 1860 (Havana); Poey, Repert., II, 157, 1868.

Hyporthodus flavicauda Gill, Proc. Ac. Nat. Sci. Phila., 1861, 98 (young specimen, taken at Newport, R. I.); Cope, Proc. Ac. Nat. Sci. Phila., 1870, 119 (same specimen).

Habitat.—West Indies to Brazil, occasionally northward in the Gulf Stream.

Etymology.—*Niveatus*, snowy.

Specimens of this species are in the museum at Cambridge from Cuba and from Rio Janeiro. Some of the Cuban specimens lack the saddle-like blotch on the tail, but in all the pearly spots on the side are persistent.

28. EPINEPHELUS FLAVOLIMBATUS.

(YELLOW-FINNED GROUPER.)

Epinephelus flavolimbatus Poey, Repertorio, I, 183, 1867 (Cuba); Poey, Synopsis, 1868, 286; Poey, Enum., 1875, 15; Jordan & Evermann, Proc. U. S. Nat. Mus., 1886, 475 (Pensacola).

Habitat.—West Indian fauna, north to Pensacola.

Etymology.—*Flavus*, yellow; *limbus*, edge.

Since the paper by Jordan & Swain was published, three specimens of this species have been obtained at Pensacola by Mr. Stearns. These differ a little from Poey's account, but they evidently belong to the same species as the *E. flavolimbatus* of Poey. In all details of form the species seems to agree fully with *E. niveatus*, but the coloration is quite unlike that of the latter species, and so sharply defined that we have not much hesitation in admitting it as a distinct species. The coloration is described in detail by Jordan & Evermann in the paper above quoted.

29. EPINEPHELUS ASPERSUS.

Serranus aspersus Jenyns, Voyage Beagle, Fishes, 1842, 6 (Porto Praya, St. Jago in the Cape Verde Islands).

Habitat.—Cape Verde Islands.

Etymology.—*Aspersus*, speckled.

This species is known from Dr. Jenyns's account of a young example taken at Porto Praya. No one has since recognized the species. Jenyns's account agrees in many respects with *E. flavolimbatus*, and his species may prove to be the young of the latter.

30. EPINEPHELUS GOREENSIS,

Serranus goreensis Cuv. & Val. VI, 511, 1830 (Gorea); Jenyns, Voyage of the Beagle, Fishes, 1840, 5 (St. Jago; Porto Praya; Cape Verde Islands); Günther I, 133 (copied); Steindachner, Beiträge zur Kenntniss der Fische Afrika's, 6, 1881, with plate (Gorea; Rufisque; Canary Islands).

Habitat.—Coast of Africa and islands in the eastern Atlantic.

Etymology.—*Goreensis*, from the island of Gorea, where the species was discovered.

This species is known to us from descriptions and from Dr. Steindachner's excellent figure. It seems to be nearly allied to *Epinephelus gigas* and to *E. æneus.*

31. EPINEPHELUS CHRYSOTÆNIA.

Cerna chrysotænia Doderlein, Rivista delle specie del Genere *Epinephelus* o *Cerna*, 41, plate ii, f. 4, 1882 (Palermo).

Habitat.—Mediterranean Sea.

Etymology.—*Χρυσός*, gold; *ταινία*, band.

This species is known from Professor Doderlein's description only.

32. EPINEPHELUS CANINUS.

Serranus caninus Valenciennes, Webb & Berthelot, Ichth. Îles Canaries, 40, 1836 (Canaries).
Cerna canina Doderlein, Rivista, Epinephelus, 1882, 26, tav. 1, f. 2 (full description and synonymy).
Serranus cernioides Capello, Catal. Peix. Portug. Part III, 156 et Part III, 244, estamp. iv, f. 1, 1867 (Portugal).

Habitat.—Mediterranean Sea; Atlantic coasts of southern Europe and northern Africa.

Etymology.—*Caninus*, canine.

Our knowledge of this species is chiefly drawn from Professor Doderlein's "Rivista," quoted above.

33. EPINEPHELUS ALEXANDRINUS.

? *Sparus scirenga* Rafinesque, Caratteri de Alcuni nuovi Genere, etc., 1810, 50 (Palermo).
Serranus alexandrinus Cuv. & Val., Hist. Nat. Poiss., II, 281, 1829 (Alexandria, Egypt).
Plectropomus fasciatus Costa, Fauna del Regno di Napoli, Pesci, 1844, tav. vi, f. 1, 2, 5 (not *Holocentrus fasciatus* Bloch) (Naples).
Serranus costæ Steindachner, Ichth. Beiträge, VI, 11, 1878 (Mediterranean).
Cerna costæ or *Cerna alexandrina* Doderlein, Rivista di *Epinephelus* o *Cerna*, 1882, 47, et seq. tav. iii, f. 7.

Habitat.—Mediterranean Sea.

Etymology.—*Alexandrinus*, from Alexandria, Egypt, where the species was first found.

We have drawn our knowledge of this species chiefly from the account given by Professor Doderlein. If we can place any dependence whatever on Rafinesque's descriptions, his *Sparus scirenga* is more likely to be this species than *Mycteroperca rubra* or any other of the Serranoid fishes which are found in the waters of Sicily. The character of yellowish longitudinal stripes along the flanks and of caudal fin entire seem to point to this species rather than to any other. The following is Rafinesque's account:

"136. Sp. SPARUS *Scirenga.*—Olivastro, alcune linee longitudinali giallastre ai lati de la testa e dei fianchi, opercolo angolato superiormeute, linea laterale curva, coda iguale intiera, *Oss.* Il suo nomine volgare è l' istesso che il suo specifico, e gli è comune con un pesce molto diverso il *Notognidion scirenga;* hà il muso appuntato, l' iride rossa indorata, ed un solo raggio spinoso all' anale; la sua carne non è disprezzevole e giunge alla lunghezza di due piedi; non sono certo se appartiene effetivamente a questo genere e dubbito che abbia molto affinitá col genere *Lutianus.*"

34. EPINEPHELUS ÆNEUS.

Serranus æneus Isidore Geoffroy Saint-Hilaire, "Poissons de l'Égypte ed. Panckoucke, 208, 1809" (Egypt).

Cerna ænea Doderlein, Rivista delle specie del Genere *Epinephelus* o *Cerna*, 1882, 34, tav. ii, f. 3 (with full description and synonymy).

Habitat.—Mediterranean Sea.

Etymology.—*Æneus*, brassy.

We have not studied this species, and we draw our, account of it from the paper of Professor Doderlein.

35, EPINEPHELUS GIGAS.

(MEROU.)

? *Labrus guaza* Linnæus, Syst. Nat., ed. X, 285, 1758 ("*Habitat* in Pelago," may be *E. nigritus*).

Perca gigas Brünnich, Ichthyol. Massiliensis, 65, No. 81, 1768 (Marseilles).

Holocentrus gigas Bloch & Schneider, Syst. Ichth., 1801, 322 (copied).

Serranus gigas Cuv. & Val., II, 270, pl. xxxii, 1828; Günther, I, 132, 1859 (Madeira; Cape of Good Hope); Steindachner, Ichth. Berichte, IV, 11, 1867 (excl. syn. pars; Barcelona; Tangier; Lisbon; Teneriffe); Steindachner, Ichth. Beitr., XII, 6, 1882 (comparison with *Epinephelus caninus*); Steindachner, Ichth. Beitr., 1876, V, 127 (Canary Is.; Madeira; Cape Verde; Cape of Good Hope; Brazil); Day, British Fishes, 16, pl. v. (south coast of England) and of European authors generally.

Cerna gigas Doderlein, Rivista del Genere *Epinephelus* o *Cerna*, 1882, 10, tab. 1, f. 1.(detailed description and synonymy).

Epinephelus gigas Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 388 (copied).

Holocentrus merou Lacépède, Hist. Nat. Poiss., IV, 377, 1803 (after Brünnich).

Serranus mentzeli Cuv. & Val., II, 291, 1828 (coast of Brazil); Günther, I, 140, 1859 (copied).

Serranus dichropterus Cuv. & Val., II, 293, 1828 (Brazil; not type, which was from Japan, having been also the type of *Holocentrus ongus* Bloch).

Perca robusta Couch, "Mag. Nat. Hist., 1832, V, 21, f. 7" (Polperro).

Serranus marginatus Lowe, "Proc. Zool. Soc. Lond., 1833, 142" (Madeira).

Serranus fimbriatus Lowe, "Trans. Cambr. Phil. Soc., 1836, 195, pl. i" (Madeira).

Serranus ongus Günther, I, 1859, 142 (Bahia; not *Epinephelus ongus* Bloch, a Japanese fish).

Epinephelus brachysomus Cope, Trans. Am. Phil. Soc. Phila., 1871, 466 (Rio Janeiro).

Habitat.—Eastern Atlantic; Mediterranean; coast of Brazil.

Etymology.—*Gigas*, giant.

We have compared Brazilian specimens (*Epinephelus mentzeli*) with the descriptions of this species given by Professor Doderlein and by Dr. Day. We can find no difference whatever, and we agree with Dr. Steindachner in regarding the two as identical.

The following description is taken from No. 4506, M. C. Z., 15 inches long, collected at Rio de Janeiro by Professor Agassiz:

Head, 2¼ in length; depth, 2¾. D. XI, 15, A. III, 8; scales 17–85 to 90–x. Body rather deep; profile steep; snout short, rather pointed; lower jaw little projecting; canines small; preopercle without salient angle, the teeth just above the angle large and strong; lower limb of preopercle entire. Gill rakers very short, x + 15. Interorbital space narrow, not as wide as eye, which is 5¾ in head; maxillary 2⅗ in head. Third dorsal spine highest, 2¾ in head. Anal high and rounded, its second spine 5 in head; caudal rounded.

Color, in spirits, dark brown, with rather faint round whitish spots which are irregular and arranged somewhat in vertical rows, and most distinct on caudal peduncle. Dorsal, anal, caudal, and pectorals broadly edged with black. Other specimens from Rio de Janeiro and Santos belong to the same species. There is not much doubt that *Epinephelus brachysomus* Cope, and the Brazilian specimens referred by Cuvier and Valenciennes to *Epinephelus dichropterus* belong to this form.

The *Labrus guaza* Linnæus is some species of *Epinephelus*, with the caudal rounded, the color dusky, and the dorsal rays XI, 16. *Guasa* is the Spanish name in the West Indies for *Promicrops guttatus* and other large *Serranoids*.

The following key to the Mediterranean species of *Epinephelus* is translated from that given by Vinciguerra (Risultate Ittiologici del Violante, 1883, 33):

a. Upper jaw naked; caudal rounded.
  b. Opercle without oblique lines .... GIGAS.
  bb. Opercle with oblique lines .... ÆNEUS.
aa. Upper jaw with small scales; caudal truncate or concave.
  c. Dorsal with 13 or 14 soft rays .... CANINUS.
  cc. Dorsal with 16 soft rays .... ALEXANDRINUS.

36. EPINEPHELUS MYSTACINUS.

(CHERNA DE LE ALTO.)

Serranus mystacinus Poey, Memorias Cuba, I, 52, 1851, tab. 10, f. 1 (Cuba); Günther, I, 109, 1859 (South America).

Schistorus mystacinus Poey, Repertorio, II, 154, 1868; Poey, Synopsis Pisc. Cubens., 1868, 287; Poey Enumeratio Pisc. Cubens., 1875, 18.

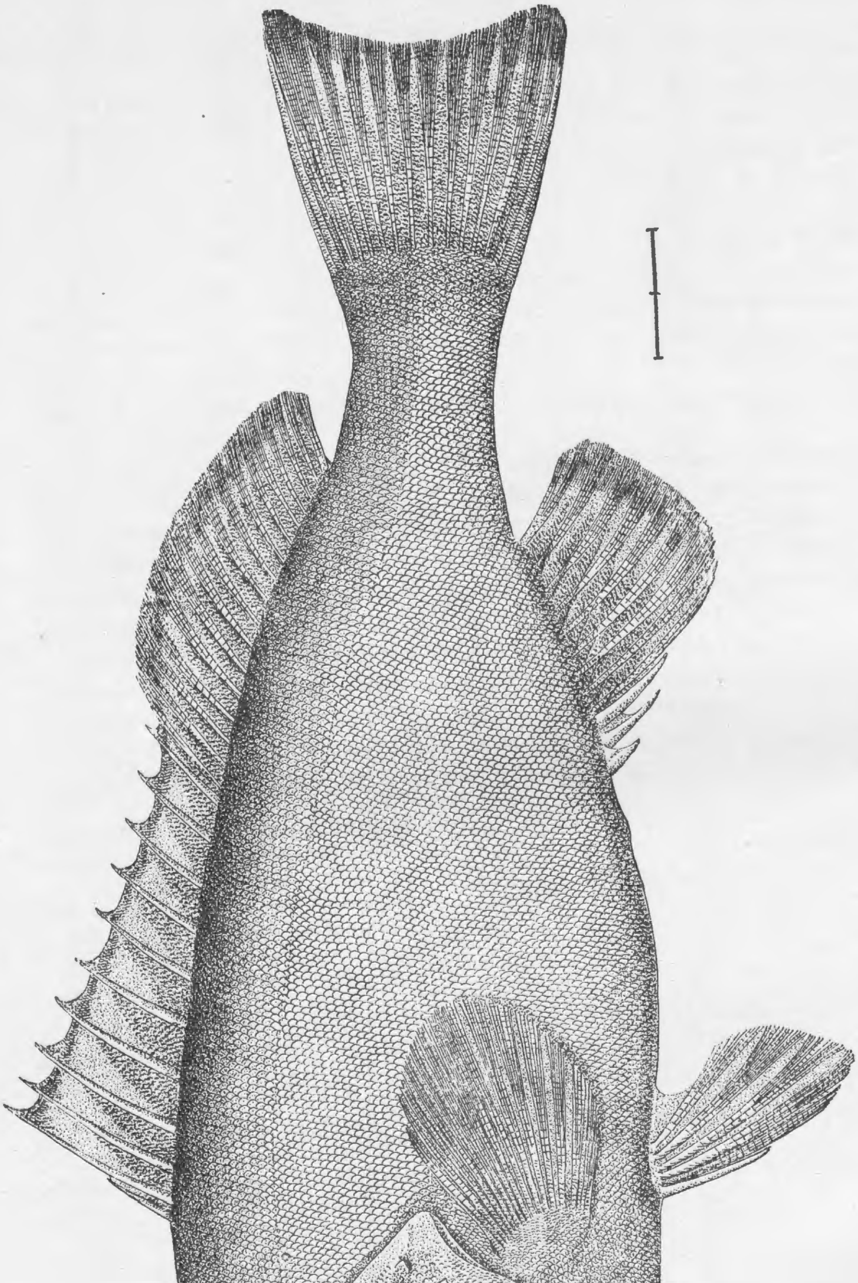
Epinephelus mystacinus Jordan & Swain, *l. c.*, 383 (Havana).

Habitat.—West Indian fauna.

Etymology.—*μύσταξ*, moustache.

This rather scarce species has been well described by Jordan & Swain.

PLATE LXI.



EPINEPHELUS MORIO (Cuv. & Val.). The Red Grouper.

(No. 22129, U. S. National Museum; from Florida.)

37. EPINEPHELUS MORIO.

(RED GROUPER; CHERNA AMERICANA; CHERNA DE VIVERO.)

Serranus morio Cuv. & Val., Hist. Nat. Poiss., II, 285, 1828 ("New York" and San Domingo); Dekay, New York Fauna, Fishes, 1842, 23 (copied); Günther, I, 142, 1859 (Cuba); Steindachner, Ichth. Beitr., V, 127, 1876 (Rio Janeiro); Poey, Repertorio, I, 197.

Epinephelus morio Gill, Cat. Fish. E. Coast, 1861, 28 (name only); Poey, Syn. Pisc. Cub., 1868, 285 (Havana); Poey, Enum. Pisc. Cub., 15; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 379 (Beaufort, N. C.); Goode, *op. cit.*, 1879, 115 (St. John's River; Indian River); Goode & Bean, *op. cit.*, 1879, 139 (Pensacola); Bean, *op. cit.*, 1880, 99 (Bermuda); Poey, Anal. Hist. Nat., 319, 1881 (Puerto Rico); Goode & Bean, *op. cit.*, 1882, 238 (name only); Jordan & Gilbert, *op. cit.*, 1882, 272 (Pensacola); Poey, Bull. U. S. Fish Comm., 1885, 118 (Key West); Jordan & Gilbert, Syn. Fish. N. A., 1883, 510; Bean, Cat. Fishes Exhib. London, 60, 1883 (Key West, Fla.); Jordan, Proc. U. S. Nat. Mus., 1884, 124 (Key West); Jordan & Swain, Proc. U. S. Nat. Mus. 1884, 381, (description and synonymy).

Serranus erythrogaster Dekay, New York Fauna, Fishes, 1842, 21, tab. 19 (Florida); Storer, Synopsis, 1846, 30 (copied); Holbrook, Ichth. S. Carol., 1860, 29, pl. 5, fig. 2 (Charleston); Günther, I, 133 (copied).

Epinephelus erythrogaster Gill, Cat. Fishes East Coast U. S. 30, 1861 (name only).

Serranus remotus Poey, Memorias Cuba, II, 140, 1860 (Havana).

Habitat.—Atlantic coast of America, Virginia to Rio Janeiro.

Etymology.—*Morio*, (Moor), translation of the name *nègre* used at San Domingo.

Specimens of this species from Charleston, St. Thomas, Parà and Rio Janeiro are in the museum at Cambridge.

38. EPINEPHELUS NIGRITUS.

(BLACK JEW-FISH).

Serranus nigritus Holbrook, Ichth. S. Car., Ed. 1, 173, pl. xxv, f. 11, 1856 (Charleston); Günther, I, 1859, 134 (copied).

Epinephelus nigritus Gill, Cat. Fish. E. Coast U. S., 1861, 30 (name only); Goode & Bean, Proc. U. S. Nat. Mus., 1878, 182; Goode & Bean, *op. cit.*, 1879, 139 (Pensacola); Goode, *op. cit.*, 1879, 115 (Indian River, Florida); Jordan & Gilbert, Syn. Fish. N. A., 1883, 541 (copied); Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 380; Jordan, Proc. U. S. Nat. Mus., 1885, 208 (Pensacola); Bean, Proc. U. S. Nat. Mus., 1885, 231 (Pensacola).

Habitat.—South Atlantic and Gulf coast of United States, Charleston, Pensacola.

Etymology.—*Nigritus*, blackened.

This large Grouper, the largest in size of all our species of *Epinephelus*, is not uncommon off the coast of Florida. We have examined many specimens, large and small, since the publication of the memoir of Jordan and Swain, and the relations of the species may be considered as well established. This species reaches a weight of probably 500 pounds, about the same size as the largest known examples of *Promicrops guttatus* and *Stereolepis gigas*. None of the European species of *Epinephelus* reach so large a size, the extreme weight of *Epinephelus gigas* being, according to Doderlein, about 50 kilogrammes; that of *E. caninus* 90 kilogrammes.

We have proposed to consider this species and its near ally, *E. merus* as constituting a subgenus distinct from the other *Epinepheli* on account of the difference in the form of the upper portion of the skull. We have suggested for this group the Portuguese name "*Garrupa*" (=Grouper), a name widely used in America for the larger Serranoid fishes.

The following notes are taken from the skull of a small example (about 18 inches long) from the beach of the Grand Lagoon at Pensacola:

COMPARISON OF THE SKULL OF EPINEPHELUS NIGRITUS WITH THAT OF E. MORIO.

In *E. morio* the skull is narrow and the upper surface rugose, the interorbital area is deeply concave, and the median crest, though low, is quite prominent; the occipital crest is sharp and drawn out so that it gradually merges into the interorbital ridge; the outline of the skull immediately behind the orbit is convex; the top of the temporal crest points inward to the occipital crest; the stay of the occipital crest forms a groove with the posterior part of the crest.

In *E. nigritus* the skull is very broad and flat, the interorbital area is little concave, and the median ridge is scarcely evident; the occipital crest disappears before reaching the interorbital region; the outline of the skull above is everywhere more or less flattened; the top of the temporal crest points outward; the stay of the occipital crest meets the crest at right angles and does not form a groove with it.

39. EPINEPHELUS MERUS.

(MERO DE LO ALTO.)

Centropristis merus Poey, Synopsis Piscuim Cubensium, 288, 1868 (Cuba).
Cerna sicana Doderlein, Rivista delle Specie del Genere *Epinephelus* o *Cerna*, 1882, 81 (Palermo).

Habitat.—West Indian fauna, taken off Cuba, Sicily, and Brazil.

Etymology.—*Merus*, from *mérou*, the French name of *Epinephelus gigas*, derived from Latin *morrhua*, cod-fish.

The brief description given by Poey of his *Centropristis merus* agrees with *Epinephelus nigritus* in all respects except the presence of but ten dorsal spines. The same may be said of the description given by Doderlein of a large *Epinephelus* recently taken in the waters about Palermo, to which he has hesitatingly given the name of *Serranus* or *Cerna sicana.**

I find in the Museum of Comparative Zoology two specimens (9737, 9788), each about 15 inches long, collected by Professor Agassiz at Rio de Janeiro, and a smaller one from Rio Grande do Sul. These specimens much resemble the *Epinephelus nigritus;* but all three agree in having, like the types of *merus* and *sicanus*, but ten dorsal spines, and, as in these species, the second dorsal spine is much elevated. There seems to be little room for doubt that all these specimens belong to one species, hitherto imperfectly known. This species should then retain the oldest specific name *Epinephelus merus.*

The following description is taken from 9737, M. C. Z.:

Body very deep and short, deeper and more compressed than in any other of our species of *Epinephelus.* Head large and blunt, the anterior profile regularly convex; interorbital area broad, as in *E. nigritus*, rather convex; eye small; mouth very large, the lower jaw projecting; supplementary maxillary small. Teeth, as usual in *Epinephelus*, in very broad bands; three or four very small canines in front of each jaw; no

*NOTE.—È questione d' altronde se i suddetti caratteri possono dar luogo ad istituire una specie novella, o se sieno effetto di una semplice anomalia di forma delle preacennate due specie (*caninus, cernioides*). Io non oso pronunciarmi in proposito; ed unicamente in via provvisoria e per indicarne la specialità, mi faccio coraggio di denominarla *Serranus* o *Cerna sicana*, in allusione al luogo ove fu presa."

lateral canines. Nostrils round, near together, the posterior largest. Preopercle without salient angle, but rather coarsely serrate; two or three very coarse, irregular teeth just below angle, these turned downward much as in *Epinephelus mystacinus*. Opercular spine moderate.

Gill-rakers very short and thick, x + 12, the longest not twice as high as broad and all very coarsely toothed; preorbital moderate, nearly as broad as the small eye.

Scales moderate, not very rough; dorsal fin rather deeply notched, the second spine highest, nearly three times the height of the first, but little higher than the third; soft dorsal high; caudal rounded; anal fin high, rounded, the spines moderate, graduated; pectorals short.

Color, in spirits, plain dark brown; fins all darker; a dark mustache along the edge of the maxillary. In the young specimen the caudal fin is abruptly paler. Head $2\frac{3}{5}$ in length of body; depth $2\frac{4}{5}$. D. X, 14; A. III, 9. Scales 86 (series). Second dorsal spine $2\frac{3}{5}$ in head; second anal spine 6. Pectoral $1\frac{4}{5}$; maxillary 2; eye 7; snout, $3\frac{3}{5}$; interorbital area, $4\frac{1}{2}$; soft dorsal rays $2\frac{2}{3}$ in head.

Since writing the above we have examined a specimen of *Epinephelus nigritus* from Pensacola which possesses but ten dorsal spines. We are unable to distinguish it from *E. merus*. If the number of dorsal spines prove to be constantly ten in Brazilian or European specimens this character may distinguish *E. merus* or *sicanus* as a distinct species or subspecies. It would appear that the number eleven is not constant in northern specimens, as one of about ten examined has ten spines.

Genus X.—PROMICROPS.

Promicrops (Gill MSS.) Poey, Synopsis Piscium Cubensium, 287, 1868 (*guasa*).
Itaiara Vaillant & Bocourt, Mission Scientifique au Mexique, 1875, 90 (*itaiara*).

TYPE.—*Serranus guasa* Poey = *Perca guttata* Linnæus.

Etymology.—*Πρό*, before; *μιχρός*, small; *ὤψ*, eye, in allusion to the shortness of the anterior part of the cranium.

A full account of the single known species of this genus is given by Jordan and Swain in the paper already quoted.

ANALYSIS OF SPECIES OF PROMICROPS.

a. Color olivaceous with darker cross-shades, which fade with age; head and body with round black spots; second anal spine as long as third; profile slightly concave above eye; interorbital area flattish, very broad, its width 5 in head; canine teeth very small; dorsal spines low and strong; the third, fourth, and fifth subequal, about 4 in head; scales moderate (about 95). GUTTATUS, 40.

40. PROMICROPS GUTTATUS.

(GUASA; JEW-FISH; MEROU; JACOB EVERTZEN.)

Cugupuguacu Marcgrave, Hist. Brazil, etc., 1648, 169 (Brazil); Willoughby, Hist. Pisc., 1686, 303, with plate (after Marcgrave).
Itaiara Marcgrave, Hist. Brazil, etc., 1648 (Brazil).
Perca guttata Linnæus, Syst. Nat., 1758, X, 292 (after Marcgrave, Willoughby, etc., excl. syn. Catesby).
Serranus itaiara Lichtenstein, Acta Berolin., 1820–'21, 278 (Brazil); Cuvier and Valenciennes, II, 1828, 376 (Brazil); Peters, Berliner Monatsber., 1865, 110 (identification with *S. galeus* M. & H.); Steindachner, Ichth. Beitr., V, 127, 1876.
Serranus (*Itaiára*) *itaiara* Vaillant and Bocourt, Miss. Sci. au Mexique., 1875, 90, pl. ii, f. 4 (identification with *S. quinquefasciatus* (Brazil; Tauesco; Mexico).

Epinephelus itaiara Jordan, Proc. U. S. Nat. Mus., 1884, 124 (Key West).
Promicrops itaiara Jordan and Swain, *op. cit.*, 1884, 877 (Key West; Havana; Mazatlan; Panama; Punta Arenas).
Serranus galeus Müller and Troschel, Schomburgk's Reise in Brit. Guiana, 621, about 1842; Günther, I, 1859, 130 (Brazil).
Epinephelus galeus Jordan, Proc. Ac. Nat. Sci. Phila., 1883, 285 (identification of type of *Serranus galeus*).
Serranus guasa Poey, Memorias Cuba, II, 1860, 141, 354, tab. 13, f. 8 (Cuba).
Promicrops guasa Poey, Rep., II, 154, 1867; Poey, Synopsis Pisc. Cub., 287, 1868; Poey, Enum. Pisc. Cubens., 1875, 18; Poey, Bull. U. S. Fish Comm., 1882, 118 (Key West); Jordan and Gilbert, Syn. Fishes N. A., 1883, 542 (copied); Gill, Rep. U. S. Fish Comm., 1871-'72, 806 (name only).
Epinephelus guasa Goode and Bean, Proc. U. S. Nat. Mus., 1882, 238 (name only).
Serranus quinquefasciatus Bocourt, Ann. Sci. Nat., 1868, 223 (Nagualate, Pacific coast of Guatemala).
Epinephelus quinquefasciatus Jordan and Gilbert, Bull. U. S. Fish Comm., 1882, 106, 110, 112 (Mazatlan; Panama; Punta Arenas; no descr.).

Habitat.—Both coasts of tropical America north to Florida and Gulf of California, south to Brazil.

Etymology.—*Guttatus*, spotted.

We have adopted the specific name *guttatus* for this species, because we feel sure that it is the real type of the Linnæan *Perca guttata*. In the paper of Jordan and Swain it is supposed that the *Cugupuguacu* of Willoughby may be the *Bodianus cruentatus*, and that the latter species is concerned with *Epinephelus catus* in forming the Linnæan type. We have since examined Willoughby's work. His description is a copy of Marcgrave's, and his figure represents the *Promicrops* which is the subject of Marcgrave's description, and nothing else.

Linnæus's *Perca guttata* is based, then, on Marcgrave's fish, and on the reprints of Marcgrave's description given by Willoughby, Ray, and Sloane, and on the Hind of Catesby (*Epinephelus catus*), which both Catesby and Linnæus wrongly supposed to be Marcgrave's species. The name *guttatus* can not go with the *Bodianus*, because that species was not known to any of the writers before Linnæus. It must go with Marcgrave's *Cugupuguacu*, which is the base of all the pre-Linnæan descriptions except that of Catesby. From Catesby's figure Linnæus must have taken the phrase in his diagnosis "corpore punctis sanguineis adsperso." Otherwise the *Perca guttata* rests entirely on Marcgrave's "Cugupuguacu," which is unquestionably our *Promicrops*.

The three species of which the synonymy has been thus entangled should, in our opinion, stand as *Epinephelus catus*, *Promicrops guttatus*, and *Bodianus cruentatus*.

Specimens of this huge Serranoid are in the Museum at Cambridge from Rio de Janeiro, Bahia, Pernambuco, and Cannarivieras.

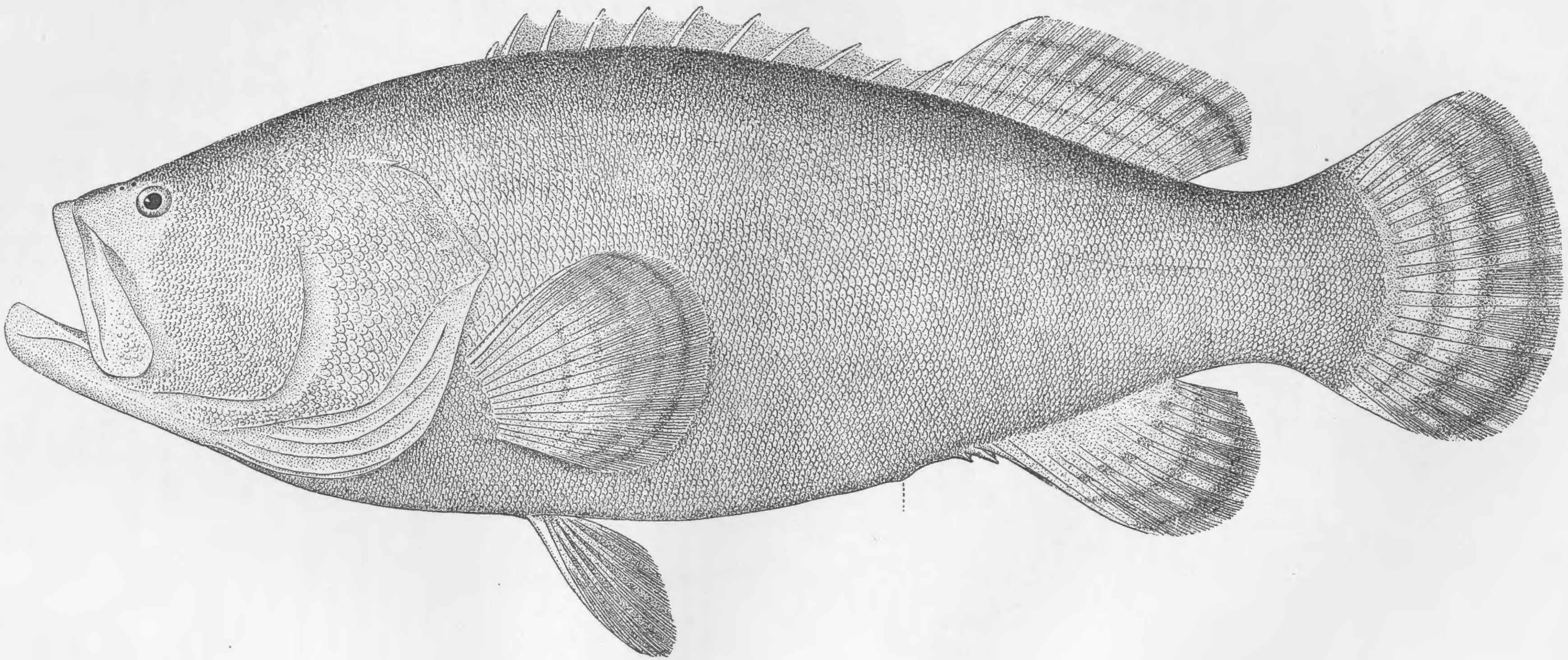
Genus XI.—MYCTEROPERCA.

Mycteroperca Gill, Proc. Ac. Nat. Sci. Phil., 80, 1863 (*olfax*).
Triostropis Gill, Proc. Ac. Nat. Sci. Phil., 104, 1865 (*guttatus=venenosus*).
Parepinephelus Bleeker, Systema Percarum Revisum, 257, 1875 (*acutirostris*).

TYPE.—*Serranus olfax* Jenyns.

Etymology.—*Μυκτήρ*, nostril; *πέρκη*, perch.

A few changes are made in the arrangement of the species of this genus as given by Jordan and Swain. Three species, *M. olfax*, *M. calliura*, and *M. dimidiata*, have been examined by us, and can be more correctly defined than was possible when the former paper was written. Two new species, *M. xenarcha* and *M. jordani*, have been



PROMICROPS GUTTATUS (Linnæus). The Guasa or Jew-fish.

(No. 22306, U. S. National Museum; from St. John's River, Florida.)

added to the group, while another, *M. reticulata*, has been eliminated, this species being identical with *M. tigris*. The name *rubra* takes the place of *scirenga*, and that of *apua* supersedes *guttata* for the red variety of *M. venenosa*. We have found it convenient to divide the group on the character of the nostrils, a basis of division more natural than that adopted in our former paper.

Professor Peters (Berliner Monatsberichte, 1865, 107) gives a detailed account of the specimen which was the original type of *Epinephelus ruber*. This *Epinephelus ruber* is a *Mycteroperca*, as is shown by the number of fin rays (D. XI, 16; A. III, 11), by the projecting lower jaw, the pointed snout, and by the general resemblance in form of body, fins, head, and teeth which the species is said to show to *Mycteroperca acutirostris*. As elsewhere stated, there is little doubt of the identity of *ruber* and *acutirostris*.

ANALYSIS OF SPECIES OF MYCTEROPERCA.

a. Nostrils very close together, the posterior decidedly larger than the anterior (*Mycteroperca*).

b. Second dorsal spine highest, its length more than one-third that of head; third spine scarcely shorter; caudal slightly lunate; canine teeth moderate; angle of preopercle not salient; anal fin angulated, its longest rays about $2\frac{1}{3}$ in head, its posterior margin concave; gill-rakers coarse and long, x + 15; scales small (13–20–x). Color brown, with grayish reticulations around brown spots; fins dusky edged; specimens from deep water (var. *ruberrima*) chiefly red. OLFAX, 41.

bb. Second dorsal spine low, shorter than third, the third and fourth highest.

c. Margin of anal fin posteriorly concave, its middle rays much exserted.

d. Outer rays of caudal scarcely produced, not two-thirds length of head; canine teeth moderate; angle of preopercle little salient; scales small (lat. l. about 130); color plain red; vertical fins without black edgings; gill-rakers long, x + 17. ROSACEA, 42.

dd. Outer rays of caudal much produced, more than two-thirds length of head; preopercle with salient angle; canine teeth strong; scales small (lat. l. 140); gill-rakers about 4 + 20. Color brownish with small darker spots; vertical fins broadly edged with blackish ....FALCATA, 43.

x. Upper canines directed strongly forward, the lower backward; coloration obscure. var. *falcata*

xx. Upper canines nearly vertical; coloration paler and brighter.........var. *phenax*.

cc. Margin of anal fin not concave posteriorly, the outline of the fin rounded or slightly angular.

e. Gill-rakers rather few, x + 12; body without dark cross-bars, covered with grayish reticulations around small brown spots, these not evident on head; anal fin rounded; preopercle with a salient angle; caudal deeply lunate; scales moderate (lat. l. 90 to 100) form rather robust; anal fin not angulate.........CALLIURA, 44.

ee. Gill-rakers very few, short, and thick, about x + 6; body with light and dark cross-bars, these often becoming obsolete with age; head usually with distinct reticulations around yellowish spots; anal fin with angular margin, subtruncate posteriorly; preopercle without salient angle; scales rather small (lat. l. 133); form rather robust..TIGRIS, 45.

x. Ground color dark olive ....var. *tigris*.

xx. Ground color bright red ....var. *camelopardalis*.

aa. Nostrils small, subequal, well separated.

c. Gill-rakers in moderate or small numbers, from 8 to 18 on lower part of anterior arch (*Trisotropis* Gill).

d. Anal fin not angulated, its outline more or less evenly rounded; soft parts of vertical fins edged with black in life.

e. Angle of preopercle not salient, its teeth scarcely enlarged; gill-rakers x + 8 to 10.

f. Gill-rakers very few and short, x + 8 developed (besides some rudiments) General color pale, bright red, or grayish, with roundish spots or blotches of black or red darker than the ground color; the blacker blotches along middle of sides much larger and quadrate in the young; red always present somewhere in life (fading in spirits); pectorals blackish, in the adult broadly tipped with orange-yellow; scales rather small (about 125); caudal lunate. VENENOSA, 46.

y. General color gray, with red and black markings.................var. *venenosa*.

yy. General color scarlet, with red and black markings ....var. *apua*.

ff. Gill-rakers rather slender, about x+10 (besides several rudiments); caudal subtruncate; nostrils small.

g. Scales not very small (about 110)); color dark olive-green, sides of head and body with rivulations of dark bluish around roundish dark bronze spots, large or small (these markings subject to considerable variation, fading in spirits); sides with darker quadrate areas.......................BONACI, 47.

z. Dark blotches on body rather large, often quadrate............var. *bonaci*.

zz. Dark spots on body very small, close set of a deep bronze-orange. var. *xanthosticta*.

gg. Scales very small (30 to 140); angle of preopercle not salient, but the teeth at the angle somewhat larger; general form, appearance, and color of *E. bonaci*. Color olive-green; head with numerous dark green streaks radiating from eye; a dark mustache along maxillary; body with small, irregular, dark, quadrate blotches; fins, except pectorals, mostly dusky ....JORDANI, 48.

ee. Angle of preopercle more or less salient, its teeth somewhat enlarged; gill-rakers more numerous, x + 12 to 14.

h. Scales very small (about 140); caudal peduncle without black spot; interorbital area scarcely concave; cheeks without distinct dusky stripes; commissure without yellow; caudal distinctly lunate; gill-rakers few, about 12 on lower part of anterior arch..MICROLEPIS, 49.

hh. Scales rather small (about 120); interorbital area channeled; angle of preopercle little salient; body slender; caudal little concave; sides with small, faint spots of darker; commissure with yellow-green ..................INTERSTITIALIS, 50.

ggg. Scales not very small (about 110); upper part of body dark brown, the lower half abruptly paler; a pale ring around caudal peduncle, behind which is a squarish dark blotch, smaller than eye, at base of upper rays of caudal; caudal deeply lunate; teeth strong..........................DIMIDIATA, 51.

dd. Anal fin angulated, its middle rays much exserted, its posterior margin concave; body rather robust; scales moderate (about 110); caudal fin subtruncate; gill-rakers about x + 18; angle of preopercle slightly salient, with coarser teeth; seventh ray of anal nearly half head; tenth ray of dorsal somewhat produced; color nearly plain dark olivaceous, the edges of the fins scarcely darker. XENARCHA, 52.

cc. Gill-rakers very long and slender, in greatly increased number (x + 25 to 35). (*Parepinephelus* Bleeker.)

h. Caudal fin lunate, its angles more or less produced in the adult, the fin subtruncate in the young; anal fin more or less angulate in the adult, rounded in the young; soft dorsal somewhat angular; scales rather large (lat. l., 95); body rather deep, the snout sharp; preopercle with a salient angle which is armed with larger teeth; dorsal spines low; gill-rakers close set, x + 30, the longest 7½ in head; ventrals not reaching to vent; color olive-gray with darker reticulations around pale spots; fins not much darker on their edges; a dark mustache along the maxillary; adult examples nearly uniform brown. RUBRA, 53.

41. MYCTEROPERCA OLFAX.

(YELLOW GROUPER.)

a. Green variety (*olfax*).

Serranus olfax Jenyns, Zoöl. of the Beagle, Fishes, 9, pl. 4, 1840 (Galapagos Islands); Günther, Proc. Zool. Soc. London, 1877, 67.

Mycteroperca olfax Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 376 (copied); Jordan, Proc. U. S. Nat. Mus., 1884 (Abingdon Island, Galapagos; Panama).

b. Red variety (*ruberrima*).

Mycteroperca olfax ruberrima Jordan & Bollman, var. nov. (Abingdon Island).

Habitat.—Galapagos Islands; Panama.

Etymology.—*Olfacto*, to smell, from the large size of the nostrils.

This species is well represented in the museum at Cambridge, some of the specimens there being 2 feet in length. The following description is taken from No. 24198, M. C. Z., 2 feet long, from James Island, Galapagos:

Head $2\frac{8}{10}$ to 3 in length; depth, $3\frac{1}{3}$. D., XI, 17; A., III, 11. Scales, 30–120–x.

Body robust, not strongly compressed; head deep, the snout rather sharp, the anterior profile steep; mouth large, the maxillary reaching somewhat beyond eye, $2\frac{1}{5}$ in head, its surface scaly, as in other species; teeth moderate; canines normal; nostrils large, very close together, separated by a narrow vertical septum, the posterior some three times the diameter of the anterior, which is broader than the septum (in the dried example examined by Jenyns the anterior nostril seems to have been overlooked, and a horizontal basal membrane in the posterior nostril was taken for the nasal septum); eye small, 7 in head; preorbital as broad as eye; interorbital area flattish and broad, $4\frac{2}{3}$ in head; gill-rakers coarse and long, x+15; preopercle without salient angle, its notch moderate; scales small, chiefly cycloid.

Dorsal spine strong, the second and third elevated so that the posterior outline of the fin is concave, first spine just half the second, second and third equal, $2\frac{2}{3}$ in head, fourth $1\frac{1}{2}$ in third; soft dorsal scarcely angular; caudal fin shallow-lunate; soft anal falcate, its posterior margin concave, the longest rays $2\frac{1}{3}$ in head (its form as in the adult of *rosacea*, *falcata*, *xenarcha*, and *rubra*).

Color brown, with some traces of grayish vermiculations around small round brown spots; fins all dusky, especially distally.

Young covered all over with round brown spots, much smaller than the pupil; a black mustache; pectoral with a narrow pale edge.

A large specimen taken by the *Albatross* at Abingdon Island, in the Galapagos, seems to have been bright red in life. It probably represents a deep-water variety analagous to the red varieties of West Indian species. It may be distinguished as var. *ruberrima*. The anal is a little lower than in an equally large specimen of the typical *olfax* taken in the same locality. No other difference is apparent.

42. MYCTEROPERCA ROSACEA.

Epinephelus rosaceus Streets, Bull. U. S. Nat. Mus., VII, 1877, 51 (Angel Island, Gulf of California).
Trisotropis rosaceus Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 107 (Mazatlan).
Mycteroperca rosacea Jordan & Swain, *op. cit.*, 362, 1884 (Mazatlan).

Habitat.—Gulf of California.

Etymology.—*Rosaceus*, rosy.

Only two specimens of this species are yet known; one of these has been described in detail by Jordan & Swain, the other by Dr. Streets.

43. MYCTEROPERCA FALCATA.

(SCAMP; BACALAO; ABADEJO.)

a. Var. *falcata.*

Serranus falcatus Poey, Memorias de Cuba, II, 138, 1860 (Havana).
Trisotropis falcatus Poey, Synopsis Pisc. Cubens., 285, 1868 (Havana); Poey, Ann. Lyc. Nat. Hist. N. Y., 309, 1869 (Havana); Poey, Enum. Pisc. Cubens., 15, 1875 (Havana).
Mycteroperca falcata Jordan & Swain *op. cit.*, 1884, 362 (Havana).

b. Var. *phenax.*

Trisotropis falcatus Goode & Bean, Proc. U. S. Nat. Mus., 140, 1879 (Pensacola, Fla.); Poey, Bull. U. S. Fish Comm., II, 118, 1882 (Key West, Fla.); Jordan & Gilbert, Proc. U. S. Nat. Mus., 273, 1882 (Pensacola, Fla.); Jordan & Gilbert, Synopsis Fishes North America, 538, 1883 (copied from Goode & Bean).
Epinephelus falcatus Jordan, Proc. U. S. Nat. Mus., 1884, 124 (Key West).
Mycteroperca falcata phenax Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 363 (Key West).

Habitat.—West Indian fauna, Pensacola to Cuba.

Etymology.—*Falcatus*, scythe-shaped.

As we have found that *Mycteroperca rubra* (*acutirostris*) has often or usually the anal fin angulated, as in the present species, it is probable that Dr. Steindachner was correct in referring his specimens showing this character from Messina and Rio Janeiro to *M. rubra* (*acutirostris*) rather than to *M. falcata.* (See Steindachner, Ichth. Beitr., XII, 3, 1882, and Jordan & Swain, *l. c.*)

We have specimens of this species from Cuba and from Bahia, the variety *phenax* from Pensacola and Key West.

44. MYCTEROPERCA CALLIURA.

Mycteroperca calliura Poey, Repertorio, 1867, I, 181, 309 (Cuba); Ann. Lyc. Nat. Hist. N. Y., IX, 307, 1869; Poey, Enum. Pisc. Cubens., 14, 1875.
Trisotropis calliurus Poey, Syn. Pis. Cubens., 284, 1868 (Cuba); Jordan & Swain, *op. cit.*, 366 (copied).

Habitat.—West Indian fauna, Cuba.

Etymology.—Κάλλος, beauty; οὐρα, tail.

A specimen in the museum at Cambridge (10011, 14 inches long), sent by Poey from Havana, is apparently typical of this species.

Body rather deep and compressed; preopercle with salient angle; gill-rakers x+12; nostrils as in *M. tigris*, *olfax*, etc., the posterior considerably the larger, the two close together, and the large nostril with a sort of interior septum at its base crossing it horizontally. Head 3 in length; depth 3. D. XI, 16; A. III, 11. Snout 4⅗ in head; eye 5; scales about 90 to 100; color brownish, everywhere with grayish reticulations around small brown spots, these not larger than pupil and not evident on the head; fins all edged with dusky.

45. MYCTEROPERCA TIGRIS.

(BONACI GATO.)

a. Var. *tigris* (brown variety).

Serranus tigris Cuv. & Val., IX, 440, 1833 (San Domingo); Günther, I, 112 (copied).
Trisotropis tigris Poey, Ann. Lyc. Nat. Hist. N. Y., 1869, 307 (Havana); Poey, Enum. Pisc. Cubens., 1875, 14.
Mycteroperca tigris Jordan & Swain, *op. cit.*, 364 (Havana).
Serranus felinus Poey, Memorias de Cuba, II, 134, 1860 (Havana).
Serranus repandus Poey, Memorias de Cuba, II, 135, 1860 (Havana).
Trisotropis reticulatus Gill, Proc. Ac. Nat. Sci., 1865, 105 (Barbadoes).
Mycteroperca reticulata Jordan & Swain, *l. c.*, 373 (Barbadoes).

b. Var. *camelopardalis* (red variety).

Serranus camelopardalis Poey, Mem. Cuba, II, 132, 1860 (Havana).
Trisotropis camelopardalis Poey, Syn. Pisc. Cub., 283, 1868; Poey, Ann. Lyc. Nat. Hist. N. Y., 307, 1869; Poey, Enum. Pisc. Cub., 1875, 14.
Serranus rivulatus Poey, Memorias Cuba, II, 1860, 135 (Havana).

Habitat.—West Indian fauna.
Etymology.—*Tigris*, tiger.

Several specimens in the museum at Cambridge, sent from Havana by Poey, agree perfectly with the type of *Trisotropis reticulatus*. These prove, on closer study, to be specimens of the *M. tigris*, from which the dark cross-bands have faded. There seems no reason whatever for doubting the identity of *E. reticulatus* with *E. tigris*.

A specimen of this species is in the museum at Cambridge from Maranhão. Another from Cuba is labeled as the type of *Serranus felinus* Poey.

46. MYCTEROPERCA VENENOSA.

(ROCK-FISH; BONACI CARDENAL; YELLOW-FINNED GROUPER; BONACI DE PIEDRA.)

a. Var. *venenosa* (gray variety).

Perca marina venenosa, the Rock-fish, Catesby, Fishes Carolina, etc., tab. 5 (Bahamas).
Perca venenosa Linnæus, Syst. Nat., x, 292, 1758 (after Catesby); *ibid.*, XII, 486; Gmelin, Syst. Nat., 1788, 1318, (copied); Bloch & Schneider, Syst. Ichth., 1801, 92 (copied).
Mycteroperca venenosa Jordan & Swain, *l. c.*, 373 (Key West; Havana).
Epinephelus venenosus Jordan, Proc. U. S. Nat. Mus., 1884, 124 (Key West).
Serranus petrosus Poey, Memorias Cuba, II, 136, 1860 (Havana); Poey, Repertorio, II, 165, 1868.
Trisotropis petrosus Poey, Ann. Lyc. Nat. Hist. N. Y., 1869, 304; Poey, Enum. Pisc. Cubens., 1875, 13; Poey, Bull. U. S. Fish Comm., 1882, 118 (Key West); Jordan & Gilbert, Syn. Fish. N. A., 1883, 918 (copied).
Trisotropis undulosus Goode, Bull. U. S. Nat. Mus., V, 55, 1876 (Bermudas; excl. syn.).

b. Var. *apua* (red variety).

Pirati apia Marcgrave, Hist. Bras., 158, 1648 (Brazil).
Bodianus apua Bloch, Ichth., VII, 37, Taf. 229, 1790 (Brazil, after a drawing by Prince Maurice—the same used by Marcgrave).
Bonaci cardenal Parra, Piezas de Hist. Nat. Cuba, 29, lam. XVI, 1787 (Havana).
Johnius guttatus Bloch & Schneider, Syst. Ichthyol., 77, 1801 (after Parra).
Bodianus marginatus Bloch & Schneider, *l. c.*, 331 (after Marcgrave).
Serranus cardinalis Cuv. & Val., Hist. Nat. Poiss., II, 378, 1828; Poey, Repertorio, II, 200, 1867 (after Parra).
Trisotropis cardinalis Poey, Ann. Lyc. Nat. Hist. N. Y., 1869, 303 (Cuba); Poey, Enum. Pisc. Cubens., 1875, 13.
Serranus rupestris Cuv. & Val., Hist. Nat. Poiss., IX, 437, 1833; Günther, Cat. Fish. Brit. Mus., I, 145, 1859 (San Domingo).
Mycteroperca venenosa guttata Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 375 (Havana).

Habitat.—West Indies, Florida Keys, and southward.

Etymology.—*Venenosus*, venomous, the flesh being sometimes poisonous.

We now adopt the name *apua* for the red variety of this species instead of *guttatus*. The *Bodianus apua* of Bloch could have been intended for nothing else than the *Bonaci cardenal*, although the figure is a very incorrect one.

Specimens of the red variety *apua*, from the Florida Keys, are in the museum at Cambridge. Others were obtained by the *Albatross* at St. Lucia.

47. MYCTEROPERCA BONACI.

(Bonaci ararÁ; Black Grouper.)

a. Var. *bonaci*.

Bonaci arara Parra, Piezas de Hist, Nat. Cuba, 1787, tab. 16, f. 2 (Havana).
? *Serranus bonaci* Poey, Memorias de Cuba, 1860, II, 129 (Cuba).
Trisotropis bonaci Poey, Syn. Pisc. Cubens., 1868, 283; Poey, Ann. Lyc. Nat. Hist. N. Y., 306, 1869; Poey, Enum. Pisc. Cubens., 1875, 13.
Epinephelus bonaci Jordan, Proc. U. S. Nat. Mus., 1884, 124 (Key West).
Mycteroperca bonaci Jordan & Swain, l. c., 1884, 370 (Key West, Havana).
Serranus brunneus Poey, Mem. Cuba, 1860, II, 131; Poey, Repertorio Fis. Nat., II, 156, 1868.
Trisotropis brunneus Poey, Syn. Pisc. Cub., 1868, 284; Poey, Ann. Lyc. Nat. Hist. N. Y., 305, 1869; Poey, Enum. Pisc. Cubens., 1875, 13; Poey, Bull. U. S. Fish Comm., 118, 1882 (Key West); Jordan & Gilbert, Syn. Fish. N. A., 1883, 538 (copied).
Serranus ararâ Poey, Memorias Cuba, II, 1860, 132 (Cuba; not of Cuv. & Val.); Steindachner, Ichthyol. Notizen, 1867, VI, 42.
Serranus decimalis Poey, Memorias Cuba, II, 1860, 138 (Cuba).
Serranus cyclopomatus Poey, Mem. Cuba, II, 1860, 353 (Cuba).
Serranus latepictus Poey, Mem. Cuba, II, 1860, 353 (Cuba).
Trisotropis aguaji Poey, Repertorio, II, 229, 1868; Poey, Synopsis, 1868, 284; Poey, Ann. Lyc. Nat. Hist. N. Y., IX, 306; Poey, Enumeratio, 14.

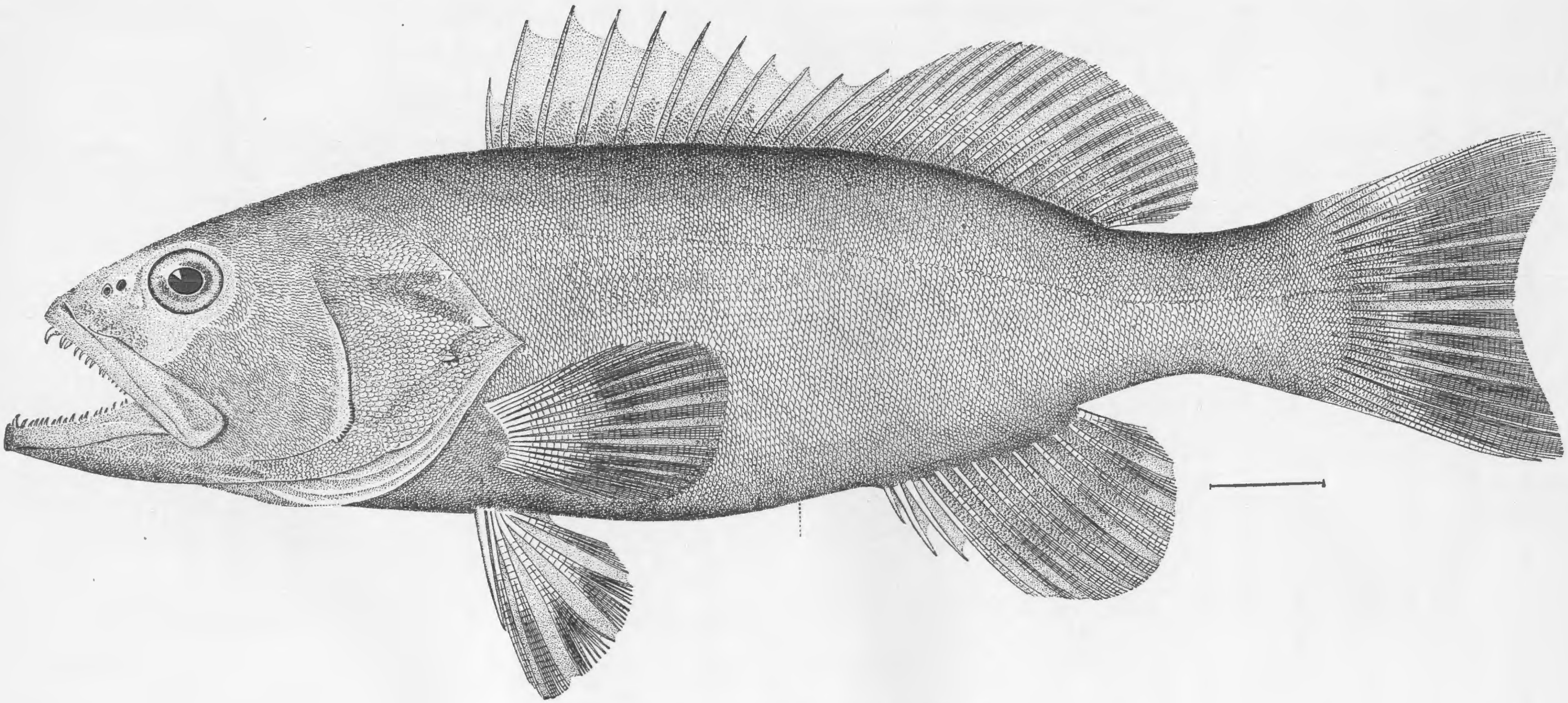
b. Var. *xanthosticta*.

Mycteroperca bonaci xanthosticta Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 371 (Pensacola).

Habitat.—West Indies, Pensacola to Brazil.

Etymology.—*Bonaci*, the Cuban name for the species.

Specimens of this species are in the museum at Cambridge, from Cuba, Nassau, and Rio Janeiro.



MYCTEROPERCA MICROLEPIS (Goode & Bean). The Gag.

(No. 5137, U. S. National Museum ; from Pensacola, Florida.)

We still feel a little doubt as to whether this is the original *bonaci* of Poey. If it should prove to be not that species, the present species should stand as *Mycteroperca decimalis.*

48. MYCTEROPERCA JORDANI.

Epinephelus jordani Jenkins & Evermann, Proc. U. S. Nat. Mus., 1888 (Guaymas).

Habitat.—Gulf of California.
Etymology.—Named for David Starr Jordan.

This species is very close to *M. bonaci*, from which it differs chiefly in the smaller scales. It is known from several young examples, the largest something more than a foot long, collected by Professors Evermann and Jenkins in the Gulf of California.

49. MYCTEROPERCA MICROLEPIS.

(GAG; AGUAJI.)

Serranus acutirostris Cuvier & Valenciennes, Hist. Nat. Poiss., IX, 432 (Charleston: no descr.; not type); Dekay, New York Fauna, Fishes, 1842, 23 (Charleston).
Trisotropis acutirostris Gill, Rept. U. S. Fish Comm., 1871–'72, 806 (name only).
Trisotropis brunneus Goode & Bean, Proc. U. S. Nat. Mus., 1879, 115, 143 (Pensacola; not of Poey).
Trisotropis microlepis Goode & Bean, Proc. U. S. Nat. Mus., 1879, 141 (West Florida); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 238 (no descr.); Jordan & Gilbert, Syn. Fish. N. A., 1883, 538 (copied).
Epinephelus microlepis Jordan, Proc. U. S. Nat. Mus., 1884, 124 (Key West; Cedar Keys).
Mycteroperca microlepis Jordan & Swain, *op. cit.*, 367 (Key West; Pensacola; Cedar Keys); Jordan, Proc. U. S. Nat. Mus., 1886, 27 (Beaufort, N. C.).
Trisotropis stomias (Goode & Bean, MSS.), Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 273 (Pensacola); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 427 (Pensacola; Key West); Jordan & Gilbert, Syn. Fish. N. A., 918, 971; Bean, Cat. Fishes Exhib. London, 1883, 61 (Pensacola).

Habitat.—South Atlantic and Gulf coast of United States, north to Beaufort, N. C.
Etymology.—*Μικρός*, small; λεπίς, scale.

Thus far this species, common on the coasts of Carolina and Florida, has not been taken in the West Indies. It is however frequently seen in the Havana markets (from Key West) and some one of Poey's nominal species may have been based on it. A specimen of this species from Mobile is in the museum at Cambridge.

50. MYCTEROPERCA INTERSTITIALIS.

? *Serranus interstitialis* Poey, Memorias, II, 127, 1860 (Cuba).
? *Trisotropis interstitialis* Poey, Synopsis Pisc. Cubens., 1868, 285; Poey, Ann. Lyc. Nat. Hist. N. Y., 308, 1869; Poey, Enum. Pisc. Cubens., 14, 1875.
Mycteroperca interstitialis Jordan & Swain, *l. c.*, 365 (Havana).
? *Trisotropis chlorostomus* Poey, Repertorio, II, 231, 1868; Poey, Synopsis Pisc. Cubens., 285, 1868; Poey, Ann. Lyc. Nat. Hist. N. Y., 308, 1869 (Cuba).

Habitat.—West Indian fauna, Cuba.
Etymology.—*Interstitialis*, having interstices.

We have some doubt as to whether the Havana specimens described by Jordan and Swain are identical with either the *interstitialis* or the *chlorostomus* of Poey. We know of no better identification, however, and in this case nothing will be gained by the exchange of one doubtful opinion for another. This is certainly a distinct species and it must have been known to Poey.

51. MYCTEROPERCA DIMIDIATA.

Serranus dimidiatus Poey, Memorias Cuba, 1860, II, 129 (Cuba).

Trisotropis dimidiatus Poey, Syn. Pisc. Cubens., 1868, 285; Poey, Ann. Lyc. Nat. Hist. N. Y., 1869, 308; Poey, Enum. Pisc. Cubens., 1875, 14, II, 129, 1860 (Cuba).

Mycteroperca dimidiata Jordan & Swain, *l. c.*, 367 (copied).

Habitat.—West Indian fauna, Cuba.

Etymology.—*Dimidiatus*, halved, upper half of body differing in coloration from lower.

We find a small specimen of this species (26953, M. C. Z., 8 inches long) in the museum at Cambridge. It was sent from Havana by Professor Poey, and it is probably one of his types.

Body rather deep and compressed; mouth small, lower jaw projecting; canines strong, as in *M. falcata*; snout rather sharp, 4 in head; maxillary 2; eye 5; nostrils small, not far apart, the anterior rather the larger; angle of preopercle salient, armed with stronger teeth; gill-rakers rather slender, x + 14. Scales rather small, about 110; caudal fin rather deeply lunate; anal fin rounded.

Head 3 in length; depth 3. D. XI, 16; A. III, 11.

Color, in spirits, quite dark above, the lower half abruptly paler; a narrow pale ring around caudal peduncle, behind which is a squarish dark blotch, smaller than eye, at base of upper rays of caudal; a dark area from tip of lower jaw through eye to the boundary between the dark and pale on the sides. Caudal, soft dorsal, ventrals, and anal edged with black.

52. MYCTEROPERCA XENARCHA.

Mycteroperca xenarcha Jordan, Proc. Ac. Nat. Sci. Phila., 1887 (Galapagos Islands; Payta).

Habitat.—Galapagos Archipelago; Coast of Peru.

Etymology.—Ξενός, strange; ἀρχός, anus.

This species is known from numerous specimens in the Museum of Comparative Zoology at Cambridge, from the Galapagos Islands and from Payta, Peru.

53. MYCTEROPERCA RUBRA.

Epinephelus ruber Bloch, Ichthyologia, VII, 22, 1793, Tafel 330 ("Japan" (?)); Bloch & Schneider, Systema Ichthyol., 1801, 299 (copied).

Serranus ruber Peters, Berliner Monatsberichte, 1865, 107 (re-description of original type).

?? *Sparus scirenga* Rafinesque, Caratteri di alcuni Nuovi Generi etc., 50, 1810 (Palermo; as likely to be *Epinephelus alexandrinus*).

Mycteroperca scirenga Jordan & Swain, *l. c.*, 369 (copied).

Serranus acutirostris Cuv. & Val., II, 286, 1828 (Brazil); Valenciennes, "Ichthyologie des Îles Canaries, pl. iii, f. 1" (Canary Islands; Messina); Guichenot, Explor. Sci. Algérie, Zool., v, 35, 1850 (Algiers); Günther, I, 135, 1859; Steindachner, Ichth. Beitr., XII, 5, 1882 (identified with *S. undulosus*).

Parepinephelus acutirostris Bleeker.

Cerna acutirostris Doderlein, Revista del Genere *Epinephelus* o *Cerna*, 1882, 59 (Palermo; description and full synonymy).

Serranus undulosus Cuv. & Val., II, 295, 1828 (Brazil); Steindachner, Ichth. Beitr., V, 127, 1876 (Rio Janeiro); Günther, I, 143, 1859 (said to have "pectorals yellow"); Steindachner, Ichth. Beitr., XII, 1882, 3 (Brazil; Port Said; Beiruth; Messina).

Trisotropis undulosus Poey, Ann. Lyc. Nat. Hist. N. Y., 1869, 305 (after one of the original types).

Serranus fuscus Lowe "Trans. Cambr. Philos. Soc., VI, 196, 1836" (Madeira); Günther, I, 1859, 134 (Madeira; Canary Islands); Steindachner, Ichthyol. Bericht., IV, 1867, 14, Taf. 2 (Cadiz; Teneriffe).

Serranus emarginatus Valenciennes, "Ichthyol. Îles Canaries, 10, 1835 to '50" (Canary Is.).

Serranus tinca Cantraine "Nouv. Mém. Acad. Brux., 1831, XI."

Cerna nebulosa Cocco "Indice Pesci Messina; Gen. 45, sp. 2," 1844 (Palermo).

Cerna macrogenis Sassi, "Descr. Genova e il Genovasato, I, 139," 1846.

Epinephelus chalinius Cope, Trans. Am. Philos. Soc., 1871, 465 (St. Martin's).

Cerna acutirostris var. *lata*, Doderlein, *l. c.*, 74 (Palermo; monstrous form).

Habitat.—West Indies, Brazil, Mediterranean Sea, and islands of eastern Atlantic.

Etymology.—*Ruber*, red; from the supposed coloration of the original bleached specimen.

This species is very well distinguished from all the other *Epinephelinæ* by the greatly increased number of the gill-rakers, a character first pointed out by Dr. Bean.

The following description is taken from No. 4805, M. C. Z., from Rio de Janeiro, 13 inches long:

Body rather deep, compressed, the snout sharp, the anterior profile straight; mouth moderate, the maxillary extending just beyond eye, $2\frac{1}{3}$ in head; canine teeth small; preopercle with a salient angle. Gill-rakers very long and slender, x+31, the longest four-fifths diameter of eye and $7\frac{1}{2}$ in head. Dorsal spines small; soft dorsal slightly angulated, the longest ray $2\frac{4}{5}$ in head; anal fin (in most specimens, especially in adults) sharply angulated as in *M. falcatus*, the longest ray $1\frac{7}{8}$ in head; caudal lunate, the angles well produced in the adult, the fin subtruncate in young; pectoral $1\frac{5}{8}$ in head. Head $2\frac{1}{2}$ in length; depth $2\frac{4}{5}$; D. XI, 16, A. III, 11. Scales, 95.

Coloration grayish olive, with reticulations of dark around irregular roundish pale spots; a black moustache along edge of maxillary; fins not much darker than body. Young with the markings more distinct than they are in the adults.

The coloration in this species differs from that of *M. bonaci* in this respect; in *M. rubra* the reticulations belong to the dark ground color; in the other the dark spots of the ground color are surrounded by paler reticulations.

A genuine specimen of this species is in the museum at Cambridge, sent by Poey from Havana, and therefore presumably a type of one of Poey's nominal species. I am unable, however, to identify it with any of these, as none show the combination of angular preopercle and paler spots surrounded by darker reticulations of the ground color.

There seems to be no reason for considering the *Sparus scirenga* as this species rather than as some one of the others found in the waters of Sicily. We are informed by our friend, M. Alexandre Thominot, of the Musée d'Histoire Naturelle at Paris, that the types both of *acutirostris* and *undulosus* possess numerous gill-rakers. There is, therefore, no doubt of the correctness of the current identification of this species.

We have two young examples sent by Dr. Doderlein from Palermo. These agree entirely with young examples from America. All of the large examples which we have seen have the anal angulated as in *M. falcata*. Doderlein makes no mention of this character and his figures do not show it, and it is not shown in the figures published by Dr. Steindachner. Dr. Steindachner, however, states that while most of his specimens have the anal rounded, a number from Rio Janeiro and Messina have its outline angulated. Possibly two varieties or species both with many gill-rakers are confounded under the name *rubra*. This seems doubtful, however, as the agreement in other respects is very close among all the specimens examined by us and those figured by authors.

We retain for this species the early but inappropriate name of *ruber*, as we have little doubt that the original *Epinephelus ruber* was the young of this species.

This typical specimen—6½ inches (m. 165) long is still preserved in the University of Berlin. It has been redescribed by Professor Peters, and his account shows an almost complete agreement with the young of *acutirostris* in all respects except the coloration. The coloration is now wholly pale or bleached, a fact which led Bloch to suppose that it had been red.

At my request, Dr. F. Hilgendorf, of the University of Berlin, has again examined the species. He sends a drawing of the head, which shows a full agreement in form of mouth and nostrils with M. *acutirostris*. He adds the following notes (translated):

The gill-rakers are indeed numerous. I count 24 on the ceratobranchial of the first arch. The longest of these measures 6½^{mm}.

The points in which *ruber* differs from *acutirostris* (compared with a larger example—12581, m. 283 long, from Athens) are the following: The pale coloration which is hardly to be explained by bleaching, as the dark-brown pigment suffers little, nor is it to be accounted for by difference in age. The caudal is in *ruber* apparently strongly rounded, and the pectorals as well as ventrals are longer in *ruber*. The ventrals reach at least to the vent. The point of the pectoral is 78^{mm} from the snout, 86^{mm} from the end of the caudal (as 7 to 8). In *acutirostris* these numbers are respectively 123^{mm} and 160 ^{mm} (as 3 to 4). This difference may be expressed by saying that in *acutirostris* (or in old examples?) the hinder parts of the body are more stretched. The streaks on the sides shown in Bloch's figure are merely the boundaries of the groups of muscles.

The difference in the form of the caudal above noticed may, we know, be due to age, as in specimens of 6 inches it is very rarely lunate. The difference in form is not unlikely also a matter of age. The pale color of the type of *Epinephelus ruber* may be due to exposure of the type to sunlight. A few weeks of such exposure will destroy all pigment cells. As the specimen has now been more than a century in alcohol, such an exposure may have some time taken place.

Genus XII.—DERMATOLEPIS.*

Dermatolepis Gill, Proc. Ac. Nat. Sci. Phila., 54, 1861 (*punctatus*).
Lioperca Gill, Proc. Ac. Nat. Sci. Phila., 237, 1862 (*inermis*).

TYPE.—*Dermatolepis punctatus* Gill.

Etymology.—Δέρμα, skin; λεπίσ, scale.

This well-marked genus is allied to *Epinephelus*, but shows some positive affinities with *Rypticus*. Two species are known, both fully described in the paper of Jordan & Swain. To these we venture to add a third, known only from a rather insufficient description given by Dr. Steindachner.

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* Closely allied to *Dermatolepis* is the genus *Cromileptes* Swainson (= *Serranichthys* Bleeker), based on *Serranus altivelis* Cuv. & Val. The latter genus has but ten dorsal spines; the anterior profile is concave and the dorsal fin extremely high.

ANALYSIS OF SPECIES OF DERMATOLEPIS.

a. [Dorsal rays XI, 17; scales very small, some of them ctenoid; interorbital space not half diameter of eye, which is $4\frac{1}{2}$ in head; maxillary reaching middle of eye; angle of preopercle salient, with 5 to 7 strong teeth, the two lowermost being turned forward; lower limb of preopercle entire; third dorsal spine highest, twice diameter of eye; anal spines graduated; pectoral as long as from snout to edge of preopercle; color brown, the scales edged with darker; fins brownish. D. XI, 17, A. III, 8.] (*Steindachner*) .... ANGUSTIFRONS, 54.

aa. Dorsal rays XI, 19; scales all cycloid, imbedded (115 to 125 in lat. l.); head about $2\frac{2}{3}$ in length; depth $2\frac{1}{2}$; preopercle without salient angle.

b. Preopercle evidently serrate, the serrate rather coarse and blunt; upper jaw with very small canines; pectoral fins long, more than two-thirds length of head, reaching vent; anal spines rather strong; dusky olive, with large rounded whitish spots; no black spots on head; a whitish streak from snout through eye toward front of dorsal .... INERMIS, 55.

bb. Preopercle subentire; canine teeth obsolete; pectoral fins short, not two-thirds length of head and not reaching vent; anal spines short; dusky olive, with round whitish spots; head with smaller black spots .... PUNCTATUS, 56.

54. DERMATOLEPIS ANGUSTIFRONS.

Serranus angustifrons Steindachner, Verh. Zool.-bot. Gesellsch., Wien, 1864, XIV, 230, tafel vii, figs. 2, 3, (Cuba.)

Habitat.—West Indian fauna.

Etymology.—*Angustus*, narrow; *frons*, forehead.

We know nothing of this species except what is contained in the original description. Were it not for the statement that the scales are ctenoid, we should refer it without hesitation to the genus *Dermatolepis*. As it is, we know of no better place for it, as it is not a genuine *Epinephelus*.

The following is Dr. Steindachner's description:

Serranus (Cerna) ongus, spec. Bloch, Günther (?), an Serranus angustifrons n. sp.

(Tafel VII, Fig. 2, 3.)

Die von Cuv. Val. und Dr. Günther gegebene Beschreibung von *Serranus ongus* spec. Bl.=*S. dichropterus* ist so allgemein gehalten und arm an charakteristischen Merkmalen, dass ich nicht mit voller Bestimmtheit zu ermitteln vermag, ob ein im kais. Museum befindliches, von Cuba eingesendetes Exemplar zu *Serrunus* [*Serranus*] *ongus* zu beziehen sei oder einer neuen Art angehöre, die wegen der auffallend geringen Breite der Stirne den Namen *S. angustifrons* rechtfertigen würde. Um die Hebung dieser Zweifel zu ermöglichen, gebe ich die naturgetreue Abbildung des Kopfes, von der Seite und von oben gesehen.

Der ganze Körper ist sehr stark comprimirt.

Die Kopflänge beträgt nahezu $\frac{1}{3}$ der Totallänge des Fisches; die Kopfbreite ist $3\frac{2}{3}$ mal in der Kopflänge, die grösste Körperhöhe weniger als 4 mal in der Totallänge enthalten. Die geringste Körperhöhe am Schwanzstiele kommt nicht ganz $\frac{1}{3}$ der grössten Leibeshöhe gleich. Das länglichrunde Auge stösst mit seinem oberen Rande fast an die Profillinie des Kopfes, liegt um etwas mehr als $1\frac{1}{2}$ Augenlängen vom unteren Kopfrande entfernt. Die länge des Augendiameters ist $4\frac{1}{2}$ mal in der Kopflänge, die lange Spitze des hinteren häutigen Kiemendeckelanhanges inbegriffen, enthalten.

Die Stirnbreite zwischen den Augen beträgt kaum $\frac{2}{3}$ der Länge eines Auges. Das hintere Ende des Oberkiefers reicht in senkrechter Richtung bis unter die Mitte des unteren Augenrandes zurück. Der hintere Vordeckelrand ist convex und sehr fein gezähnt; der Vordeckelwinkel springt über den hinteren Rand vor, und trägt 5–7 starke Zähne, von denen die beiden unteren mit ihrer Spitze nach vorne gekrümmt sind. Der untere Vordeckelrand ist wie bei vielen Serranen (nicht aber bei allen, wie Dr. Günther in seiner Synopsis der Genera der Percidae Band I, pag. 55, des Catal. of the Acanth. Fish. of the Brit. Mus. angibt) ungezähnt; der knöcherne Theil des Kiemendeckels ist nach hinten in 3 stark plattgedrückte Stacheln ausgezogen, von denen der mittlere am längsten ist.

Von den 11 Dorsalstacheln ist der dritte am höchsten, beiläufig noch einmal so hoch als der erste oder 2 Augendiametern an Länge gleich. Der letzte Dorsalstachel erreicht die Länge von 1½ Augendiameter; der höchste Gliederstrahl der Dorsale ist etwas höher als der dritte Stachelstrahl derselben Flosse.

Die Ventrale ist bedeutend, die Caudale nur ein wenig kürzer als die Pectorale; diese letztere ist von dreieckiger Gestalt, und der Entfernung der Schnauzenspitze vom oberen Ende des Vordeckels an Länge gleich.

Der zweite Analstachel ist länger als der letzte Dorsalstachel, aber etwas kürzer als der dritte Analstachel, übertrifft übrigens an Stärke sowohl diesen, als auch jeden der 11 Dorsalstacheln. Der gliederstrahlige Theil der Anale, so wie der Dorsale ist nach hinten abgerundet.

Der ganze Körper (mit Ausnahme der nackthäutigen Lippen) ist mit sehr kleinen, gezähnten Schuppen bedeckt, die Seitenlinie erstreckt sich bis zum Beginne des hinteren Längendrittels der schwach abgerundeten Schwanzflosse.

Der Körper ist von brauner Farbe, jede der kleinen Körperschuppen zeigt am, oder etwas vor dem freien Rande, und zwar parallel mit demselben einen schmalen schwärzlichen Saum. Die Brust- und Bauchflossen sind von schwärzlichbrauner Farbe, die Flossenhaut der Dorsale ist nur zunächst den einzelnen Stacheln von schwärzlicher, im übrigen von bräunlicher Färbung. D. 11-17. A. 3-8. P. 19.

55. DERMATOLEPIS INERMIS.

Serranus inermis Cuv. & Val., Hist. Nat. Poiss., IX, 436, 1833 (Antilles); Poey, Memorias Cuba, I, 1851, 54, lam. 4, f. 2 (Cuba); Günther, I, 1859, 153 (Cuba); Poey, Repertorio, I, 198, 1867.

Lioperca inermis Poey, Syn. Pisc. Cubens., 282, 1868 (Havana); Poey, Enum. Pisc. Cubens., 17, 1875.

Dermatolepis inermis Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 405 (Havana).

Habitat.—West Indies.

Etymology.—*Inermis*, unarmed.

Of this species we have examined a single specimen from Havana.

56. DERMATOLEPIS PUNCTATUS.

Dermatolepis punctatus Gill, Proc. Ac. Nat. Sci. Phila., 54, 1861 (Cape San Lucas); Gill, *op. cit.*, 250, 1862; Jordan & Gilbert, Proc. U. S. Nat. Mus., 229, 1881 (Socorro Island); Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 407 (Socorro Island).

Habitat.—Lower California; Revillagigedo Islands.

Etymology.—*Punctatus*, spotted.

This species is known from three specimens, one of these the type of the detailed account given by Jordan and Swain.

According to Dr. Gilbert, this species is very abundant about the Revillagigedo Islands, where it reaches a weight of about 50 pounds, and is exceedingly voracious.

Genus XIII.—BODIANUS.

Bodianus Bloch, Ichthyologia, 1790 (*guttatus*, *bodianus*, etc., species with entire preopercle and spine on opercle).

Cephalopholis Bloch & Schneider, Syst. Ichth., 1801, 311 (*argus* = *guttatus*).

Bodianus Cuvier, Règne Animal, 1817, 276 (*guttatus*, etc.).

Bodianus Gill, Proc. Ac. Nat. Sci. Phila., 237, 1862 (restriction of *Bodianus* Bloch to allies of *B. guttatus*).

Enneacentrus Gill, Proc. Ac. Nat. Sci. Phila., 105, 1865 (*ouatalibi* = *fulvus*).

Petrometopon Gill, Proc. Ac. Nat. Sci. Phila., 105, 1865 ("*guttatus*" = *cruentatus*.)

Menephorus Poey, Ann. Lyc. Nat. Hist. N. Y., X, 50, 1869 (*dubius*).

TYPE.—*Bodianus guttatus* Bloch.

Etymology.—*Bodiano*, *Pudiano*, Portuguese name of the larger Labroid fishes in Brazil.

We revert to our first opinion, and to the earlier opinion of Dr. Gill, that the name *Bodianus* should be used for this genus.

The name is a latinization of a Portuguese name of *Harpe rufa*, and the latter species, under the name of *Bodianus bodianus*, was included by Bloch among the original types of the genus *Bodianus*, it being wrongly supposed by Bloch to agree with other species referred to *Bodianus* in having an opercular spine and an entire preopercle.

Cuvier separated *Harpe rufa* from the others, retaining the name *Bodianus* for the Serranoids only, these agreeing more or less closely with the definition of Bloch.

Gill later restricted the name to the nine-spined allies of *Epinephelus*, his *Bodianus* corresponding to the use of the word in this paper. Later he transferred the name to *Harpe rufa*, dividing the group he had formerly called *Bodianus* into *Enneacentrus* and *Petrometopon.*

It seems to us that the restriction of *Bodianus*, made by Cuvier and Gill, by which the *Labridæ* were omitted from the genus is legitimate, and as it has priority over other arrangements we may accept it.

The investigations of Professor Peters on the types of Bloch show that *Cephalopholis argus* Bloch & Schneider is identical with *Bodianus guttatus* Bloch, and that the species in question has really but nine spines in its dorsal, as is shown in the figures both of Schneider and Bloch. *Cephalopholis* is therefore a strict synonym of *Enneacentrus*, and should be adopted unless *Bodianus* is substituted for both of them.

Three well-marked groups or subgenera are included among our species of *Bodianus.* We can not tell what value these groups may have without examining a much larger series of species than has yet been in our hands. Of our species, *fulvus*, the type of *Enneacentrus*, has the interorbital area channeled, its bones thin and smooth, while *cruentatus*, the type of *Petrometopon* Gill, has this area narrow and transversely convex, the bones hard and thickened.

The skulls of the other species have not been examined, but *tæniops* and *dubius* will probably be found to agree with *fulvus*, and *panamensis* with *cruentatus.*

Somewhat allied to *Bodianus* is the Asiatic genus *Variola* Swainson (= *Uriphæton* Swainson = *Phæthonichthys* Bleeker, *Pseudoserranus* Klunzinger); type *Serranus luti* or *louti.*

In *Variola* the soft dorsal, anal, and caudal are drawn out in long streamers, the canines are very strong, and there is a strong lateral canine on each side of the lower jaw, besides those in front. The cranium above resembles that of the *Serraninæ*, the smooth area of the vertex being large, the crests low. This genus is in some degree intermediate between the *Epinephelinæ* and *Serranus.*

ANALYSIS OF AMERICAN SPECIES OF BODIANUS.

a. Caudal fin rounded or subtruncate.

b. Sides with nine or ten dark cross-bands; sides of head and jaws with many round bluish or yellowish spots; a large jet-black spot behind eye; vertical fins edged with blue; lower jaw much projecting; preopercle very finely serrulate, its angle not salient; scales rather large (lat. l. about 80); second anal spine longest; caudal much rounded. PANAMENSIS, 57.

bb. Sides without cross-bands.

c. Skull with interorbital area, narrow, convex, hard and thickened (*Petrometopon* Gill); body, head and fins more or less covered with scarlet or orange spots; about four round, inky spots along base of dorsal; lower jaw not strongly projecting; caudal fin much rounded; scales rather large (lat. l. about 80) .... CRUENTATUS, 58.

x. Color reddish gray, with many vermilion spots, those most distinct on top of head. var. *cruentatus*.

xx. Color dusky olive, the spots dark orange red, those on the head obscure. var. *coronatus*.

cc. Skull with the interorbital area channeled, the bones thin and smooth (*Enneacentrus*); head and body with few or many small, blue, dark-edged spots; lower jaw strongly projecting.

d. Snout with one or two blue stripes; back of tail without conspicuous black blotch; caudal rounded; scales small (lat. l. about 115) .... TÆNIOPS, 59.

dd. Snout without stripes; back of tail with two black spots; lower jaw with a black spot at tip; caudal subtruncate; scales moderate (lat. l. about 90) .... FULVUS, 60.

f. Ground color lemon-yellow; blue spots few .... var. *fulvus*.

ff. Ground color bright scarlet .... var. *ruber*.

fff. Ground color brown .... var. *punctatus*.

aa. Caudal fin lunate; body covered with blue spots. (*Menephorus* Poey.)

e. Body rather deep; preopercle evenly convex, without salient angle; mouth small, the lower jaw much projecting; gill-rakers slender, long, about x + 20; color carmine red, the head, back, and sides more or less covered with blue, dark-edged points; caudal tips black; some dark spots on maxillary and about eye .... DUBIUS, 61.

57. BODIANUS PANAMENSIS.

Serranus panamensis Steindachner, Ichth. Beiträge, IV, 1, 1871, with plate (Panama).
Enneacentrus panamensis Jordan & Swain, *l. c.* 398 (copied).

Habitat.—Panama.

Etymology.—*Panamensis*, from Panama, where the species was first found.

This species is known to us from Dr. Steindachner's description.

Serranus gymnopareius, Cuv. & Val., II, 248 (from unknown locality); resembles this species somewhat, but it is probably not American.

Epinephelus striatus Bloch Ichth., taf. 330, said to be from Jamaica; is also unknown to us. Cuvier and Valenciennes regard this species as probably identical with the *gymnopareius*. In any case, the name *striatus* is preoccupied by *Epinephelus striatus*. *Bodianus gymnopareius* is said to resemble *Serranus scriba* in form, but it is especially distinguished by having the precopercle for the most part bare of scales; seven or eight brown bands across the body; some traces of a dark longitudinal band; caudal truncate; D. IX, 17; A. III, 7. It is described from a small, stuffed specimen.

58. BODIANUS CRUENTATUS.

(ENJAMBRE; CONEY; ROUGH HIND.)

a. Scarlet variety (*cruentatus*).

Perca guttata Bloch, Ichthyol., pl. 312, 1792 (description and figure from a drawing by Plumier); not of Linnæus.
Serranus guttatus Castlenau, Anim. nouv. ou rares, S. Amer., 1854, 312 (Brazil).
Enneacentrus guttatus Jordan & Swain, *l. c.* 399 (Havana).
Sparus cruentatus Lacépède, Hist. Nat. Poiss., IV, 157, tab. 4, f. 1, 1803 (on a copy of Plumier's drawing.).
Serranus apiarius Poey, Memorias Cuba, II, 143, 1860 (Havana).
Petrometopon apiarius, Poey, Synopsis Pisc. Cubens., 1868, 288; Poey, Enum. Pisc. Cubens., 1875, 20 (name only).

Serranus coronatus (pale variety) Günther, I, 124, 1859 (Puerto Cabello, Cuba, Jamaica, and Trinidad) Cope, Trans. Am. Philos. Soc., 1871, 466 (St. Croix; New Providence).

b. Brown variety (*coronatus*).

Serranus coronatus Cuv. & Val., II, 371, 1828 (Martinique); Poey, Repertorio, I, 198, 1868.
Serranus coronatus var. *nigriculus*, Günther, I, 1859, 124.
Enneacentrus guttatus coronatus Jordan & Swain, *l. c.* 398 (Key West; Havana).
Petrometopon guttatus Poey, Synopsis Pisc. Cub., 1868, 288 (Havana); Poey, Enum. Pisc. Cubens., 1875, 19.
Epinephelus guttatus Jordan, Proc. U. S. Nat. Mus., 1884, 125 (Key West).

Habitat.—West Indian fauna; Brazil to Florida Keys.

Etymology.—*Cruentatus*, dyed with blood.

As this species is in no wise concerned in forming the *Perca guttata* of Linnæus, we no longer retain for it the specific name of *guttatus*. The specific name next in date is the *cruentatus* of Lacépède. This appropriate name seems to be subject to no doubt, and must be adopted.

59. BODIANUS TÆNIOPS.

Serranus tæniops Cuv. & Val., II, 370, 1828 (Cape Verde); Günther, I, 121, 1859 (St. Vincent); Steindachner, Fische Afrikas, 1881, 4, taf. 1 ("very common on the coast of Senegambia to the Cape Verde Islands and Guinea; rare on the coasts of the Bahama Islands to Florida").
Bodianus tæniops Jordan & Gilbert, Syn. Fish. N. A., 1883, 919 (copied).
Enneacentrus tæniops Jordan & Swain, *l. c.*, 402 (copied).

Habitat.—West Indies and Florida Keys to west coast of tropical Africa.

Etymology.—*Ταινία*, band; *ὤψ*, face.

We have seen no specimens of this species.

60. BODIANUS FULVUS.

(GUATIVERE; NIGGER-FISH; YELLOW-FISH; BUTTER-FISH.)

a. Yellow variety (*fulvus*).

Turdus cauda convexa (the Yellow-fish) Catesby, Nat. Hist. Carolina, 1743, pl. x, f. 2.
Labrus fulvus Linnæus, Syst. Nat., ed. x, 1758, 287 (after Catesby); Linnæus, Syst. Nat., ed. XII, 1766, 479.
Enneacentrus fulvus Jordan & Swain, *l. c.* 402 (Havana).
Guativere amarilla Parra, Descr. Dif. Piezas, Hist. Nat. Cuba, 1787, lam. v. f. 2 (Cuba).
Holocentrus auratus Bloch, Ichthyol., VII, 57, 1792, taf. 236 ("East Indies"); Bloch & Schneider, Syst. Ichthyol., 1801. 314.
Serranus auratus Cuvier & Valenciennes, II, 364, 1828 (copied); Peters, Berlin. Monatsber., 1865, 103. (identification of *Holocentrus auratus* Bloch).
Bodianus guativere Bloch & Schneider, Syst. Ichth., 1801, 336 (based on both Parra's figures).
Serranus guativere Cuv. & Val., II, 383, 1828 (on Parra's second figure); Müller & Troschel, "Schomburgk's Hist. Barbad., 1848, 665;" Cope, Trans. Am. Philos. Soc., 1871, 466 (New Providence); Poey, Repertorio, I, 203.

b. Scarlet variety (*ruber*).

Carauna Marcgrave, Hist. Brasil, 1648, 147 (Brazil).
Guativere Parra, Descr. Dif. Piezas, Hist. Nat., 1787, lam. V, f. 1 (Cuba).
Perca punctata Bloch, Ichthyol.. 1792, 314 (on a figure by Plumier).
Gymnocephalus ruber Bloch & Schneider, Syst. Ichthyol., 1801, 346, taf. 67 (on *Carauna* of Marcgrave; not *Epinephelus ruber* Bloch).
Serranus ouatalibi Cuv. & Val., II, 381, 1828 (Havana); Guichenot, Ramon de la Sagra, Cuba, Poiss., 1845, 15 (Havana); Müller & Troschel, Schomburgk's Exped. Barbad., 1848, 665 (Barbadoes); Günther, I, 1859, 120 (Jamaica; Cape Verde); Cope, Trans. Am. Phil. Soc., 1871, 466 (St. Croix; New Providence; St. Kitt's); Poey, Repertorio, I, 202, 1867.

Enneacentrus fulvus ouatalibi Jordan & Swain, *l. c.*, 402 (Havana).
Serranus carauna Cuv. & Val., II, 384, 1828 (Brazil); Castelnau, Anim. nouv. Amér. Sud, I, pl. i. f. 1. (Brazil).

c. Brown variety (*punctatus*).

Perca marina puncticulata (the NEGRO-FISH) Catesby, Nat. Hist. Carolina, etc., 1743, pl. 7 (Bahamas).
Perca punctata Linnæus, Syst. Nat., x, 1758, 291 (based on Catesby); Linnæus, Syst. Nat., XII, 1766, 485.
Enneacentrus punctatus Poey, Syn. Pisc. Cubens., 1868, 288 (Cuba); Goode, Bull. U. S. Nat. Mus., V, 1876, 59 (Bermudas).
Epinephelus punctatus Jordan & Gilbert, Syn. Fish. N. A., 1883, 541.
Bodianus punctatus Jordan & Gilbert, Syn. Fish. N. A., 919 (name only).
Enneacentrus fulvus punctatus Jordan & Swain, *l. c.* 403 (Havana).
Perca punctulata Gmelin, Syst. Nat., 1788, 1315 (after Catesby).
Enneacentrus punctulatus Poey, Enum. Pisc. Cubens., 20, 1875 (Havana).

Habitat.—West Indian fauna: Florida Keys to Brazil.
Etymology.—*Fulvus*, tawny in color.

Specimens of this abundant species are in the museum at Cambridge from St. Thomas, Sombrero, Barbadoes, Havana, Nassau, Camaru, Maranhâo, and Rio de Janeiro. We have also examined specimens from Bahia.

61. BODIANUS DUBIUS.

Serranus dubius Poey, Memorias, II, 142, 1860 (Cuba).
Enneacentrus dubius Poey, Synopsis Pisc. Cubens., 289, 1868.
Menephorus dubius Poey, Ann. Lyc. Nat. Hist. N. Y., X, 50, 1869; Poey, Enumeratio Pisc. Cubens., 1875, 21.
Enneacentrus dubius Jordan & Swain, *l. c.*, 405 (copied).
? *Menephorus punctiferus* Poey, Enumeratio Pisc. Cubens., 21, 1875 (Cuba).

Habitat.—Cuba.
Etymology.—*Dubius*, doubtful.

Two specimens of this species were known to Professor Poey, one 155^{mm} long, which became the type of *Serranus dubius;* the other, 250^{mm}, which became the type of *Menephorus punctiferus*. The two specimens probably belong to the same species, as the differences indicated are of slight value.

I find in the museum at Cambridge a third specimen, without label to indicate its origin. The following is a description of this specimen, which is about 9 inches in length:

Head, $3\frac{1}{5}$ in length; depth, $2\frac{5}{6}$. D. IX, 11 + (the fin having been injured in youth); A. III, 9. Scales, 96.

Body rather deep and compressed, formed much as in *Bodianus fulvus;* head anteriorly pointed, the profile forming a slight, even curve. Mouth small; maxillary extending to posterior edge of pupil, $2\frac{1}{6}$ in head; lower jaw much projecting; teeth moderate, the anterior canines in both jaws rather strong. Interorbital space narrow. Eye moderate, $4\frac{1}{2}$ in head, as long as snout. Preopercle finely serrate, its outline evenly convex. Gill-rakers slender and long, x + 20. Scales moderate, strongly ctenoid. Caudal fin lunate, its angles pointed, the inner rays $2\frac{1}{3}$ in head, the outer $1\frac{3}{5}$. Dorsal spines low, stiff, the longest 3 in head; outline of the fin not notched. Anal fin high and rounded, its longest rays $2\frac{1}{3}$ in head. Second anal spine stronger than third, but scarcely longer, $3\frac{1}{4}$ in head. Pectoral long, reaching past tips of ventrals, $1\frac{1}{6}$ in head.

Color much as in *Bodianus fulvus ruber*—bright red; head, back, and sides covered with blue points which are edged with blackish; dorsal edged with dusky; caudal tips black above and below; maxillary with a row of dark spots; some dark spots about eye.

Genus XIV.—PARANTHIAS.

Brachyrhinus Gill, Proc. Acad. Nat. Sci. Phila., 1862, 236 (*creolus=furcifer*) (preoccupied in entomology).

Paranthias Guichenot, Ann. Soc. Linn. Maine-et-Loire, X, 1868 (*furcifer = creolus*).

TYPE.—*Serranus furcifer* Cuv. & Val.

Etymology.—*Παρά*, near; *Anthias*, a related genus.

This is one of the most strongly marked of our Serranoid genera, well distinguished among the *Epinephelinæ* by the number of fin rays (D. IX, 18), by the deeply forked caudal, and by the form of the mouth and frontal region, in which respects it bears much resemblance to the *Anthiinæ*. But one species is known, a beautifully colored fish, inhabiting deep waters.

ANALYSIS OF THE SPECIES OF PARANTHIAS.

a. Body moderately elongate, strongly compressed; the profile convex and the snout short, as in the suborder *Anthiinæ;* snout about 4 in head; eye about 4; maxillary reaching to below middle of eye, 2⅗ in head; maxillary broadened posteriorly, its surface scaled, as in *Anthias;* teeth small, recurved, in a narrow band in each jaw; two to four straight canines near the front of each jaw; preorbital very narrow; preopercle finely serrate, with salient angle or enlarged teeth; gill-rakers slender; scales small, closely and regularly imbricated, most of them strongly ctenoid; dorsal fin low, the spines strong, the third longest, 2¼ in head; soft rays of dorsal low, scarcely higher than longest spine; anal short, its longest (second) soft ray 2 in head, its third spine longest, 2⅗ in head; ventrals narrow, not reaching vent; pectorals lanceolate, as long as head; humeral scale long; color bright red, or salmon color, with three small violet spots, one on side of back and one or two on the tail, a bar of similar color extending from upper corner of pectoral across the humeral process; sides with faint oblique streaks along the rows of scales; dorsal fin with a longitudinal blackish streak. Head, 3⅘ in length; depth, 3. D. IX-18; A. III, 9. Scales, 90 to 120 .... FURCIFER, 62.

62. PARANTHIAS FURCIFER.

(RABIRUBBIA DE LO ALTO.)

Rabirrubia de lo alto Parra, Piezas de Hist. Nat. Cuba, 43, lam. 27, fig. 2, 1787 (Havana).

Serranus furcifer Cuv. & Val., Hist. Nat. Poiss., II, 264, 1828 (Brazil).

Anthias furcifer Günther, Cat. Fish. Brit. Mus., I, 91, 1859 (Brazil).

Paranthias furcifer Guichenot, Ann. Linnæan Soc., x, 1868; Jordan, Cat. Fish. N. Am., 83, 1885 (name only); Jordan, Proc. U. S. Nat. Mus., 377, 1885 (Cape San Lucas; Galapagos Isl.; Panama); Jordan, Proc. U. S. Nat. Mus., 1886, 39 (Havana); Jordan, Proc. U. S. Nat. Mus., 1889, 181 (Charles, Chatham, and Albemarle Islands, Galapagos).

Brachyrhinus furcifer Poey, Ann. Lyc. Nat. Hist., 34, 1871 (Cuba); Poey, Enumeratio Pisc. Cubens., 19, 1875 (Havana); Jordan & Gilbert, Synopsis Fish. N. Am., 916, 1883.

Serranus creolus Cuv. & Val., Hist. Nat. Poiss., II. 265, 1829 (Martinique; San Domingo); Storer, Synopsis Fish. N. Am., 278, 1846 (copied); Günther, Cat. Fish., Brit. Mus., I, 100, 1859 (Cuba; West Indies); Günther, Fish. of Cen. Am., 409, 1869; Steindachner, Ichth. Beiträge, IV, 6, 1875 (Panama; Lower California; Galapagos).

Brachyrhinus creolus Gill, Proc. Ac. Nat. Sci. Phil., 249, 1862 (Cape San Lucas); Poey, Synopsis, 281, 1868 (Havana); Poey, Ann. Lyc. Nat. Hist. New York, 46, 1871.

Paranthias creolus Guichenot, Ann. Linnæan Soc., X, 1868.

Corvina oxyptera Dekay, New York Fauna, Fishes, 1842, 77, pl. xxx, f. 96.

Serranus colonus Valenciennes, Voyage Vénus, Zool., 300, pl. 2, fig. 1, 1846 (Galapagos Isl.).

Habitat.—Both coasts of tropical America.

Etymology.—*Furcifer*, one who carries a fork, from the form of the tail.

We have examined numerous specimens of this species from Cuba, Cape San Lucas, and the Galapagos Islands. We are unable to distinguish the Pacific coast form (*colonus*) from the Atlantic *furcifer*.

The skeleton of the species has been described in detail by Dr. Günther (I, 101).

Genus XV.—HYPOPLECTRUS.

Plectropoma species Cuvier & Valenciennes (not type).
Hypoplectrus Gill, Proc. Ac. Nat. Sci. Phila., 1862, 236 (*puella*).

TYPE.—*Plectropoma puella* Cuv. & Val.

Etymology.—Ὑπό, below; πλῆκτρον, spur.

The species of this genus agree very closely with the type of *Serranus*, *Prionodes*, etc., differing chiefly in the form of the body, which is more deep and compressed than in the other groups allied to *Serranus*. The skull differs from that of *Prionodes* chiefly in the development of the occipital crest, which, in accordance with the form of the body, is much elevated. All the species have several antrorse serræ on the lower limb of the preopercle, much as in *Plectropoma*, *Acanthistius*, and related genera, but smaller than in any of these. The species have been usually placed in *Plectropoma*, but, except the analogous armature of the preopercle, we know of no natural character which would tend to show any special affinity between *Plectropoma* and *Hypoplectrus*. In the form of the body there is, however, some resemblance between *Hypoplectrus* and *Gonioplectrus*.

The species of *Hypoplectrus* are all American, and a study of their relations offers many difficulties.

We have examined typical examples of a large number of the nominal species. While each of these shows certain striking peculiarities in color, most of them are absolutely identical in other respects. Moreover, even among those in which the coloration seems most sharply defined there are many variations. After an examination of the large series of typical forms sent by Professor Poey to the museum at Cambridge, we find ourselves driven to the conclusion that nearly all the forms of *Hypoplectrus* constitute but a single species, subject to almost endless variations in color. This view we here adopt, leaving for convenience' sake the various nominal species to stand as color varieties, produced by the action of some agencies as yet unknown.

ANALYSIS OF THE SPECIES OF HYPOPLECTRUS.

a. Scales large, 6-46-13; body short and deep, the depth $2\frac{1}{4}$ in length; head $2\frac{3}{5}$; profile from dorsal to occiput convex, concave above eye; preorbital narrow; maxillary reaching to below middle of eye; lower jaw slightly included; teeth strong, large teeth in front $\frac{4}{6}$; fourth dorsal spine highest, $2\frac{1}{2}$ in head; middle caudal rays little shorter than the outer ones; pectoral reaching anal; teeth of preopercle growing larger downwards; angle and lower limb with about nine strong radiating serræ; those nearest the angle largest, the others directed more and more forwards. Color (of the single specimen known), black with violet luster; faint, pale streaks along the rows of scales on lower parts of body; caudal fin abruptly translucent yellowish; pectorals colorless; tips of dorsal and anal spines and edge of soft rays abruptly whitish .... LAMPRURUS, 63.

aa. Scales moderate, 60 to 65 in the lateral line (8–60–20 to 11–65–30); dorsal rays X, 15, depth 2 to $2\frac{1}{4}$ in length, the head about 3; maxillary 2 in head; caudal fin slightly lunate: fourth dorsal spine highest, $2\frac{2}{3}$ in head; pectorals narrow, about reaching second anal spine; gill-rakers short and slender, x + 12. Coloration extremely various, the following being the nominal species or varieties thus far described .... PUELLA, 64.

b. Soft dorsal checkered or spotted with pale blue or crossed by blue lines (these occasionally obsolete).

c. Body all violet with five or six more or less distinct black cross-bands, the middle one broadest, covering the space from the fourth to the tenth dorsal spine and meeting its fellow under the belly; the band at the nape broad and saddle-like, bounded by two pale cross-streaks on nape, opercle, and cheek; snout pale, a pale shade across it; ventrals pale or dark; other fins, except spinous dorsal mostly pale. Scales 8–60–20.

x. Cheek with a blue band before eye and some blue spots before it, var., *puella* 64 *a*.

x. Cheek without blue band; no blue spots on snout; colors duller, var. *vitulinus*, 64 *b*.

cc. Body and head yellow anteriorly; body abruptly black posteriorly, the black extending forward to a wavy line reaching from first dorsal spine to vent; a broad dark blue band in front of eye, bordered by sky-blue; fins chiefly orange; ventral and anal bordered by sky-blue .... var. *pinnavarius*, 64 *c*.

ccc. Body dusky, the head and belly orange, the top of head olivaceous; a black spot on each side of caudal peduncle close behind dorsal; black band or spot in front of eye not bordered by blue; cheeks, opercles, and breast with vertical lines of metallic blue; dorsal yellowish; pectoral and caudal orange; a black spot in the axil; upper margin of pectoral blue; anal orange with blue border; ventral greenish, its base orange...... var. *maculiferus*, 64 *d*.

bb. Soft dorsal plain, without distinct blue lines or spots.

d. Preorbital region with one or more dark blue stripes, bordered by bright sky-blue (not fading in spirits).

e. Body yellow anteriorly, black posteriorly, the black extending forward to a line joining the nape and last anal ray; fins orange; a single blue-black stripe or spot in front of eye, ocellated with sky-blue; caudal peduncle very dark above. var. *guttavarius*, 64*e*.

ee. Body all orange yellow; fins orange; snout and lower jaw blue; two blue stripes, each bordered with sky-blue, before the eye.......... var. *gummigutta*, 64*f*.

dd. Preorbital region without blue stripes; scales usually (?) smaller (11–65–30).

f. Preorbital region with violet spots; a round black spot on side of caudal peduncle; dorsal light greenish; body light olive green above, reddish below; pectorals pale yellow, the first ray blue; ventrals, anal, and caudal light orange .... var. *aberrans*, 64*g*.

ff. Preorbital region without distinct violet spots.

g. General color blackish, brown or yellowish—not indigo-blue.

h. Color brownish, the middle of the front of body yellowish; fins all yellow except the ventrals, which are black .... var. *accensus*, 64 *h*.

hh. Color yellowish pink; caudal and pectorals pale; ventrals and anal bright light blue .... var. *affinis*, 64 *i*.

hhh. Color of body black, with violet shades.

i. Pectoral and caudal fins abruptly bright yellow .... var. *chlorurus*, 64*j*.

ii. Pectoral and caudal fins violet black, like the rest of the body .. var. *nigricans*, 64 *k*.

gg. General color deep indigo blue everywhere on body and fins; body with four to six broad cross-bars of darker blue.

j. Cheeks plain, without distinct stripes .... var. *indigo*, 64 *l*.

jj. Cheeks with a dark blue suborbital band, between two bands of clear blue. var. *bovinus*, 64 *m*.

aaa. Scales small, about 80 in the lateral line.

k. [Caudal moderately emarginated. Color saffron-yellow, orange on caudal, anal, and ventrals; a narrow blue band from eye across cheek and some small blue spots on side of muzzle; a narrow blue line along upper edge of preopercle; two faint vertical lines on opercle; back brownish anteriorly; jaws, pectoral, and dorsal fins saffron-yellow. Eight teeth on lower margin of preopercle. Depth 2⅓ in length. Scales, 12–81–32 [(*Cope*). CROCOTUS, 65.

kk. [Caudal forked. Color purple with lighter cloudings; fins colorless, the external caudal ray darker; caudal deeply lunate, the external rays much prolonged, especially those of the upper lobe, which are twice as long as the middle rays. Depth 2¼ in length. Scales 9–76–29.] (*Goode & Bean*)..GEMMA, 66.

63. HYPOPLECTRUS LAMPRURUS.

Serranus lamprurus Jordan & Gilbert, Bull. U. S. Fish Comm., 322, 1881 (Panama).

Hypoplectrus lamprurus Jordan, Proc. U. S. Nat. Mus., 376, 1885 (Panama).

Habitat.—Panama fauna.

Etymology.—*Λαμπρός*, bright; *οὐρά*, tail.

This species is known only from a single specimen, taken by Professor Gilbert at Panama.

It is well distinguished from the Atlantic species by the much smaller scales. The single type has almost exactly the coloration of the form called *Hypoplectrus chlorurus*. We can only guess as to the color variations which it may undergo.

64. HYPOPLECTRUS PUELLA.

(VACA.)

a. var. *puella.*

Plectropoma puella Cuv. & Val., Hist. Nat. Poiss., II, 405, plate 37, 1828 (Martinique); Storer, Synopsis Fish. N. Am., 282, 1846 (copied); Poey, Memor. Cuba, I, 62, 1851 (Havana); Günther, Cat. Fish. Brit. Mus., I, 165, 1859 (Jamaica).

Hypoplectrus puella Poey, Synopsis Pisc. Cubens., 290, 1868 (Havana); Poey, Enumeratio, 23, 1875, (Cuba).

b. var. *vitulinus.*

Plectropoma vitulinum Poey, Memor. Cuba, I, 68, 1851 (Havana).

Hypoplectrus vitulinus Poey, Enumeratio, 23, 1875 (Havana).

c. var. *pinnivarius.*

Hypoplectrus pinnivarius Poey, Synopsis Pisc. Cubens., 291, 1868 (Havana); Poey, Enumeratio, 24, 1875 (Havana).

d. var. *maculiferus.*

Hypoplectrus maculiferus Poey, Ann. Lyc. Nat. Hist. N. Y., X, 78, tab. 1, X, 2, 1871 (Havana); Poey, Enumeratio, 24, 1875 (Havana).

e. var. *guttavarius.*

Plectropoma guttavarium Poey, Memor. Cuba, I, 70, 1851 (Havana); Günther, Cat. Fish. Brit. Mus., I, 166, 1859 (copied); Cope, Trans. Am. Phil. Soc., Phil., XIV, 466, 1871 (St. Croix).

Hypoplectrus guttavarius Poey, Synopsis Pisc. Cubens., 291, 1868 (Havana); Poey, Enumeratio, 24, 1875 (Havana).

Plectropoma melanhorina Guichenot, "Poiss., in Ramon de la Sagra, Hist. Cuba, 18, pl. 1, fig. 1" (about 1855.)

f. var. *gummigutta.*

Plectropoma gummigutta Poey, Memor. Cuba, I, 70, 1851 (Havana); Günther, Cat. Fish. Brit. Mus., I, 166, 1859 (copied).

Hypoplectrus gummigutta Poey, Synopsis Pisc. Cubens., 290, 1868 (Havana); Poey, Enumeratio, 23, 1875 (Havana).

g. var. *aberrans.*

Hypoplectrus aberrans Poey, Synop. Pisc. Cubens., 291, 1868 (Havana); Poey, Enumeratio, 24, 1875 (Havana).

h. var. *accensus.*

Plectropoma accensum Poey, Memor. Cuba, I, 72, 1851 (Havana).

Hypoplectrus accensus Poey, Synopsis Pisc., Cubens., 290, 1868 (Havana); Poey, Enumeratio, 24, 1875 (Havana).

i. var. *affinis.*

Plectropoma affine Poey, Memor. Cuba, II, 427, 1860 (Havana).

Hypoplectrus affinis Poey, Enumeratio, 24, 1875 (Havana).

j. var. *chlorurus.*

Plectropoma chlorurum Cuv. & Val., Hist. Nat. Poiss., II, 406, 1828 (Martinique); Storer, Synopsis Fish. N. Am., 283, 1846 (copied); Günther, Cat. Fish. Brit. Mus., I, 167, 1859 (Martinique); Cope, Trans. Am. Phil. Soc., Phil., XIV, 466, 1871 (St. Croix); Vaillant & Bocourt, Miss. Sci. Mex., IV, 104, 1874, pl. v, f. 2.

Hypoplectrus chlorurus Poey, Synopsis Pisc. Cubens., 290, 1868 (Havana).

Serranus chlorurus Jordan & Gilbert, Synopsis Fish. N. Am., 537, 1883.

l. var. *nigricans.*

Plectropoma nigricans Poey, Memor. Cuba, I, 71, 1851 (Havana).

Hypoplectrus nigricans Poey, Synopsis Pisc. Cubens., 290, 1868 (Havana); Poey, Ann. Lyc. Nat. Hist., 35, 1871 (Cuba); Poey, Enumeratio, 24, 1875 (name only); Jordan & Gilbert, Synopsis Fish. N. Am., 918, 1883; Goode & Bean, Proc. U. S. Nat. Mus., 238, 1882 (Gulf Mexico); Jordan, Proc. U. S. Nat. Mus., 149, 1884 (Florida Keys); Jordan, Cat. Fish. N. Am., 83, 1885.

m. var. *indigo.*

(AÑIL.)

Plectropoma indigo Poey, Memor. Cuba, I, 69, 1851, tab. 3, fig. 1 (Havana); Günther, Cat. Fish. Brit. Mus., I, 166, 1859 (copied).

Hypoplectrus indigo Poey, Synopsis Pisc. Cub, 290, 1868 (Havana); Poey, Ann. Lyc. Nat. Hist., 35, 1871 (Cuba); Poey, Enumeratio, 23, 1875 (name only); Jordan, Proc. U. S. Nat. Mus., 1886, 39 (Havana).

n. var. *bovinus.*

Plectropoma bovinum Poey, Memor. Cuba, I, 69, 1851 (Havana); Günther, Cat. Fish. Brit. Mus., I, 166 (copied).

Hypoplectrus bovinus Poey, Synopsis Pisc. Cubens., 290, 1868 (Havana); Poey, Enumeratio, 23, 1875 (Havana).

Habitat.—West Indian fauna.

Etymology.—*Puella*, a little girl.

We have examined large numbers of specimens of this type in the museum at Cambridge, and elsewhere. The best series seen is that sent by Poey to the museum from Havana. So far as we can discover, the various nominal species of this type are absolutely identical in all respects except in color. Many of them—*e. g.*, *puella*, *indigo*, *chlorurus*—seem at first sight to be certainly different. Nevertheless each of these forms is subject to wide variations, and from the material which we have seen we can draw no other conclusion than this. All belong to a single species, which varies excessively in its coloration. Blue, yellow, and black are arranged in great variety of patterns, in different specimens, and the cause of such variation is still unknown.

The following localities are represented in the specimens examined by us:

Puella, Havana; St. Thomas; St. Croix.

Vitulinus, Havana.

Pinnivarius, Havana.

Maculiferus, Havana.

Guttavarius, Havana.

Chlorurus, Havana.

Nigricans, Florida Keys; Havana; St. Thomas.

Indigo, Havana.

The other nominal species we have not seen.

65. HYPOPLECTRUS CROCOTUS.

Plectropoma crocota Cope, Trans. Am. Phil. Soc., Phil., XIV, 466, 1871 (St. Martin's, W. Indies).

Habitat.—West Indian fauna.

Etymology.—*Crocotus*, saffron color; from *crocus*, saffron.

We have not seen this species. The single known specimen is no longer to be found in the museum of the Academy at Philadelphia, Pa.

66. HYPOPLECTRUS GEMMA.

Hypoplectrus gemma Goode & Bean, Proc. U. S. Nat. Mus., 428, 1882 (Garden Key, Fla.); Jordan, Proc. U. S. Nat. Mus., 149, 1884; Jordan, Cat. Fishes N. Am., 83, 1885.

Habitat.—West Indian fauna; Florida Keys.

Etymology.—*Gemma*, a jewel.

Two specimens of *Hypoplectrus* have been described, both of which are said to differ from the type of *Hypoplectrus puella* in the smaller scales. These two, described under the specific names of *crocotus* and *gemma*, differ widely in color, and apparently in the form of the caudal fin.

As we know that the differences in coloration are almost valueless for specific distinction in this group, the assumed difference in the form of the caudal alone prevents us from regarding *crocotus* and *gemma* as color varieties of the same form. We have not seen either of these nominal species, both of which are known from a single specimen.

Genus XVI.—PARALABRAX.

Paralabrax Girard, Proc. Acad. Nat. Sci. Phila., 1856, 131 (*nebulifer*).
Atractoperca Gill, Proc. Acad. Nat. Sci. Phila., 1861, 165 (*clathratus*).
Gonioperca Gill, Proc. Acad. Nat. Sci. Phila. 1863, 80 (*albomaculatus*).

TYPE.—*Labrax nebulifer* Girard.

Etymology.—*Παρά*, near; *Labrax*, old name of the genus *Morone;* from the Greek *λάβραξ*, sea-bass.

This genus is very close to *Centropristis*, with which it agrees very nearly in the form of the skull.* The scales are, however, much smaller than in *Centropristes*, the

* We have not examined the skulls of *Paralabrax albomaculatus* or of *P. humeralis*, though we have no doubt of their general agreement in this respect with the other species.

caudal fin is always lunate, and some of the anterior dorsal spines are in all the species considerably elevated. The number of soft rays in the dorsal is also greater in *Paralabrax* than in *Centropristis.* The five known species of *Paralabrax* are found on the Pacific coast of America, while those of *Centropristis* are confined to the Atlantic coast.

There is no warrant for the separation of either *Atractoperca* or *Gonioperca* as genera distinct from *Paralabrax.*

ANALYSIS OF SPECIES OF PARALABRAX.

a. Interorbital area more or less scaly, the scales extending forward at least to the middle of pupil; gill-rakers x +14 to 17; preorbital broad, as broad as eye in adult; some of the serræ on lower limb of preorbital hooked forward.

b. Scales on top of head extending forward as far as front of eyes; no round dark spots anywhere except on cheeks and preorbital region; body rather elongate; lower jaw projecting; eye moderate, shorter than snout, about $5\frac{1}{2}$ in head; mouth large, the maxillary $2\frac{3}{5}$ in head, rather narrower than the preorbital; first two dorsal spines short, the third very long, three times second and nearly 2 in head; soft dorsal rather low; caudal slightly lunate; second anal spine as long as third and much stouter; pectorals moderate, $1\frac{1}{2}$ in head; color greenish, with irregular pale and dark mottling and traces of dark oblique cross-bars; fins dusky, mottled; preorbital, suborbital, and cheeks profusely marked with round orange spots; a dark streak downward and backward from eye; head $2\frac{4}{5}$ in length; depth $3\frac{1}{3}$; D. X, 14; A. III, 7; scales 14–72–24 ....NEBULIFER, 67.

bb. Scales on top of head extending forward only to middle of eyes; head and sides of body everywhere covered with dark orange spots; gill-rakers short and thick, x + 12, the longest $2\frac{1}{2}$ in eye; body moderately elongate; lower jaw projecting, but less so than in *P. nebulifer;* eye small, 5 to 6 in head, shorter than snout; maxillary reaching middle of eye, $2\frac{2}{3}$ in head; scales quite rough. Second dorsal spine short, not half the third, which is $1\frac{4}{5}$ in head, the fourth scarcely shorter; second anal spine shorter than third; pectoral moderate, $1\frac{1}{2}$ in head; caudal slightly concave; color olive brown, thickly covered everywhere above with dark hexagonal or roundish spots, so close together as to leave the ground color appearing as reticulations around them; these spots are more or less confluent on the back, and are most distinct, and tinged with orange on sides of head, on branchiostegals, and on base of pectorals; about seven dusky cross-bars along the sides, in which the spots are deeper in color and more confluent; a bluish stripe from eye across cheeks; lower parts yellow; soft dorsal and caudal with bronze spots. Head 3 in length; depth 3; D. X, 14; A. III, 7. Scales 12–70(pores)25 ....MACULATOFASCIATUS, 68.

aa. Interorbital area chiefly naked,* the scales on top of head beginning more or less behind the pupil; gill-rakers, x + 17 to 22.

c. Preorbital rather broad, more than three-fourths width of eye; sides of back with large white spots; fourth dorsal spine usually higher than third, so that the posterior margin of the dorsal fin is deeply concave; snout $3\frac{1}{6}$ in head; eye $5\frac{1}{2}$; least width of preorbital 6; interorbital area flattish, the scales beginning opposite last part of pupil; maxillary 2; nostrils small, subequal; gill-rakers shortish, x + 19; first dorsal spine short; second one-third longer; third more than three times second; fourth still longer (in specimens examined by us, usually not longer in adults, according to Dr. Steindachner, $2\frac{3}{5}$ in head), the fin thus very deeply notched; anal spines short, graduated, the second $4\frac{2}{3}$ in head; caudal lunate; color, in alcohol, dark above, abruptly pale below; a large, dark, oblique dash below eye, covering most of cheek; a row of five, oblong, horizontal, white blotches just below lateral line; first and second largest, about as long as eye; a single one as large as third blotch above this row below the second to fourth rays of soft dorsal; caudal dusky, its central and posterior part pale; anal and ventral black; pectoral pale; spinous dorsal dusky at base; soft dorsal mottled with dark. Head $2\frac{3}{4}$ in length; depth $3\frac{1}{6}$; D. X, 14; A. III, 7; scales 70...ALBOMACULATUS, 69.

* This character may prove unreliable. According to Dr. Steindachner, the top of the head is chiefly scaly in *Paralabrax humeralis.*

cc. Preorbital narrow, not two-thirds width of eye.

d. Caudal forked; snout $3\frac{2}{3}$ in head; eye $5\frac{1}{2}$; preorbital narrow, three-fifths width of eye; maxillary $2\frac{1}{2}$ in head; top of head naked from back part of eye; gill-rakers long, x + 17; teeth small; preopercle strongly serrate, the lower teeth turned forward; first dorsal spine short; second half longer; third $2\frac{2}{3}$ times length of second, 2 in head; fourth a little shorter, the others gradually shorter, the ninth longer than the second; anal spines small, graduated; the second $4\frac{1}{2}$ in head; pectoral long, $1\frac{1}{2}$ in head; caudal forked, the upper lobe the longer; Color (faded in our specimens), according to Steindachner, dark olive, with six or seven dark cross-shades; head with numerous bluish spots edged with darker; body with round dark brown spots, smaller than pupil, most conspicuous on caudal peduncle; vertical fins dusky especially at tip, their basal parts showing pale reticulations around dark spots; ventrals blackish; pectorals pale, with a large lunate dusky blotch at base. Head $2\frac{4}{5}$ in length; depth $3\frac{2}{3}$. D. X, 14; A. III, 7; scales 17–67(pores)–32............ HUMERALIS, 70.

dd. Caudal slightly lunate, not forked; body elongate, more compressed than in related species; snout pointed; eye shorter than snout, $4\frac{1}{2}$ in head; preorbital narrow, not so broad as maxillary, less than half width of eye; maxillary $2\frac{2}{3}$ in head; gill-rakers rather long, x + 20; third, fourth, and fifth dorsal spines about equal, the third twice the second, 2 in head; second anal spine longer than third; caudal fin slightly lunate; color grayish green, with obscure broad dusky streaks and bars; sides often shaded and mottled with bluish and greenish, but usually without distinct spots; a broad, dark, longitudinal shade along axis of body; belly plain silvery gray. Head 3 in length; depth 3; D. X, 14; A. III, 7. Scales 14–73–23.. CLATHRATUS, 71.

67. PARALABRAX NEBULIFER.

("JOHNNY VERDE.")

Labrax nebulifer Girard, Proc. Acad. Nat. Sci. Phil., 142, 1854 (Monterey).

Paralabrax nebulifer Girard, Proc. Acad. Nat. Sci. Phil., 132, 1856, (Monterey); Girard, U. S. Pac. R. R. Survey, 33, pl. xii, fig. 1, 1858 (Monterey); Günther, Cat. Fish. Brit. Mus., 1, 62, 1859 (Monterey).

Serranus nebulifer Steindachner, Ichth. Beiträge, III, 1, 1875 (Monterey; San Diego); Jordan & Gilbert, Proc. U. S. Nat. Mus., 456, 1880, (Monterey; San Pedro; San Diego); Jordan & Jouy, Proc. U. S. Nat. Mus., 12, 1881 (San Diego); Jordan & Gilbert, Proc. U. S. Nat. Mus., 47, 1881 (San Pedro, San Diego); Jordan & Gilbert, Proc. U. S. Nat. Mus., 278, 1881 (Ascension Isl.); Jordan & Gilbert, Synopsis Fish. N. Am., 536, 1883 (Monterey); Jordan, Cat. Fish. N. Am., 83, 1885; Jordan, Nat. Hist. Aquat. An., 413, 1886 (San Pedro; Monterey).

Habitat.—Coast of Southern California from Monterey to Magdalena Bay.

Etymology.—*Nebulifer*, bearing a cloud, from the coloration.

This species is common on the coast of southern California. It lives in shallow water and is regarded as a food-fish of excellent quality. It reaches a length of about 18 inches.

68. PARALABRAX MACULATOFASCIATUS.

(SPOTTED CABRILLA.)

Serranus maculatofasciatus Steindachner, Ichth. Notizen, VII, 5, 1868 (Mazatlan); Vaillant & Bocourt, Miss. Sci. au Mex., IV, 72, 1874; Jordan & Jouy, Proc. U. S. Nat. Mus., 12, 1881 (San Diego); Jordan & Gilbert, Proc. U. S. Nat. Mus., 46, 1881 (San Pedro; San Diego); Jordan & Gilbert, Synopsis Fish. N. Am., 536, 1883 (San Diego); Jordan & Gilbert, Bull. U. S. Fish Com., 107, 1882 (Mazatlan); Jordan, Cat. Fish. N. Am., 83, 1885 (name only); Jordan, Proc. U. S. Nat. Mus., 376, 1885 (Mazatlan); Jordan, Nat. Hist. Aquat. Anim., 1886, 414.

Serranus acanthophorus Bocourt, Ann. Sci. Nat., X, 1870, 223 (west coast of Mexico).

Habitat.—Lower Californian fauna, San Pedro to Mazatlan.

Etymology.—*Maculatus*, spotted; *fasciatus*, banded.

This species is abundant about San Diego, and thence southward as far as Mazatlan. It is a good food fish, similar in quality to the preceding species, but reaching a smaller size.

69. PARALABRAX ALBOMACULATUS.

Serranus albomaculatus Jenyns, Zoöl. Beagle, Fishes, 3, pl. 2, 1840 (Galapagos Archipelago); Günther, Cat. Fish. Brit. Mus., I, 105, 1859 (copied); Steindachner, Ichth. Beiträge, IV, 4, 1875, pl. 1, f. 2 (Panama; Galapagos); Jordan, Proc. U. S. Nat. Mus., 376, 1885.

Paralabrax albomaculatus Jordan & Bollman, Proc. U. S. Nat. Mus., 1889, 181 (Charles and Albemarle Islands; Galapagos).

Gomoperca (*albomaculata*) Gill, Proc. Ac. Nat. Sci. Phila., 1863, 80.

Serranus humeralis Günther, Proc. Zool. Soc. London, 1877, 68.

Habitat.—Galapagos Islands, north to Panama.

Etymology.—*Albus*, white; *maculatus*, spotted.

The specimens examined by us are in the museum at Cambridge and came from Indefatigable Island, James Island, and Albemarle Island, of the Galapagos group. No. 10,222, 2 feet in length, from Indefatigable Island, is the special type of our description. The peculiar and handsome coloration of this species separates it at once from the others. According to Dr. Steindachner this species is quite common in the deep channels separating the Galapagos islands from each other. Other specimens lately examined were taken by the *Albatross*.

70. PARALABRAX HUMERALIS.

Serranus humeralis Cuv. & Val., II, 246, 1828 (Chili); Lesson, "Voyage Coquille, Zool., II, 236;" Gay, Hist. Chile, Zool., II, 149, 1847; Günther, I, 104 (copied); Kner, Neue Fische aus dem Museum Godeffroy, 1868, 4 (Peru); Steindachner, Ichth. Notizen, VII, 3, 1868 (Chili).

Serranus semifasciatus Gay, Hist. Chile, Zool., II, 151, with plate, 1847 (Juan Fernandez).

Percichthys godeffroyi Günther (Iquique) (*fide* Steindachner).

Habitat.—Coasts of Peru and Chili.

Etymology.—*Humeralis*, pertaining to the humerus or shoulder, from the dusky shoulder.

We know this species from specimens (10097) in the museum at Cambridge, collected at Callao, Peru, by Dr. Steindachner. These specimens are doubtless identical with the very young examples originally described by Cuvier and Valenciennes, although their coloration is not quite the same.

These specimens differ in several respects from the description of *Serranus humeralis* given by Dr. Kner, but all probably belong to one species.

The figure and scanty description of *Serranus semifasciatus* Gay seem to agree fairly with *Paralabrax humeralis*.* The general characters, so far as shown in the figure agree very well, especially as to the general form, the armature of the preopercle, and the forms of the fins. The description is taken from the drawing, and is valueless as regards details, the fin-rays, except those of the spinous dorsal (x) not being counted.

The account of the coloration is apparently drawn from life, which doubtless explains the difference between it and that above given in the text.

* Dr. Steindachner observes (Ichth. Beitr., VII, 24, 1878): "*Percichthys godeffroyi*, Günther, aus Iquique ist ein Meeresbewohner, gehört zur Gattung *Serranus* und fällt mit *Serranus humeralis* C. V. = *S. semifasciatus* Gay zusammen, einer Art die nach Dr. Günther's systematischer Anordnung der Fische zur Gattung *Centropristis* bezogen werden müsste."

The following is the original description:

Serranus semifasciatus.

S. corpore elongato, supra cinereo-cœrulescente transverse vittis rubris fasciato; capite lateribusque frequentibus parvulis maculis rubescentibus variegatis; abdomine albicante-cœrulescente; dorsali medio emarginata caudalique fuscis rubro-punctatis; pectoralibus rufus; ventralibus ac anali nigrescentibus; oculis mediocribus, rubris.

Describimos esta especie segun un deseño que hicimos de ella en Juan Fernandez; es muy parecida de los anteriores Serranos, particularmente de los dos primeros; la forma general de su cuerpo se prolonga bastante; el dorso está redondeado y su altura es la cuarta parte de la longitud total; cabeza algo grande, cónica, y tan larga como la elevacion del Pez; hocico levemente arqueado; boca grande, y las dos quijadas casi iguales; los dientes no se perciben en el dibujo; ojos medianos y en medio de la cabeza; opérculo fina é igualmente dentado al rededor; la dorsal tiene una profunda escotadura entre su parte blanda y la parte espinosa; esta se compone de diez rayos sólidos, los dos primeros mas cortos que el tercero y cuarto, que son los mayores; los otros seis van disminuyendo proporcionalmente: la parte blanda es mas larga que la espinosa, igual en toda su estension y casi triangular; las pectorales son ovales y pequeñas á proporcion de la especie, aunque bastante anchas; la anal es tambien pequeña, con tres espinas, de las cuales la primera es la mas corta, y la segunda y tercera tan largas como los rayos blandos que las siguen; la caudal está un poco escotada; no podemos contar los rayos en el dibujo.

Color: de un azul ceniciento sobre el dorso, con seis ó siete medias bandas verticales de color de ladrillo, y los lados y la cabeza sembrados de infinitas manchitas rojizas; el veintre es azulado, levemente bañado de blanquizo; la dorsal y la caudal tienen manchas rojas sobre un fondo moreno; la pectoral parece bermeja; las aletas abdominales y la anal son negruzcas.

Longitud total, 11 pulg.

"Esta especie no es muy comun en los mares de Chile." (Gay, Historia de Chile, tomo II, pp. 151-152).

71. PARALABRAX CLATHRATUS.

(CABRILLA.)

Labrax clathratus Girard, Proc. Ac. Nat. Sci. Phil., 143, 1854 (San Diego).

Paralabrax clathratus Girard, Proc. Ac. Nat. Sci. Phil., 131, 1856; Girard, U. S. Pac. R. R. Survey, 34, 1858, pl. xii, fig. 5 (San Diego); Günther, Cat. Fish. Brit. Mus., I, 63, 1859 (San Diego).

Atractoperca clathrata Gill, Proc. Ac. Nat. Sci. Phil., 164, 1861.

Serranus clathratus Steindachner, Ichth. Beiträge, III, 1, 1875 (Monterey; San Diego); Jordan & Gilbert, Proc. U. S. Nat. Mus., 456, 1880 (Monterey; Santa Barbara; San Pedro; San Diego); Jordan & Jouy, Proc. U. S. Nat. Mus., 12, 1881 (San Pedro; Santa Barbara; San Diego; Monterey); Jordan & Gilbert, Proc. U. S. Nat. Mus., 47, 1881; Jordan & Gilbert, Synopsis Fish. N. Am., 535, 1883; Rosa Smith, Proc. U. S. Nat. Mus., 234, 1883 (Todos Santos Bay, Cal.); Jordan, Cat. Fish. N. Am., 83, 1885 (name only); Jordan, Nat. Hist. Aquat. An., 413, 1886.

Habitat.—Coast of southern California, from San Francisco to the Cerros Islands.

Etymology.—*Clathratus*, latticed, from the lattice-like markings.

This is the most abundant species of *Paralabrax* on the California coast. It is an excellent food fish, and it reaches a weight of nearly 5 pounds, and length of 18 inches.

Genus XVII.—CENTROPRISTIS.

Centropristes Cuvier, Règne Animal, Ed. 2, 1829 (*nigricans*).

Centropristis Cuvier & Valenciennes, Hist. Nat. Poiss., III, 56, 1829 (*nigricans*).

Triloburus Gill, Cat. Fish. East. Coast U. S., 30, 1861 (name only, *trifurca*).

TYPE.—*Coryphæna nigrescens* Bloch & Schneider = *Perca striata* L.

Etymology.—*Κέντρον*, spine; *πριστής*, saw.

This genus is very close to *Serranus*, from which it differs chiefly in the form of the upper part of the skull, which approaches somewhat more nearly to the condition seen in the *Epinephelinæ*. The supraoccipital crest is much longer than in *Serranus*, and it encroaches more on the frontal region. The three species of *Centropristis* are closely related, and are not very different from the species of *Paralabrax*.

ANALYSIS OF SPECIES OF CENTROPRISTIS.

a. Dorsal spines with dermal flaps, which scarcely project beyond the tip of the spine; longest dorsal spine less than half length of head (*Centropristis*).

b. Caudal fin with its angles little produced, the longest ray not exserted for a distance equal to the length of the fin; gill-rakers about 20; scales on cheek in more than seven rows; body robust, the back somewhat elevated anteriorly; eye small, nearly 5 in head; lower jaw projecting; maxillary 2½ in head; teeth in broad bands, the canines small; posterior border of preopercle finely serrate, the angle and lower border with larger teeth; dorsal spines rather strong, the middle ones rather higher than the posterior, which are lower than the soft rays; highest dorsal spine 2 in head; none of the spines filamentous; pectorals very long, 1½ in head; anal spines graduated; color dusky brown or black with paler longitudinal streaks; dorsal with oblique light and dark stripes; young with a black longitudinal band, many dark cross-shades, and a large black spot on last dorsal spines. Sexes notably different, the fin rays longer in the male. Head, 2⅗ in length; depth 3. D. X, 11; A. III, 7. Scales 5–52–13. STRIATUS, 72.

bb. Caudal fin with its upper and lower lobes filamentous, much produced, the middle rays still longer, length of longest ray in the adult 2 in body; gill-rakers about x + 12; scales on cheek in seven rows; color grayish, each side with three longitudinal rows of quadrate black blotches, the upper series obscure, the second from eye below the lateral line to caudal quite distinct, the third series composed of shorter spots on a level with the lower half of the pectorals; some jet-black spots about opercle and above axil; dorsal with a series of jet-black spots along its base; caudal with the middle rays black at their tips, the outer pale; jet-black spots on middle rays. D. X, 11; A. III, 7, lat. l., 52. OCYURUS, 73.

aa. Dorsal spines, or some of them, tipped with fleshy filaments, which project considerably beyond the tip of the spine; longest dorsal spine about half length of head; caudal lobes more or less produced (*Triloburus* Gill).

c. Body rather elongate, little compressed, the anterior profile nearly straight; eye large, as long as snout, about 4 in head; mouth large, the lower jaw projecting, the maxillary 2 in head, reaching beyond middle of eye; lower edge of subopercle, interopercle, and preopercle finely serrate, the serræ on he angle scarcely enlarged; gill-rakers rather long, about x + 12; canines small; top of head naked; ten rows of scales on cheek; dorsal spines slender, graduated rapidly to the third or fourth, thence decreasing to the last; fourth dorsal spine 2 in head; anal spines graduated, the second 4 in head; pectorals 1⅓ in head; color olive-gray; sides with about seven broad, diffuse, brown bars extending from back obliquely forward to level of pectorals; a large black spot on membrane of last dorsal spines; dorsal filaments scarlet; caudal with irregular cross-rows of round brownish spots; other fins similarly marked. Sexes little different. Head 2⅔ in length; depth 3⅓. D. X, 11; A. III, 7. Scales 6–52–14. PHILADELPHICUS, 74.

72. CENTROPRISTIS STRIATUS.

(THE BLACK SEA-BASS, BLACK-FISH, TALLY-WAG, HANNAHILL, BLACK-WILL, BLACK HARRY.)

Labrus striatus Linnæus, Syst. Nat., Ed. x, 1758, 285 ("America,") description very brief, but not to be referred to any other fish).

Perca atraria Linnæus, Syst. Nat., XII, 485, 1766 (Carolina); Gmelin, Syst. Nat., 1314, 1788 (copied); Bloch & Schneider, Syst. Ichthy., 88, 1801 (copied); Gronow, Syst., Ed. Gray, 111, 1854 (copied).

Centropristis atrarius Günther, Cat. Fish. Brit. Mus., I, 86, 1859 (New York); Holbrook, Ichth. S. Carolina, 42, 1860 (Carolina); Gill, Cat. Fish. East Coast N. Am., 28, 1873; Goode & Bean, Fishes Essex Co., 19, 1879 (Nahant; Salem; Beverly Bar).

Serranus atrarius Jordan & Gilbert, Synopsis Fish. N. Am., 533, 1883; Goode & Bean, Proc. U. S. Nat. Mus., 238, 1882 (Gulf of Mexico); Jordan & Gilbert, Proc. U. S. Nat. Mus., 600, 1882 (Charleston); Bean, Cat. Internat. Fish. Ex. Lond., 61, 1883 (Matanzas River Inlet, Fla.); Jordan & Swain, Proc. U. S. Nat. Mus., 231, 1884 (Cedar Keys, Fla.); Jordan, Cat. Fish. N. Am., 82, 1885 (name only); Goode, Nat. Hist. Aquat. An., 407, 1886; Jordan, Proc. U. S. Nat. Mus., 1886, 27 (Beaufort, N. C.).

Blackfish Schöpf, Schriften der Naturforsch. Freunde, Berlin, VIII, 164, 1788 (New York).

Perca furva Walbaum, Artedi Piscium, 336, 1792 (after Schöpf).

Serranus furvus Jordan, Proc. U. S. Nat. Mus., 546, 1884; Jordan, Cat. Fish. N. Am., 82, 1885.

Coryphœna nigrescens Bloch & Schneider, Syst. Ichthy., 297, 1801 (New York).

Lutjanus trilobus Lacépède, Hist. Nat. Poiss., IV. 246, 1802 (locality unknown).

Serranus nigrescens Jordan & Gilbert, Synopsis Fish. N. Am., 917, 1883.

Perca varia Mitchill, Report Fishes N. Y., 415, pl. 3, fig. 6, 1815 (New York).

Centropristis varius Putnam, Proc. Essex Inst., 144, 1855 (Salem Harbor); Storer, Hist. Fish. Mass., 58, pl. ii, fig. 4, 1867.

Centropristes nigricans Cuv. & Val., Hist. Nat. Poiss., III, 37, pl. 44, 1829 (New York); Cuvier, "Règne Animal, Ed. Val., pl. 9 a, fig. 18;" Storer, Fish. Mass., 9, 1839 (Holmes' Hole); Dekay, New York Fauna, Fishes, 24, 1842, pl. ii, fig. 6; Linsley, "Cat. Fishes Conn., 1844;" Storer, Synopsis, 287, 1846.

Centropristes rufus Cuv. & Val., Hist. Nat. Poiss., III, 47, 1829 (Martinique ?); Storer, Synopsis, 288, 1846 (copied).

Serranus rufus Jordan, Proc. U. S. Nat. Mus., 1886, 533 (note on type of *C. rufus*).

Habitat.—Atlantic coast of United States, Cape Ann to Florida.

Etymology.—*Striatus*, striped.

This is one of the common food fishes of our Atlantic coast, from Cape Cod at least as far south as the northern parts of Florida. It reaches a weight of about 3 pounds, and the quality of its flesh is excellent. Holbrook has maintained that the northern form of this fish (*Perca striata = furvus = nigricans*) is distinct from the southern *atrarius*. The northern form (*striatus*) is said to have the air-bladder simple and the pectoral fin as long as the ventrals. In the southern fish (*atrarius*) the air bladder is sacculated and the pectoral longer than the ventral. We have been unable to verify these differences and doubt their permanence. There are, however, marked sexual differences in the adult fishes, the male having the fin rays more prolonged and the form of body different.

The specimens before us are from Wood's Holl, Beaufort, Charleston, and St. Augustine.

The type of *Centropristes rufus* has been examined by us in the museum at Paris. It is probably an ordinary *striatus*, with the caudal fin somewhat mutilated, and it very likely came from New York rather than from Martinique.

Labrus striatus Linnæus, with D. X, 11; A. III, 8, with the dorsal spines "ramentaceous," and the body marked with lines alternately brown and white, must have been the young of some *Centropristis*, in all probability of the present species.

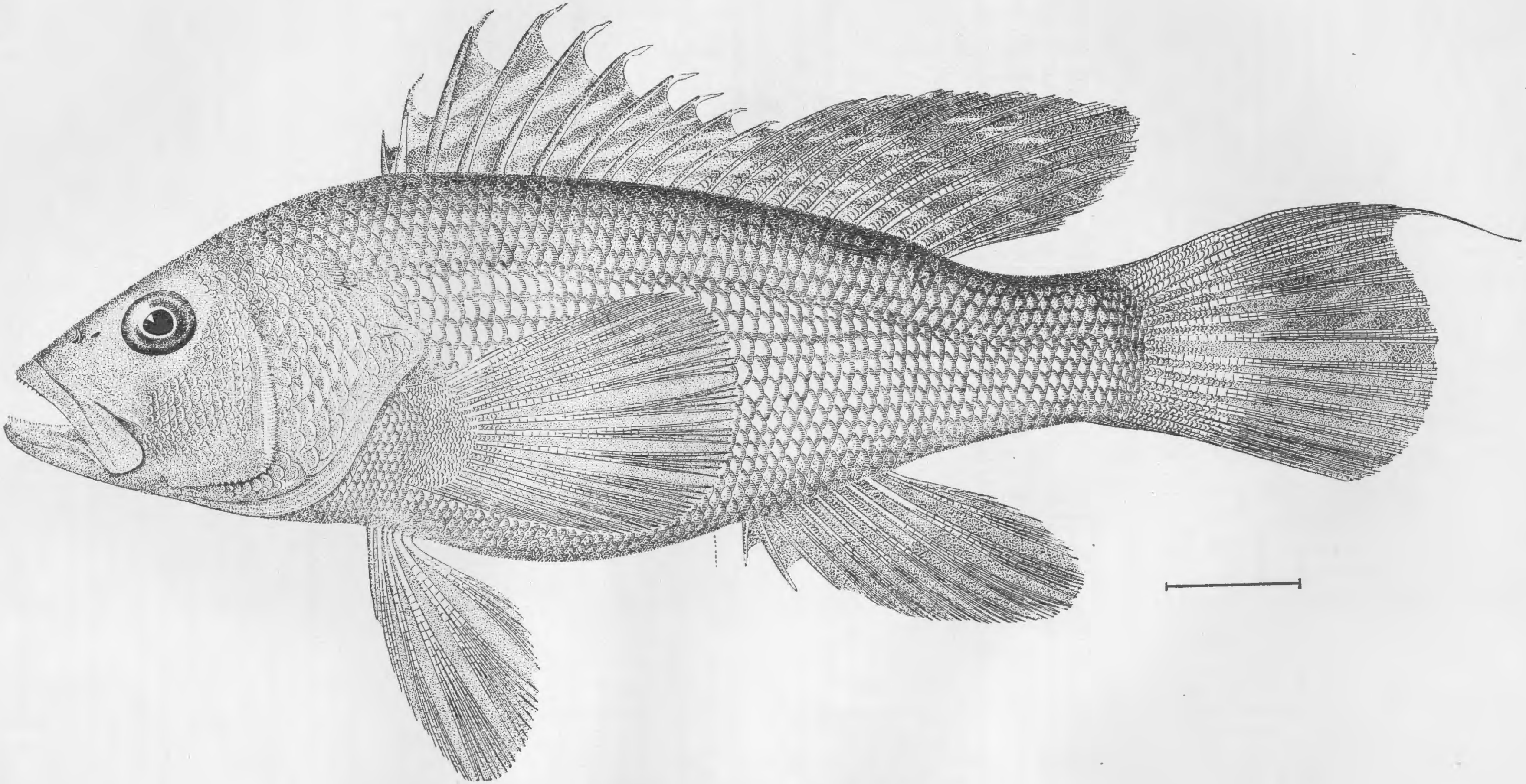
The name *striatus*, being given in the tenth edition of the Systema Naturæ, has priority over *atrarius*.

73. CENTROPRISTIS OCYURUS.

Serranus trifurcus Goode & Bean, Proc. U. S. Nat. Mus., 238, 1882 (Gulf of Mexico); Jordan & Gilbert, Proc. U. S. Nat. Mus., 273, 1882 (Pensacola); Jordan & Gilbert, Proc. U. S. Nat. Mus., 307, 1882 (Gulf of Mexico); Jordan & Gilbert, Synopsis, 917 (Gulf of Mexico) (not *Perca trifurca* L.)

Serranus philadelphicus Jordan & Gilbert, Proc. U. S. Nat. Mus., 143, 1883 (Pensacola) (not type).

Serranus ocyurus Jordan & Evermann, Proc. U. S. Nat. Mus., 468, 1886 (Pensacola).



CENTROPRISTIS STRIATUS (Linnæus). The Sea Bass.

(No. 14838, U. S. National Museum ; from Noank, Connecticut.)

Habitat.—Gulf of Mexico, north to Pensacola.

Etymology.—'Ωκὺς, swift; οὐρά, tail.

The specimens examined by us are from Pensacola, Fla. This species is very closely related to *C. striatus*, from which it differs in coloration, and in the great elongation of the dorsal and caudal rays. These characters are, however, little marked in the young. The species is scarce in the Gulf, all the known specimens having been procured in deep water by Mr. Silas Stearns. It may prove to be merely a deep-water variety of *C. striatus*.

74. CENTROPRISTIS PHILADELPHICUS.

Perca philadelphica Linnæus, Syst. Nat., Ed. X, 291, 1758 (America); Linnæus, Syst. Nat., Ed. xii, 484, 1766; Gmelin, Syst. Nat., 1314, 1788 (copied).

Serranus philadelphicus Jordan & Gilbert, Proc. U. S. Nat. Mus., 600, 1882 (Charleston Harbor); Jordan, Proc. U. S. Nat. Mus., 39, 1884; Jordan, Cat. Fish. N. Am., 82, 1885.

Perca trifurca Linnæus, Syst. Nat., Ed. XII, 489, 1766 (Carolina); Gmelin, Syst. Nat., 1322, 1788 (Carolina.)

Centropristis trifurca Dekay, Report New York Fauna, Fish., 25, 1842 (South Carolina); Storer, Synopsis, 287, 1846 (South Carolina).

Centropristis trifurcus Holbrook, Ichth. S. Carolina, 49, 1860, pl. 7, fig. 1 (Charleston).

Anthias trifurcus Günther, Cat. Fish. Brit. Mus., I, 91, 1859 (copied).

Serranus trifurcus Jordan & Gilbert, Synopsis Fish. N. Am., 534, 1883; Goode, Nat. Hist. Aquat. An., 410, 1886 (Charleston).

Lutjanus tridens, Lacépède, Hist. Nat. Poiss., IV, 246, 1802 (Carolina).

Centropristis tridens Cuv. & Val., Hist. Nat. Poiss., III, 43, 1829 (Carolina).

Habitat.—South Atlantic coast of United States (not known from the Gulf of Mexico, all the references from that region belonging to *Centropristes ocyurus*).

Etymology.—*Philadelphicus*, from the city of Philadelphia, where the species is not found.

This species, like its relative, *C. ocyurus*, inhabits rather deep water, and is consequently less frequently seen than the common Sea-bass. Our specimens are from Charleston, S. C.

Genus XVIII.—CRATINUS.

Cratinus Steindachner, Ichthyol. Beiträge, VII, 19, 1878 (*agassizii*).

TYPE.—*Cratinus agassizii* Steindachner.

Etymology.—Name unexplained; perhaps a diminutive of *crates*, a bundle of rods.

This genus is related to *Paralabrax* and *Prionodes*, differing in the form of the head and in the prolongation of most of its dorsal spines, which are attenuated into filaments, without dermal appendage. One species is known, a fish with a very peculiar physiognomy.

ANALYSIS OF SPECIES OF CRATINUS.

a. Body subfusiform, moderately compressed, the head long and low, the anterior profile gently curved; snout very long, $2\frac{2}{3}$ in head; eye moderate, 7 to 8 in head; head mostly scaled above and on sides; the scales on preorbital and cheeks very small and close set; jaws naked; interopercle scaly; preorbital very deep, its least depth 5 to 6 in head; mouth very large, the maxillary $2\frac{1}{3}$ in head, reaching middle of pupil; lower jaw much projecting; teeth moderate; nostrils oval, subequal, near together; opercular spines obscure; scales on opercles large, their bases covered with small scales; preopercle finely serrate on the rounded posterior limb only; gill-rakers moderate, rather slender; third to sixth dorsal spines greatly produced, extending far beyond the membrane; the fourth highest, more than one-third length of body; first and second spines very short; soft dorsal naked; caudal fin slightly lunate, about half as long as head; ventral shorter than pectoral, which is $2\frac{1}{5}$ in head; color greenish gray above, with darker clouds or obscure cross-bands, which disappear in spirits. Head $2\frac{1}{4}$ in length; depth $3\frac{2}{3}$ to 4. D. X, 12; A. III, 7. Scales, 9–63–22.......................... AGASSIZII, 75.

75. CRATINUS AGASSIZII.

Cratinus agassizii Steindachner, Ichth., Beitr., VII, 19 (Galapagos Islands).

Habitat.—Galapagos Archipelago.

Etymology.—Named for Louis Agassiz.

We have examined two specimens of this singular species, collected by the *Albatross* at Charles Island, one of the Galapagos. The largest is about 18 inches long. The posterior half of the body resembles that of the species of *Paralabrax;* the long, low head suggests *Philypnus.*

Genus XIX.—DULES.

Dules Cuvier, Règne Animal, Ed. II, 1829 (*auriga*).

TYPE.—*Dules auriga* Cuv. & Val.

*Etymology.** *Δοῦλος*, a slave, the fish being under the lash of the long dorsal spine.

This genus contains but a single known species. It is very close to *Prionodes*, from which it differs in the presence of but six branchiostegals, and in the whip-like prolongation of the dorsal spine. It also bears considerable resemblance to *Centropristis.* Most of the species referred by Cuvier and Valenciennes to *Dules* belong to the genus *Kuhlia* Gill (= *Moronopsis* Gill = *Paradules* Bleeker).

ANALYSIS OF SPECIES OF DULES.

a. General form of *Centropristis;* branchiostegals 6, the first being obsolete; body rather deep and compressed, somewhat as in *Hypoplectrus*, but less deep; anterior profile steep and nearly straight; mouth rather small, the lower jaw protruding; preorbital rather narrow, as broad as pupil; top of head naked; the frontal area large and well defined, broader than long; occipital crest low and short, shorter than the frontal area, the cranium much as in *Paracentropristis hepatus;* teeth small, with no marked canines; gill-rakers rather short and slender, x + 9; maxillary $2\frac{2}{3}$ in head; eye $3\frac{1}{2}$; snout 4. Scales large, those above in series parallel with the lateral line; scales on breast small; third dorsal spine extremely long, reaching beyond middle of soft dorsal; other spines all short and even; soft dorsal moderate, a little scaly at base; dorsal not notched; caudal truncate; second anal spine $2\frac{2}{5}$ in head, as long as third, and a little stouter; pectoral $1\frac{9}{10}$ in head. Coloration in spirits, brownish; a dark area from front of anal up to soft dorsal; before this a whitish area, upper parts with dark streaks along the rows of scales, these faint and not continuous; a dark band upward from middle of base of ventrals; fins clouded. Head, $2\frac{2}{3}$ in length; depth, $2\frac{1}{3}$. D. X, 13; A. III, 7. Scales, 49.......................... AURIGA, 76.

* Par ce nom de doules (*esclave*) nous avons voulu indiquer la ressemblance de ces poissons avec ceux que depuis longtemps nous avons appelés *thérapons*, nom qui lui-même, assez arbitraire, n'est que la traduction de l'épithète donnée à l'espèce de thérapon décrite le plus anciennement (*l'Holocentrus servus* de Bloch).—CUV. & VAL., III, 111.

76. DULES AURIGA.

Dules auriga Cuv. & Val., Hist. Nat. Poiss., III, 112, 1829, pl. 51 (Brazil); Dekay, New York Fauna, Fishes, 1842, 34, pl. 10, f. 34 (New York—probably an error); Jenyns, Zool. Beagle, Fishes, 1840, 16 (Maldonado Bay, Rio Plata); Castelnau, Anim. Nouv. ou rares Amér. Sud, 1855, 6 (Rio Janeiro); Günther, I, 266 (Bahia); Jordan & Gilbert, Synopsis N. A. Fishes, 1883, 542 (description from the original type); Jordan, Proc. Ac. Nat. Sci. Phila., 1884, 98.

Habitat.—Coast of Brazil.

Etymology.—*Auriga*, a coachman, from the whiplike dorsal spine.

Our account of this species is taken from several specimens (4531, M. C. Z.), the longest about 5½ inches long, collected by Professor Agassiz at Rio de Janeiro. The species seems to be not rare on the Bazilian coast, but there is no evidence of its occurrence in the West Indies or northward.

Genus XX.—PARACENTROPRISTIS.

Paracentropristis Klunzinger, Fische des Rothen Meeres, 1884, 16 (*hepatus*).

TYPE.—*Labrus hepatus* Linnæus.

Etymology.—*Παρά*, near; *Centropristis*, an allied genus.

This genus contains a single species, found in the waters of southern Europe. It is like *Prionodes* in many respects, but it has the top of the head closely scaled, a character very unusual among the *Serraninæ*.

Closely allied to *Paracentropristis* is the Japanese species *Centropristis hirundinaceus* C. & V., but as this species has the caudal deeply forked, it will probably prove to be the type of a distinct section or genus.

ANALYSIS OF SPECIES OF PARACENTROPRISTIS.

a. Top of head closely scaled, as far forward as front of eyes; caudal fin very slightly lunate; scales large, about 50 in the lateral line; body rather deep, little compressed, dorsal outline from snout to end of dorsal forming an even curve; eyes large, longer than snout, 3¼ in head; mouth large, the maxillary reaching middle of eye; nine rows of scales on cheek; gill-rakers moderate, about x + 13; lower jaw slightly projecting; fourth dorsal spine highest, 2½ in head; second anal spine higher than third, 3 in head; pectorals long, reaching front of anal. Color pinkish with about five dark cross-bars, the fourth Y-shaped; ventrals and base of anal blackish; a jet-black spot on soft dorsal in front; fins otherwise pale, with faint dark markings. Head, 2⅔ in length; depth, 3. D. X, 12; A. III, 7. Scales, 5–48–15..............HEPATUS, 77.

77. PARACENTROPRISTIS HEPATUS.

(SACCHETTO.)

Labrus maxilla inferiore longiore, etc., Artedi, Genera, 35, 1738.

Labrus hepatus Linnæus, Syst. Nat. X, 282, 1758 (after Artedi); Linnæus, Syst. Nat., Ed. XII, 474, 1766 (and of the various copyists).

Holocentrus hepatus Risso, Ichthyol., Nice, 292, 1810.

Serranus hepatus Cuv. & Val., Hist. Nat. Poiss., II, 231, 1828 (Naples); Guichenot, Explor. Sc. Algér., Poiss., 34, 1850 (and of most recent writers).

Centropristis hepatus Günther, Cat. Fish. Brit. Mus., I, 84, 1859.

Labrus adriaticus Gmelin, Syst. Nat., 1297, 1788 (Adriatic Sea) (after Brünnich, p. 98).

Labrus fuscovittatus Bonnaterre, Encycl. Méth., 110, 1788 (after Brünnich).

Holocentrus striatus Bloch, Ichthyologia, t. 235, fig. 1, 1790.

Labrus fasciatus Walbaum, Artedi, Piscium, 1792, 265 (after Brünnich, p. 98).
Labrus spalatensis Bloch & Schneider, Syst. Icth., 1801, 256 (after Brünnich).
Holocentrus triacanthus Lacépède, Hist. Nat. Poiss., IV, 376, 1803.
Holocentrus signonotus De la Roche, "Ann. Mus., XIII, 352, pl. 22, fig. 8, 1809."

Habitat.—Mediterranean Sea.

Etymology.—῞Ηπατος (from ἧπαρ, liver), a name used by Aristotle to designate some sort of fish, probably the haddock.

This little fish is abundant in the Mediterranean and adjacent waters. Our specimens are from Palermo and Venice.

The relationships of this species seem to be with the American species of "*Prionodes*." Dr. Günther refers all these species to *Centropristis*. They agree with the latter genus in the short soft dorsal and in the moderate size of the canines. The skull is, however, notably different from that of *C. striatus*, and similar to that of *Serranus scriba*.

Genus XXII.—DIPLECTRUM.

Diplectrum Holbrook, Ichthyology of South Carolina, Ed. 1, 32, 1856 (*fascicularis*=*formosus*).
Haliperca Gill, Proc. Ac. Nat. Sci. Phila., 1862, 236 (*bivittatus*=*radialis*) and other species. Restricted to *bivittatus* by Jordan & Gilbert, Synopsis, 535).

TYPE.—*Serranus fascicularis* Cuv. & Val. = *Perca formosa* Linnæus.

Etymology.—Δίς, two; πλῆκτρον, spur.

This genus is very close to *Serranus*, from which it differs chiefly in the armature of the preopercle. This character is little marked in young examples, which agree essentially with *Prionodes* in generic characters.

Five species are now known, two of them with many synonyms.

ANALYSIS OF SPECIES OF DIPLECTRUM.

a. Preopercle with two clusters of divergent spines, the one at the angle, the other higher (the two fascicles well separated in the adult, but smaller and coalescent in the young) (*Diplectrum*).

b. Head and body marked with many interrupted blue lines; body elongate, the profile strongly arched above eyes; mouth large, lower jaw slightly projecting; maxillary narrow, reaching middle of eye, 2¼ in head; canine teeth small; eye placed high, shorter than snout, about 5 in head; preorbital broad, more than twice the width of maxillary; upper part of margin of preopercle finely serrate; lower half with strong, straight spines diverging from two centers; gill-rakers short and small, x+9; top of head and preorbital region naked; smooth area on top of cranium very convex; eleven rows of scales on cheeks; fins, except caudal, scaleless; dorsal spines low and slender, the first three graduated, the rest subequal; caudal deeply lunate, the upper lobe the longer, sometimes ending in a long filament; anal spines very weak, the third longest, 1½ in eye. Pectoral, 1⅘ in head. Color brownish, silvery below; sides with seven or eight longitudinal deep-blue lines and about as many dark cross-bars, the last bar forming a large black blotch at upper base of caudal; young with two broad, dusky longitudinal stripes, which become interrupted with age; three or four distinct blue stripes on sides of top of head; two across preorbital, the lower forked; fins with narrow, wavy bars of blue and pale yellow. Head, 3 in length; depth, 3⅞. D. X, 12; A. III, 7. Scales, 9–68–18 .... FORMOSUM, 78.

aa. Preopercle with a single center of divergence of the spinules about its angle (in the adult as well as in the young) (*Haliperca* Gill).

b. Spines on produced portion of preopercle numerous, 8 to 20 in number; outline of the spinous dorsal fin somewhat convex, so that the fin is more deeply notched than in *D. formosum*; jaws equal; vertex naked; opercle black within.

c. Produced part of preopercle very broad, its (vertical) breadth about one-third length of head to end of opercular spine; gill-rakers, x + 12; eye and head about as in *D. radiale;* longest dorsal spine 3 in head; scales smaller than in *D. macropoma;* six or seven rather irregular rows on cheek. Color dull brownish, with four or five vague, dusky cross-bars, and a large dark spot at base of caudal; snout and preorbital with vague, pale blotches; base of soft dorsal, blackish; fins without blue spots; dorsal plain; caudal with an oblique white tip to each lobe; ventrals black. Head, 2⅘; depth, 3⅓. D. X, 12; A. III 8. Scales, 7–54–18. Eye, 4 in head. Snout, 3⅘ .... EURYPLECTRUM, 79.

cc. Produced portion of preopercle not very broad; its (vertical) breadth not more than one-fourth length of head.

d. Scales on cheek large and irregular, in five or six rows; width of preopercular process about one-fourth head; its posterior edge truncated; general form of body and head essentially as in *D. radiale*; gill-rakers x + 10; longest dorsal spine 2⅘ in head. Coloration (like other characters) intermediate between *D. euryplectrum* and *D. radiale;* brownish, with numerous traces of vague, dark cross-bars; a very distinct black caudal spot; snout with four or five pale blotches; a pale streak from below eye across preopercular angle; no black at base of soft dorsal; the fin with very faint traces of blue spots; caudal plain, darker toward tip; ventrals pale. Head, 3⅓; depth, 3⅓. D. X, 12; A. III, 7. Scales, 5–48–14. Snout, 4 in head. Eye, 4 .... MACROPOMA, 80.

dd. Scales on cheeks small and regularly placed in about ten rows; width of preopercular process 4½ to 5 in head, its posterior edge rounded; gill-rakers x + 10, short and slender, well separated; region above the large eye prominent; snout short, bluntish; cheeks with ten rows of scales; these regularly placed; serræ on preopercle much produced in the adult; short in the young; upper lobe of caudal little produced; longest dorsal spine 2⅘ in head. Body light brown above, dull yellowish below; the scales on sides each with a silvery center; irregular, vague, dark cross-bars, broader than the interspaces; a black bar at base of caudal; usually no blue lines or white areas on head; soft dorsal with bright blue spots, each surrounded by a dark blue ring; caudal with bars of similar spots; young with two black longitudinal stripes, the lower forming a spot at base of caudal. D. X, 12; A. III, 7. Scales, 8–51–20 .... RADIALE, 81.

bb. [Spines at angle of preopercle about four in number; scales small; color uniform brown, without bands or spots; brown on the back, silvery below; spinous dorsal marbled with violet; soft dorsal obliquely striped with violet and yellow; caudal immaculate; ventrals blackish. D. X, 12; A. III, 6.] (Cuv. & Val.) .... CONCEPTIONE, 82.

78. DIPLECTRUM FORMOSUM.

(SQUIRREL-FISH; SERRANO.)

Perca formosa Linnæus, Syst. Nat., Ed. XII, 488, 1766 (Carolina); Gmelin, Syst. Nat., 1322, 1788 (copied); and of the copyists; partly confused with *Hæmulon plumieri*, to which species some of the early references belong.

Serranus formosus Jordan, Proc. U. S. Nat. Mus., 35, 1884 (Pensacola); Jordan, Proc. U. S. Nat. Mus., 39, 1884 (Pensacola); Jordan, Proc. U. S. Nat. Mus., 125, 1884 (Key West); Jordan, Cat. Fish. N. Am., 82, 1885; Jordan, Proc. U. S. Nat. Mus., 1886, 39 (Havana).

Serranus radians Quoy & Gaimard, Voy. de l'Uranie, Poiss., 313, tab. 58, fig. 2, 1824.

Centropristis radians Günther, Cat. Fish. Brit. Mus., I, 83, 1859 (Brazil; Montevideo).

Diplectrum radians Poey, Ann. Lyc. Nat. Hist., 34, 1871 (Cuba); Poey, Enumeratio, 23, 1875.

Serranus irradians Cuv. & Val., Hist. Nat. Poiss., II, 244, 1828 (Montevideo).

Serranus fascicularis Cuv. & Val., Hist. Nat. Poiss., II, 245, pl. 30, 1828 (Brazil); Cuv. & Val., Hist. Nat. Poiss., IX, 431, 1833 (Charleston); Cuvier, Règne Animal, 1829; Storer, Synopsis, 280, 1846 (copied); Jordan & Gilbert, Synopsis Fish. N. Am., 534, 1883; Jordan & Gilbert, Proc. U. S. Nat. Mus., 273, 1882 (Pensacola).

Centropristis fascicularis Günther, Cat. Fish. Brit. Mus., I, 83, 1859 (Brazil; Charleston).

Diplectrum fasciculare Holbrook, Ichth. S. Carolina, 1860 (Charleston); Poey, Repert., I, 195, 1867; Poey, Synopsis, 282, 1868 (Havana); Gill, Cat. Fish. East Coast N. Am., 28, 1873.

Habitat.—West Indian fauna; north to Charleston, south to Montevideo.

Etymology.—*Formosus*, handsome.

This handsome fish is common on the south Atlantic and Gulf coasts of the United States on rocky bottoms at a moderate depth. It reaches a length of little more than a foot.

We have examined specimens from Charleston, Pensacola, Key West, Captiva Key, Havana, Pernambuco, and Rio Janeiro. These specimens show no evident specific differences; but the differences due to age are somewhat considerable. The smallest specimens before us (2 inches long) have a very distinct dark lateral band running from the tip of the snout and ending in a dark spot at the upper base of caudal fin; another (paler) band runs from upper part of eye to base of last dorsal rays; another from above eye along base of dorsal. These bands are sharply defined in the young, and traces of them are usually found in all examples. In the smallest specimens the preopercle is simply but coarsely serrate with a salient angle; in larger ones a portion of the preopercle is prolonged backwards and its spines begin to radiate. In examples of 4 inches the spines are not yet divided into two fasciæ, but later they begin to show radiation from two distinct centers. In specimens of 7½ inches the two fascicles of spines are distinct. In the largest the upper lobe of the caudal is filamentous.

We adopt the name *formosus* for this species, as it is evidently the original *Perca formosa* of Linnæus, sent from Charleston by Dr. Garden.

79. DIPLECTRUM EURYPLECTRUM.

Diplectrum euryplectrum Jordan & Bollman, Proc. U. S. Nat. Mus., 1889, 157 (Sea between Panama and Galapagos Islands).

Habitat.—Pacific coast of South America.

Etymology.—'Ευρύς, wide; πλῆκτρον, spur.

This species is known from numerous specimens dredged by the *Albatross* at a depth of about 35 fathoms. It is found in company with *D. macropoma*, a species which it closely resembles, and into which it may possibly be found to intergrade.

80. DIPLECTRUM MACROPOMA.

Centropristis macropoma Günther, Proc. Zool. Soc. London, 145, 1864 (Panama); Günther, Fish. Central Amer., 409, pl. LXV, 1869 (Panama).

Diplectrum macropoma Jordan & Bollman, Proc. U. S. Nat. Mus., 1889, 157 (Panama and southward).

Habitat.—Pacific coast of tropical America.

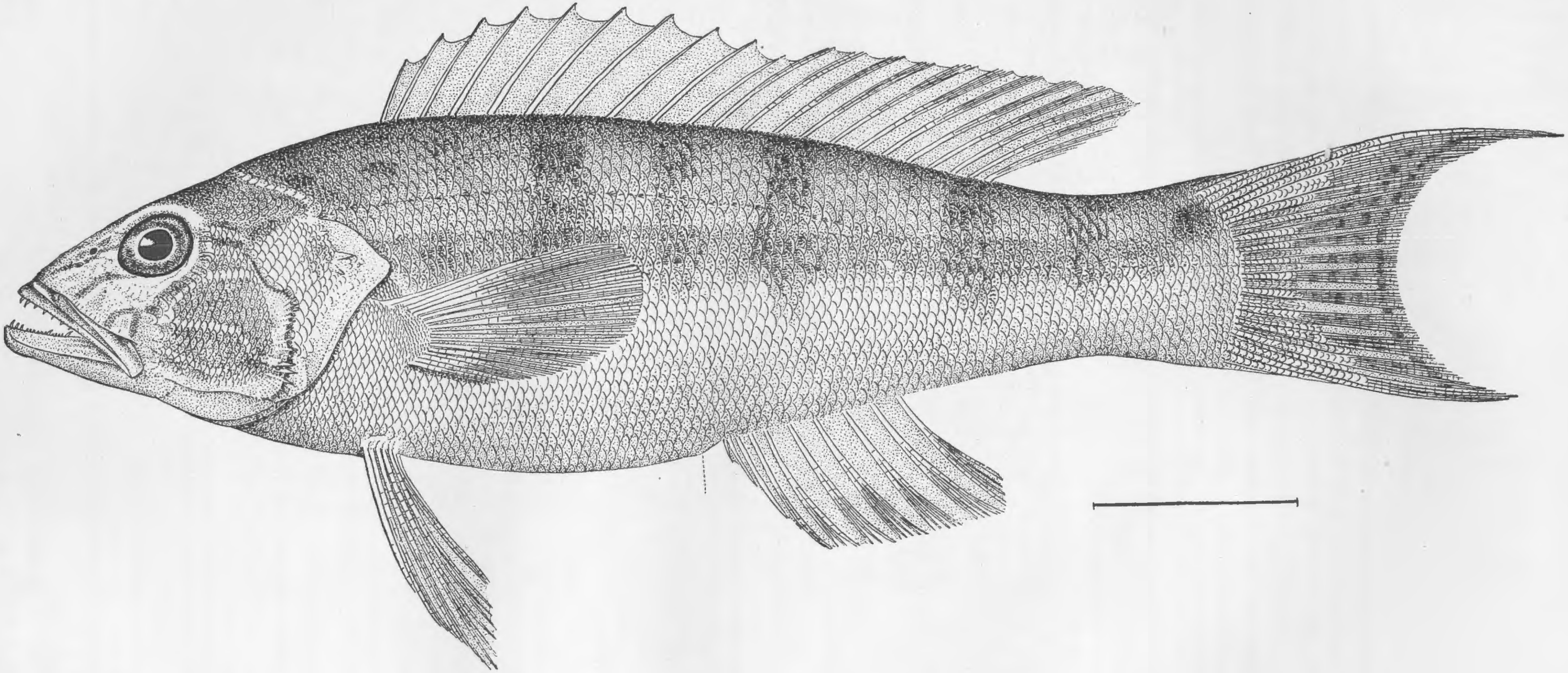
Etymology.—Μακρός, large; πῶμα, opercle.

This species, hitherto known from a single young example which we had supposed to be the young of *D. radiale*, was obtained in abundance by the *Albatross* with the preceding in the sea south of Panama. A few specimens were also taken at Panama.

81. DIPLECTRUM RADIALE.

Serranus radialis Quoy & Gaimard, Voyage Uranie, 316,1824 (Rio Janeiro); Cuv. & Val., Hist. Nat. Poiss., II, 243, 1828 (Rio Janeiro); Cuvier, Règne Animal, 1829 (name only); Jordan, Cat. Fish. N. Am. 82, 1885; Jordan, Proc. U. S. Nat. Mus., 376, 1885 (Gulf of California; Panama).

Centropristis radialis Günther, Cat. Fish. Brit. Mus., I, 83, 1859 (Bahia); Steindachner, Ichth. Beiträge, IV, 6, 1875 (Brazil).



DIPLECTRUM FORMOSUM (Linnæus). The Squirrel-fish.

(No. 12543, U. S. National Museum; from Charleston, South Carolina.)

Diplectrum radiale Streets, Bull. U. S. Nat. Mus., VII, 1877; Jordan, Proc. U. S. Nat. Mus., 1889, 181 (Panama).

Serranus bivittatus Cuv. & Val., Hist. Nat. Poiss., II, 241, 1828 (Martinique); Storer, Synop. Fish. N. Am., 279, 1846 (copied).

Centropristis bivittatus Günther, Cat. Fish. Brit. Mus., I, 82, 1859 (Martinique; Cuba).

Haliperca bivittata Poey, Synop. Pisc. Cubens., 282, 1868 (Havana); Poey, Enumeratio, 22, 1875 (Havana).

Centropristes ayresi Steindachner, Ichth. Notizen, VII, 1, 1868, Taf. I, fig. 1 (Santos).

Habitat.—Both coasts of tropical America.

Etymology.—*Radialis*, radiant, from the radiating preopercular spines.

Dr. Steindachner has already noted the identity of his *Centropristes ayresi* from Santos, Brazil, with *Diplectrum radiale.* With Dr. Steindachner we find no difference between Atlantic and Pacific examples, although the other Pacific species, *D. macropoma*, seems to be a peculiar form.

It seems evident that the *Serranus bivittatus* is merely the young of this species. Specimens sent to us from Cuba by Poey confirm this supposition, as they differ from *radiale* precisely as the young differs from the adult in *formosum.*

We have examined specimens of *Diplectrum radiale* from Guaymas, Panama, Sambaia, Rio Janeiro, and Havana.

82. DIPLECTRUM CONCEPTIONE.

Serranus conceptionis Cuv. & Val., II, 246, 1828 (Concepcion de Chile); Lesson, "Voyage Coquille, Zool., II, 236;" Gay, Hist. Chile, Zool., II, 148; Günther, I, 84.

Habitat.—Coast of Chili.

Etymology.—From Concepcion de Chile, where the species was first found.

We know this species from the account given by Cuvier and Valenciennes of a specimen 4½ inches long. It seems to be a *Diplectrum*, and it is doubtless distinct from *D. radiale*, its nearest relative.

Genus XXII.—SERRANUS.

Serranus Cuvier, Règne Animal, Ed. I, 1817, 276 (based especially on the "Serran" or "Perche de mer" of the coasts of the Mediterranean).

Serranus Cuvier, Règne Animal, Ed. II, 1829 (*cabrilla*, "le Serran proprement dit").

Prionodes Jenyns, Voyage Beagle, Fishes, 1840, 46 (*fasciatus=psittacinus*).

Haliperca Gill, Proc. Ac. Nat. Sci. Phila., 1862, 236, in part (*bivittatus=radialis*).

Mentiperca Gill, Proc. Ac. Nat. Sci. Phila., 1862, 236 (*luciopercanus*).

Pseudoserranus Klunzinger, Synopsis der Fische des Rothen Meeres, 687, 1870 (in part, not type, which is *Variola louti*).

Serranellus Jordan, subgenus nova (*scriba*).

TYPE.—*Perca cabrilla* Linnæus.

Etymology.—*Serran*, the French name of *Serranus cabrilla* and related species.

The genus *Serranus* as defined in this paper contains numerous species, mostly of the New World, and representing a considerable variety of forms.

To this genus, however, belong but a small portion of the species called *Serranus* by Günther, and the writers who have followed his arrangement, in which nearly all the *Epinephelinæ* are referred to this very different genus. On the other hand, most of the species called *Centropristis* by these authors are either near allies of *Serranus cabrilla*, or else members of the very different subfamily *Lutjaninæ*. Few European writers except Bleeker, Vaillant, Klunzinger, and Doderlein have recognized the wide divergence of *Serranus* and *Epinephelus*. Bleeker, who saw this clearly, properly retained the name *Serranus* for its original type and retained the old name *Epinephelus* for the group to which it was first given. Doderlein, for no obvious reason, substitutes the later name *Cerna* for *Epinephelus*, while Klunzinger perversely and needlessly changes these names about, calling the *Epinepheli* "*Serranus*" and making a new name for *Serranus*.*

Under *Serranus* we recognize several subgenera of more or less importance, some of which have been often regarded as distinct genera. Of these, *Prionodes* contains most species, American species, with shorter fins and smaller teeth, being weaker representatives of the European *Serranellus*. The two European species *scriba* and *cabrilla* differ considerably in the position of the lateral line, the latter species diverging from the usual Serranine type and approaching the *Anthiinæ*. The greater number of gill-rakers is also an indication of the same kind. In view of this difference, I have proposed a new subgeneric name for the type of *Serranus scriba*.

ANALYSIS OF SPECIES OF SERRANUS.

I. Dorsal fin rather short, its rays X, 11, or X, 12; canine teeth moderate or small; dorsal fin with few scales or none; species of small size, American.

a. Caudal fin truncate.

b. Scales large, 42 to 50 in the course of the lateral line; second anal spine considerably longer than third, about 2½ in head. Body deep, compressed, the head comparatively slender, the anterior profile straight or somewhat concave; lower jaw little projecting; maxillary reaching beyond middle of eye, 2½ in head; canines small, those on sides of lower jaw largest; preopercle rounded, subequally serrate; gill-rakers short and few, 6 or 8 in number; dorsal fin little emarginate, the fourth spine 3 in head; jaws scaleless; soft dorsal with small scales; pectoral long, reaching anal; color brown, with darker cross-shades; soft dorsal, anal and caudal fins checkered with blackish on a white ground; a broad white area or bar before anal fin.

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*Dr. Klunzinger remarks: "Bleeker nennt die *Serranus* jetzt *Epinephelus*. Diese Sucht, alte Namen hervorzusuchen, halte ich für verfehlt, wenigstens in Fällen, wie hier. Bloch hat allerdings verschiedene Arten dieser Gattung unter *Epinephelus* aufgeführt, die Gattungsdiagnose ist aber nichtssagend: Bloch hat die *Serranus*-Arten in viele Gattungen vertheilt, wie *Holocentrus*, *Johnius*, *Cephalopholis*, *Perca*, *u. s. w.* In den Regeln zoologischer Nomenclatur, wie die von der British Association 1865 und 1869 adoptirt wurden, heisst es in § 12: ein Name, welcher nie deutlich definirt wurde, sollte in den Namen ungeändert werden, welcher den Gegenstand zuerst deutlich bezeichnet. Dieser Regel folge ich."

Dr. Klunzinger forgets that *Serranus* was originally based on "le serran proprement dit"—that is, on *Serranus cabrilla*. If the clumsily constructed *Epinephelus* of Bloch is unsatisfactory to him, he has still the correctly defined *Epinephelus* of Bleeker. Even should he reject the name *Epinephelus* as wrong in meaning, the synonyms *Cerna* and *Merus* were both prior to his arrangement.

No writers have done so much to promote confusion in nomenclature as those who disregard the law of priority whenever the dictates of this law are opposed to their own whims. We find no excuse for the introduction of the name *Pseudoserranus* as a division of *Serranus*, when the author of the name knew that both groups had been named and defined long before.

Dr. Klunzinger seems to have wholly misunderstood the affinities of *Centropristis*. This genus, which is indistinguishable from his *Pseudoserranus*, he places in the neighborhood of *Mesoprion* (*Lutjanus*). He then divides *Centropristis* into three subgenera: *Centropristis* (*atrarius*), *Paracentropristis* (*hepatus*), and *Aprion* (*virescens*). The genus *Aprion* has no sort of affinity with *Centropristis*, and it does not belong to the *Serranidæ*. It belongs with *Lutjanus*, *Apsilus*, and *Etelis*, among or near to the *Sparidæ*.

c. Dorsal rays X, 13; head acuminate, at least in young; pectoral fin finely barred with black and whitish, precisely like the caudal fin; a very conspicuous inky-black blotch on front of soft dorsal (at least in young specimens), this being a continuation of one of the bars on the body; a black ring about tail at base of caudal, before which are six or seven dark bars, becoming progressively broader and fainter forwards; lower parts of head with a conspicuous net-work of dark streaks. Head, 2½; depth, 3. D. X, 13; A. III, 7. Scales, 6–45–17 (probably young of the next) .... SUBLIGARIUS, 83.

cc. Dorsal rays X, 12; head less slender; pectorals red; inky-black spot on front of soft dorsal small or obsolete; dusky bars on body more distinct than in *S. subligarius*, the bar at base of caudal broken into two or three dark spots; a dusky bar behind pale bar in front of anal. Head, 2⅖; depth, 2⅘. D. X, 12; A. III, 7. Scales, 5–45–14 .. FLAVIVENTRIS, 84.

bb. [Scales small, about 60 in the lateral line; margin of preopercle rounded, without stronger spines at the angle. Color reddish, with two incomplete black rings behind the eye, with a large saddle-shaped black blotch on the back of the trunk and with some small black dots on the dorsal and caudal fins. D. X, 12; A. III, 7.] (Günther.) .. ANNULARIS, 85.

aa. Caudal lunate or forked.

c. Scales large, 45 to 55 in the course of the lateral line. (*Prionodes* Jenyns.)

d. Opercle with a large inky blotch within, which extends also on the membranes of the shoulder-girdle; preorbital and maxillary narrow, the latter 2⅗ in head; teeth small; eye large, 3 in head, longer than the short snout, which is 4½ in head; dorsal spines rather high, not filamentous; soft dorsal not scaly; a notch between spinous and soft parts of dorsal; caudal well forked; second anal spine small, but longer than third, 3½ in head; scales large and regular. Head 3 in length; depth 3. D. X, 12; A. II, 7. Scales 3–47–11; sides with six dark vertical bars, the second extending as a jet-black blotch on the spinous dorsal from the fourth to the ninth spine; a paler bar before anal; fins mostly pale .... ATROBRANCHUS, 86.

dd. Opercular black blotch, if present, not extending on shoulder-girdle.

e. Scales on cheek very large in about five series; dorsal spines not quite equal; the fourth longest, about twice length of the ninth.

x. Teeth of jaws unusually small, the canines scarcely differentiated; lower teeth in one series; body slender, the head long; lower jaw little projecting; mouth large, the maxillary 2½ in head; eye large, as long as snout, 4½ in head; interorbital space flat, its width three-fifths orbit; preorbital narrow, one-fourth eye; angle of preopercle slightly projecting, the vertical margin gently concave, the serræ minute and equal; opercle produced backwards, with a single spine; gill-rakers long and slender, x + 16, the longest half eye; dorsal spines weak, flexible, low, the fourth longest, 3½ in head; the ninth 7 in head; caudal deeply lunate; anal not rounded, its spines slender, graduated; ventrals half head; pectorals long and narrow, reaching front of anal; scales large, ctenoid; scales on opercles large; top of head scaled forwards to posterior margin of pupil; dorsal and anal scaleless; dusky brownish, paler below, a series of about seven ill-defined, dusky blotches along lateral line; from these, still fainter bars run downwards; lining of opercle largely black, this appearing externally as a dusky blotch; vertical fins transparent, with minute dark specks; ventrals with median rays black; peritoneum silver; no sharp markings on body or fins. Head, 2½ in length; depth, 3½. D. X, 12; A. III, 7. Scales, 4½–48–13 .... ÆQUIDENS, 87.

xx. Teeth unusually strong, three or four on each side in upper jaw as large as the largest lateral teeth; eye very large, 2⅗ in head; maxillary 2¼ in head; jaws equal; preorbital extremely narrow, not one-third width of pupil; preopercle very sharply serrate; gill-rakers short, slender, x + 10; scales very large, covering head forward to back of pupil; first dorsal spine short, second a little longer; fourth longest, 2½ in head; the rest gradually shortened, lower than the soft rays, which are scaleless; second anal spine 4 in head, as long as third and stouter; caudal forked. Color plain olivaceous; fins all pale; sides with about six faint dark cross-bands, more or less confluent along lateral line, and disappearing below. Head, 2⅘ in length; depth, 3⅓. D. X, 12; A. III, 7. Scales, 48........................FUSCULUS, 88.

ee. Scales on cheek moderate, in about eight series; body oblong, heavy anteriorly; dorsal outline a little elevated, the profile almost straight; eyes very large, as long as snout, 3½ in head, twice the concave interorbital space; top of head naked; lower jaw not projecting; canines small; mouth large, the maxillary reaching middle of eye; preorbital narrow; gill-rakers short, about x + 10; twelve rows of scales before dorsal; dorsal spines strong, the fourth highest, 2¼ in head, a little longer than longest soft ray; dorsal fin not notched; soft dorsal a little scaly; caudal deeply lunate; second anal spine 3½ in head, stronger but scarcely longer than third spine; pectorals long, reaching anal. Color light brownish, with lighter blotches and faint dusky bars; a very conspicuous, sharply defined, vertical white bar extending upward on each side from just before vent; fins pale. Head, 2⅔ in length; depth, 3¼. D. X, 12; A. III, 7. Scales, 5–53–15..PHŒBE, 89.

eee. Scales on the cheek small, in about twelve series; second anal spine about as long as fourth dorsal spine. Body oblong, not elevated; snout sharp; lower jaw much projecting, its tip entering the profile; maxillary reaching to beyond middle of eye; teeth rather strong, much as in *S. scriba;* gill-rakers short and few, x + 8. Dorsal continuous, the spines low, the longest 3 in head; second anal spine stronger than third, and about as long, 3 in head; last ray of anal longest, 1⅓ in head; caudal somewhat lunate, the outer rays slightly produced; pectoral 1½ in head; ventral 1⅗. Color light olivaceous, with twelve irregular, broad, dark brown bands extending to below the lateral line, appearing again at level of base of pectorals as a series of rounded blotches, those in front pinkish, those behind brown; a pale streak from nape to dorsal; two pale streaks or rows of blotches below this, extending from snout through eye and backward; a broad brown streak from eye to upper angle of opercle, this again bounded by a pale streak; suborbital light blue; a dark spot at base of ventrals, one or more below base of pectorals, and one in front of the latter; caudal dark brown at base and on outer rays; pink on inner rays, reticulated with irregular, narrow, light blue lines, these marks most distinct on outer rays; a large double blotch at base of caudal; anal and ventrals light glaucous blue, thickly marked with brownish yellow spots, the blue forming reticulations around the brown spots; spinous dorsal and base of soft dorsal dusky, upper part of soft dorsal sharply spotted with dark brown, the pale ground color forming reticulations around the dark spots. Head, 2⅗ in length; depth, 3⅓. D. X, 12; A. III, 7. Scales, 5–50–15...............PSITTACINUS, 90.

cc. Scales small, the lateral line with 60 to 75. *

g. Lower jaw not very strongly projecting.

* Not described in *Serranus peruanus*, which presumably belongs to this group.

h. Body covered with irregular, inky-black spots and bands. Body long and low, the head low and sharp, the lower jaw projecting; scales small; top of head naked, the smooth area on frontal region large; scales on cheek small, in ten or twelve rows; preopercle rounded, with regular serræ; teeth small; gill-rakers very short, x + 6 to 8. Eye 4 in head; maxillary 2½, reaching to center of eye; soft dorsal and anal naked; dorsal low, not notched; caudal forked; second and third anal spines equal, the second the strongest, 2½ in head; pectoral 1⅓ in head. Color brownish above, the sides yellowish, everywhere above, below, and on fins covered with irregular, inky-black spots, blotches, and bands, the latter meeting around the belly; pectorals and anal plain; a broad ring around base of caudal, and many irregular spots around bases of ventrals and pectorals; numerous black spots on dorsals and caudal, one of those on front of spinous dorsal very conspicuous. Head, 2⅝ in length; depth, 3⅘. D. X, 11; A. III, 7. Scales, 8-68-24 (60 pores)..................TIGRINUS, 91.

hh. Body not covered with conspicuous, inky-black spots and bands.

i. Back with three or more large, conspicuous blotches of yellowish white. Body more elongate than in related species; profile slightly convex; interorbital space concave; eyes large, longer than snout, 3½ in head; maxillary reaching middle of eye; lower jaw slightly projecting; scales on cheeks small, in eleven series; scales in front of dorsal small, crowded in twenty-five series; top of head naked; dorsal spines low, fifth the longest, 2½ in head; caudal strongly lunate; anal spines graduated, the third 3½ in head; pectorals and ventrals short, not reaching vent. Color brownish red above, with areas of light yellow on sides of back; one before dorsal, a large one and a small one below spinous dorsal; a large one below last rays of soft dorsal; one on back of tail; yellow before eye; belly and lower parts light red; top of head with two pale cross-shades, one before, one behind eyes; lower fins light orange; caudal red with two conspicuous longitudinal stripes of blackish red; dorsal red-shaded, a maroon blotch on each part of it, extending upward from a similar blotch on the back. Head, 3 in length; depth, 3⅘. D. X, 12; A. III, 7. Scales, 11-73-25 ....TABACARIUS, 92.

ii. Back without conspicuous blotches of yellowish white.

j. [Coloration nearly uniform, the body elongate, without distinct bands or spots; snout short and thick; head flat above; preopercle finely serrate; scales small; top of head naked; caudal slightly lunate. Color brownish yellow on back, orange on sides, and brighter or red on belly; no spots nor bands; upper part of head bluish, the fins gray; caudal bordered above and below with brown. D. IX (X), 12; A. III, 7. Scales, 60 to 65.] (*Cuv. & Val.*)...FLAVESCENS, 93.

jj. [Coloration not uniform; reddish brown with a pale stripe along the lateral line; head, body, and sides silvery, with seven or eight large, round spots; dorsal yellowish, edged with red; caudal brownish; anal reddish brown, with two rounded, reddish brown spots. D. X, 12; A. III, 9. Scales and other characters undescribed.] (*Lesson.*) .PERUANUS, 94.

gg. Lower jaw very strongly projecting; body elongate, moderately compressed; scales small (about 70) (*Mentiperca* Gill).

k. [Snout blunt, scarcely longer than eye; caudal fin not banded; body rather deeper than in *S. luciopercanus*; dorsal fin low, rather deeply notched, the first and second spines low, the third highest; cauda. well forked; anal spines graduated; preopercle well serrated, the posterior margin vertical; color purplish above, yellowish below, the upper fins edged or tipped with orange yellow.] (*Castelnau.*) ......CASTELNAUI, 95 *kk.* Snout sharp, much longer than the large eye; preopercle finely denticulated; top of head with vertex naked; caudal deeply forked; skull depressed, with a single crest; dorsal spines moderate, the third highest.

l. Color red, with numerous inky-black spots on posterior half of body, most of them round, rather smaller than pupil, and ranged in irregular horizontal rows; a large quadrate blotch at front of soft dorsal, extending on the fin; dorsal with dark spots; lower half of caudal chiefly black; a large, oblong, silver-white blotch from before vent, extending obliquely upward and backward to near the black dorsal blotch. Head, 3 in length; depth, $3\frac{2}{5}$. D. X, 12; A. III, 7. Scales, 8–65–18. Snout, $3\frac{1}{4}$ in head; maxillary, $2\frac{2}{5}$. Eye, 4. Eleven rows of small scales on cheek; fourth dorsal spine $2\frac{1}{2}$ in head; anal spines graduated, the second $3\frac{3}{5}$ in head; pectorals $1\frac{1}{5}$ in head; ventral $1\frac{3}{5}$ .... STILBOSTIGMA, 96.

ll. Color clear brown with larger darker spots or bars on the sides; fins pale, more or less tinged with orange. Head, 3 in length; depth, $3\frac{1}{4}$. D. X, 12; A. III, 7. Scales, 7–70–20 .... LUCIOPERCANUS, 97.

II. Dorsal fin long, its rays X, 14 or X, 15; head acuminate, the lower jaw projecting; canine teeth strong, membrane of both dorsals scaly; scales small.

x. Lateral line as in other species of *Serranus*, not close to the back, on about the ninth row of scales; caudal subtruncate (*Serranellus* Jordan).

y. Scales moderate, about 73 in the lateral line; caudal fin truncate; lateral line not running near the back, not approaching nearer than about the ninth row of scales; anal spines graduated; top of head not scaly; the skin rugose; body rather short, compressed, the back a little elevated, the anteroir profile straight; head subconical, compressed, the snout acuminate; eye small, shorter than snout, 5 in head; mouth large, narrow, maxillary reaching middle of eye, $2\frac{2}{5}$ in head; lower jaw projecting; teeth in narrow bands, the canines strong, recurved, two to four in front of each jaw on each side and several on side of lower jaw, the latter largest of all; gill-rakers few and short, about x + 8; scales on cheeks quite small, in fifteen to eighteen series, about twenty series before dorsal; preopercle rather finely serrate, the angle rounded; preorbital very narrow; first four dorsal spines graduated, the rest subequal, $2\frac{3}{5}$ in head; the dorsal fin not notched; soft dorsal somewhat scaly; caudal obliquely subtruncate; the upper rays somewhat longer, the middle rays a little shortened; anal spines rather strong, graduated; pectorals long, reaching vent. Color olivaceous, the body with five to seven blackish cross-bands; two of these, under soft dorsal, very distinct; head with numerous wavy, blue lines; vertical fins vermiculated with bluish lines around small, round, reddish spots. Head $2\frac{2}{5}$ in length; depth $3\frac{1}{3}$. D. X, 14 or 15; A. III. 7. Scales, 8–73–27. SCRIBA, 98.

yy. Scales small, about 115 in the lateral line; snout scaleless, pointed, the lower jaw slightly prominent; the maxillary reaching beyond middle of eye; eye $4\frac{1}{2}$ in head, $1\frac{1}{2}$ in snout; interorbital space flat, narrow; serræ on angle of preopercle largest; caudal truncate; ventrals short. Color olive, with several dark cross-bands, most distinct on middle of side of body; two of them near middle of body darker and broader than the rest; three bluish, dark-edged streaks across cheeks* from eye to angle of preopercle; soft parts

*Es ist nicht *ein* dunkles Wangenband vorhanden (*Gthr.*), sondern bis drei, sie sind bläulich, schwarzgesäumte." (Hilgendorf.)

of vertical fins covered with very small bluish spots; angles of caudal jet-black. Head 3 in length; depth, 3½. D. X, 15; A. III, 8. Scales, 11–115–x.] (*Günther.*) .... ATRICAUDA, 99.

xx. Lateral line running high anteriorly, somewhat as in the *Anthiinæ;* one about the fifth row of scales; caudal forked (*Serranus*).

z. Lateral line running very high, on the fourth or fifth row of scales from below fourth dorsal spine to end of dorsal fin; both dorsals and anal fin with small scales; body elongate, compressed; head acuminate, compressed, formed much as in *Serranus scriba*; lower jaw strongly projecting; anterior profile nearly straight; preopercle finely serrate, the angle salient and with larger teeth; top of head scaleless, the skin rugose; maxillary reaching past middle of eye, 2½ in head; canines strong; mouth rather oblique, lower jaw projecting; scales on cheek moderate, in about eleven series; anal spines graduated; pectorals rather long, 1⅗ in head; gill-rakers longer than in any other of the *Serraninæ*, about x + 15, the longest rather longer than pupil. Color orange-yellow; four or five gray longitudinal streaks across the head, about three of which usually extend along the body; body with dark cross-shades in the young; vertical fins with blue spots. Head, 3 in length; depth, 3½. D. X, 14; A. III, 7 or 8. Scales, 9–80 to 90–20 to 25 .... CABRILLA, 100.

83. SERRANUS SUBLIGARIUS.

Centropristis subligarius Cope, Proc. Acad. Nat. Sci. Phil., 120, 1870 (Pensacola).

Serranus subligarius Goode & Bean, Proc. U. S. Nat. Mus., 238, 1882 (Gulf of Mexico); Jordan & Gilbert, Proc. U. S. Nat. Mus., 274, 1882 (Pensacola); Jordan & Gilbert, Synopsis Fish. N. Am., 535, 1883 (Pensacola); Jordan, Proc. U. S. Nat. Mus., 39, 1884 (Pensacola); Jordan, Cat. Fish. N. Am., 82, 1885.

Serranus dispilurus Jordan, Proc. U. S. Nat. Mus., 1886, 27 (Beaufort, N. C.).

Serranus brasiliensis Jordan & Eigenmann, Proc. U. S. Nat. Mus., 1887, 269 (Charleston).

Etymology.—*Subligarius*, wearing a truss, in allusion to the white cross-band.

Habitat.—South Atlantic coasts of United States.

Our specimens of this species are from Pensacola, Charleston, and Beaufort, and they correspond to *Centropristis subligarius* Cope. All of them have the dorsal rays X, 13 (in one case XI, 13), and all have the inky spot on the soft dorsal large, and very conspicous. In these the pectoral is finely barred, like the caudal fin.

Günther's *dispilurus*, from Trinidad, is said to have the dorsal X, 12, the dorsal spot small, and the pectorals red; otherwise the description agrees entirely with our specimens. With the account of *dispilurus* the short description given by Cuvier and Valenciennes of *Dules flaviventris* is in perfect agreement.

One of the types of Brisout de Barneville's *Centropristis brasiliensis* is preserved in the museum at Paris, where it has been examined by us. This has the dorsal rays X, 12, the dorsal spot obscure and diffuse, but is otherwise similar to *subligarius*. All have the second anal spine long, the caudal barred, a white bar before anal, the caudal truncate, with other characters, which readily distinguish this species from all others related to it. We feel little doubt, therefore, that *subligarius*, *brasiliensis*, and *dispilurus* are synonyms of *flaviventris*. If two species exist, *subligarius*, the northern form, would be separated from the *flaviventris* by its number of dorsal rays—greater than that of any of the other species in this division of *Serranus*; by having the pectoral fin barred like the caudal, and the black spot on the dorsal very large. It is, however, probable that *brasiliensis* represents the adult of the species, *flaviventris* or *dispilurus* younger specimens, and *subligarius* those still younger. In the type of *brasiliensis* the head is considerably less slender than in *subligarius*. This is probably a matter of age. This species reaches but a small size, none of the known specimens being six inches in length.

As all known specimens of *subligarius* have thirteen soft dorsal rays, and all of *flaviventris* examined have twelve, we let them stand for the present as distinct species.

84. SERRANUS FLAVIVENTRIS.

Dules flaviventris, Cuv. & Val., Hist. Nat. Poiss., III, 113, 1829 (Brazil); Günther, I, 267 (copied).
Centropristis brasiliensis Brisout de Barneville, "Revue Zoologique, 1847, 131" (Brazil); Günther, I, 85, 1859 (St. Helena).
Serranus brasiliensis Jordan, Proc. U. S. Nat. Mus., 1886, 533 (from Brisout de Barneville's type).
Centropristis dispilurus Jordan, Proc. U. S. Nat. Mus., 1886, 27 (Beaufort, N. C.).

Habitat.—Brazilian fauna. Trinidad to St. Helena.

Etymology.—*Flavus*, yellow; *venter*, belly.

For a discussion of the relation of this species to the preceding, see our remarks on *S. subligarius*.

The only specimen of this form which we have seen is the type of *C. brasiliensis* in the museum at Paris.

85. SERRANUS ANNULARIS.

Centropristis annularis Günther, Shore Fishes, Challenger, 1880, 6, pl. I, fig. C (Pernambuco).

Habitat.—Coast of Brazil.

Etymology.—*Annularis*, ringed.

This species is known from a short description and a figure of a very young individual about 2 inches long. It is probably a valid species—not the young of *Serranus flaviventris*.

86. SERRANUS ATROBRANCHUS.

Centropristis atrobranchus Cuv. & Val., Hist. Nat. Poiss., III, 45, 1829 (Brazil); Günther, I, 1859, 86 (copied).
Serranus atrobranchus Jordan, Proc. U. S. Nat. Mus., 1886, 532 (examination of original type).

Habitat.—Coast of Brazil.

Etymology.—*Ater*, black; *branchia*, gill (βράγχια, gills).

Only the original type of this strongly marked species is yet known. It was collected in Brazil by Delalande, and from it our description was taken.

87. SERRANUS ÆQUIDENS.

Serranus æquidens Gilbert, Proc. U. S. Nat. Mus., 1890 (west coast of Mexico).

Habitat.—Pacific coast of tropical America.

Etymology.—*Æquus*, equal; *dens*, tooth.

This species is known from its type, 7 inches long, dredged by the *Albatross* at Station 2996, off the west coast of Mexico.

88. SERRANUS FUSCULUS.

Centropristes fusculus Poey, Memorias, II, 342. 1860 (Havana).
Haliperca fuscula Poey, Synop. Pisc. Cubens., 281, 1868 (Havana); Poey, Enumeratio, 22, 1875 (Havana).

Habitat.—West Indian fauna. Cuba.
Etymology.—*Fusculus*, somewhat tawny.

This species is known only from the original type, sent by Poey to the museum at Cambridge. From this specimen (10015, M. C. Z., 7 inches in length) our description is taken.

89. SERRANUS PHŒBE.

Serranus phœbe Poey, Memor., Cuba, I, 55, 1851, pl. 2, fig. 3; Jordan, Proc. U. S. Nat. Mus., 35, 1884 (Pensacola); Jordan, Proc. U. S. Nat. Mus., 39, 1884 (Pensacola); Jordan, Cat. Fish. N. Am., 83, 1885; Jordan, Proc. U. S. Nat. Mus., 1886, 39 (Havana).
Centropristis phœbe Günther, Cat. Fish. Brit. Mus., I, 85, 1859 (Cuba).
Haliperca phœbe Poey, Synopsis Pisc. Cubens., 281, 1868 (Havana); Poey, Ann. Lyc. Nat. Hist., 34, 1871 (Cuba); Poey, Enumeratio Pisc. Cubens., 22, 1875 (Havana).

Habitat.—West Indian fauna, north to Pensacola.
Etymology.—*Phœbe*, the moon.

Our specimens of this species are from Havana and Pensacola.

90. SERRANUS PSITTACINUS.

Prionodes fasciatus Jenyns, Voy. Beagle, Fishes, 46, 1840; Günther, Cat. Fish. Brit. Mus., I, 96, 1859, (Chatham Island, Galapagos) (not *Holocentrus fasciatus* Bloch, which is *Serranus scriba*); Jordan, Proc. U. S. Nat. Mus., 1889, 81 (Charles, Hood, and Albemarle Islands, Galapagos).
Serranus psittacinus Valenciennes, Voyage Vénus, Poiss., 290, pl. I, f. 1, 1855 (Galapagos Islands).
Centropristis psittacinus Günther, I, 186 (copied).
Serranus calopteryx Jordan & Gilbert, Proc. U. S. Nat. Mus., 338, 1881 (name only); Jordan & Gilbert, Proc. U. S. Nat. Mus., 350, 1881 (Mazatlan); Jordan & Gilbert, Bull. U. S. Fish Com., 170, 1882 (Mazatlan); Jordan, Cat. Fish. N. Am., 83, 1885; Jordan, Proc. U. S. Nat. Mus., 376, 1885 (Pearl Islands; Galapagos).

Habitat.—Panama fauna. Cape San Lucas to Galapagos Islands.
Etymology.—*Psittacus*, a parrot.

We have examined specimens of this species from Mazatlan, Pearl Islands (Panama), La Paz, and from Charles, Hood, Albemarle, and Indefatigable Islands, of the Galapagos. The specimens from La Paz and Indefatigable are in the museum at Cambridge. Numerous specimens were also taken by Dr. Gilbert at the Revillagigedos.

The earliest specific name of this species, *fasciatus*, can not be used if the species be referred to *Serranus*, as already more than one *Serranus* has been called *fasciatus*. The oldest tenable specific name is therefore *psittacinus*. The genus *Prionodes* was supposed by Jenyns to differ from *Serranus* by the absence of vomerine and palatine teeth. These teeth are, as a matter of fact, well developed in the young, but in some old specimens they are small, partly covered by the skin, and possibly even deciduous.

91. SERRANUS TIGRINUS.

Holocentrus tigrinus Bloch, pl. 237, 1790; Bloch & Schneider, Syst. Ichth., 314, 1801 (East Indies).
Serranus tigrinus Jordan, Proc. U. S. Nat. Mus., 1886, 579.
Serranus præstigiator Poey, Mem. Cuba, I, 58, 1851, tab. 2, fig. 2 (Havana).
Centropristis præstigiator Günther, Cat. Fish. Brit. Mus., I, 85, 1859 (Cuba).
Haliperca præstigiator Poey, Synop. Pisc. Cubens., 282, 1868 (Havana); Poey, Enumeratio, 22, 1875 (Havana).

Habitat.—West Indian fauna.

Etymology.—*Tigrinus*, spotted like a tiger.

Of these exceedingly handsome little fish, we have examined only the original type of *Serranus præstigiator*, sent by Poey to the museum at Cambridge. We see no reason to doubt the identity of *Holocentrus tigrinus* Bloch with this species.

92. SERRANUS TABACARIUS.

(JACOME.)

Centropristes tabacarius Cuv. & Val., Hist. Nat. Poiss., III, 44, 1829 (Martinique); Storer, Synopsis, 287, 1846 (copied); Guichenot, "Ramon de la Sagra, Hist. Cub., Poiss., 28, 1850."
Haliperca tabacaria Poey, Synopsis Pisc. Cub., 282, 1868 (Havana).
Serranus tabacarius Jordan, Proc. U. S. Nat. Mus., 1886, 39 (Havana).
Serranus jacome Poey, Memor. Cuba, I, 57, 1851, tab. 2, fig. 1 (Havana).
Haliperca jacome Poey, Ann. Lyc. Nat. Hist., 34, 1871 (Cuba); Poey, Enumeratio, 22, 1875 (Havana).

Habitat.—West Indian fauna.

Etymology.—*Tabacarius*, pertaining to *tabacum*, tobacco, the fish being called *bout de tabac* (cigar stump) by the negroes at Martinique.

The specimens of this species examined by us are from Havana, where it is rather common.

93. SERRANUS FLAVESCENS.

Serranus flavescens Cuv. & Val., Hist. Nat. Poiss., VI, 506, 1830 (Martinique); Storer, Syn. Fish. N. A., 280, 1846 (copied).

Habitat.—Martinique.

Etymology.—*Flavescens*, yellowish.

Only the type of this species is as yet known. This we have not seen. For a partial description of it we are indebted to M. Alexandre Thominot, of the Muséum d'Histoire Naturelle, at Paris.

94. SERRANUS PERUANUS.

Serranus peruanus Lesson, Voyage de la Coquille, tome II, part 1, p. 234, 1828 (Payta).

Habitat.—Coast of Peru.

Etymology.—*Peruanus*, Peruvian.

We place this species in *Serranus*, solely on account of the number of the dorsal rays (X, 12). The scanty description refers only to the coloration, which resembles that of *Epinephelus analogus* and *Paralabrax maculatofasciatus*, but in both these species the number of dorsal rays is greater.

The following is Lesson's original description:

Serran péruvien.

Serranus peruanus Lesson.

P. 13; d. $\frac{10}{12}$; cat. $\frac{1}{5}$; a. $\frac{3}{9}$; c. 16.

Ce petit serran, non compris dans la révision des espéces par MM. Cuvier et Valenciennes, provient de la baie de Payta, sur la côte du Pérou, où il est commun. Il y est nommé cabrilla. Sa taille est communément de 5 pouces, bien qu'il ait parfois jusqu'à 10 ou 12 pouces. Il est entièrement d'un rouge brunâtre, marqué d'une raie blanche le long de la ligne latérale; puis tout tacheté de rouge brun sur la tête, le corps et les flancs. Le ventre et les côtés sont blanc argenté; mais sept à huit taches larges, arrondies, se dessinent sur ce fond clair et luisant. La tête est ponctuée de rouge. L'œil est cerclé d'orangé; la dorsale est fauve, rubanée de rouge ocreux. La caudale est brunâtre ainsi que les catopes. Les pectorales sont cannelle, et l'anale rouge-brunâtre avec deux taches rouge-brun arrondies.

95. SERRANUS CASTELNAUI nom sp. nov.

Centropristis nebulosus Castelnau, Animaux Nouveaux ou Rares de l'Amérique du Sud, 1855, 5, pl. I, fig. 4 (Rio Janeiro) (not *Serranus nebulosus* Cuv. & Val.).

Habitat.—Coast of Brazil.

Etymology.—*Nebulosus*, clouded.

This species is known from Castelnau's figure only, the description consisting of notes on the coloration. The figure is not very exact, as the number of soft rays in the fins can not be certainly counted. The projection of the lower jaw indicates a species allied to *S. luciopercanus*, but with deeper body and shorter snout.

As the name *nebulosus* is preoccupied in *Serranus*, this species needs a new name if referred to the latter genus.

The following is the whole of Castelnau's description:

Le corps est d'un gris ardoisé; nageoire dorsale avec des taches rouges et d'autres jaunes sur le bord supérieur; tête et nageoires rosèes; une tache d'un rouge foncé sur la base de la pectorale; nageoire caudale obscure avec un bord terminal lilas; ventre d'un blanc grisâtre. Rio-de-Janeiro.

To this scanty account the following is added by our friend, M. Alexandre Thominot, who has examined, at our request, the original type in the museum at Paris:

Centropristis nebulosus Castelnau. (Type.) D. IX-I, 12; A. (brisée); P. 18. L. lat. 72 environ; lign. transv. 16–10. Branch. 7.

Longueur totale du seul spécimen qui est une mauvaise peau 0^{m} 308. La tête contenue environ trois fois dans l'étendue du poisson sans tenir compte de la caudale. Mandibule plus longue que la mâchoire supérieure. Dents en carde sur les mâchoires, au vomer et sur les ptérygoïdiens; sur la mâchoire inférieure on aperçoit, sur les côtés, quatre ou cinq petites canines. Œil égal à l'espace interorbitaire, ou de même dimension que le parcours compris entre la deuxième narine et le bout du museau et forme environ le cinquième de la tête. Pectorales de même longueur que l'espace compris entre le bout du nez et le bord de l'interopercule. Ventrales de même dimension que le lobe inférieur de la caudale. Premier rayon épineux dorsal contenu trois fois et demi dans la hauteur du troisième qui est lui-même égal au 4^{me}; le 2^{me} est contenu deux fois et un tiers dans ce même rayon. L'épine operculaire la plus longue est égale au premier rayon dorsal.

Je ne puis rien vous dire de la coloration; je craindrais de faire quelque erreur.

96. SERRANUS STILBOSTIGMA.

Prionodes stilbostigma Jordan & Bollman, Proc. U. S. Nat. Mus., 1889, 158 (sea west of Ecuador).

Habitat.—Pacific coast of equatorial America.

Etymology.—Στιλβός, shining; στίγμη, spot.

This species is known from a single example, dredged in 45 fathoms, at the equator, off the coast of Ecuador.

In form it agrees very closely with *Serranus luciopercanus* of the Atlantic coast, but the coloration is quite different.

97. SERRANUS LUCIOPERCANUS.

Serranus luciopercanus Poey, Memorias, I, 56, 1851, tab. 9, fig. 1 (Havana); Steindachner, "Verh. Zool. Ges. Wien, 1866, 777, tab. 16, f. 1."

Centropristis luciopercanus Günther, Cat. Fish. Brit. Mus., I, 84, 1869 (copied); Vaillant & Bocourt, Miss. Sci. au Mexique, 1874, Pl. V, f. 1.

Mentiperca luciopercana Poey, Synop. Pisc. Cubens., 281, 1868 (Havana); Poey, Enumeratio, 23, 1875 (Havana).

Habitat.—West Indian fauna.

Etymology.—*Luciopercanus*, resembling *Lucioperca*, a synonym of the percoid genus *Stizostedion.*

Of this species we have seen only the original type, a young specimen sent by Poey to the museum at Cambridge. *Serranus luciopercanus* and its near relative, *S. stilbostigma*, differ somewhat in form from the other species of *Prionodes.* The snout is sharper and the lower jaw unusually prominent. But both these characters are subject to intergradations. The snout is very sharp in *S. subligarius*, and the lower jaw in *S. psittacinus* is almost as long as in *S. luciopercanus.* For these reasons we are unable to recognize *Mentiperca* as a distinct genus.

98. SERRANUS SCRIBA.

(THE SEA-PERCH; VAQUETA.)

Perca lineis utrinque septem, etc., Artedi, Genera, 40, 1734.

Perca scriba Linnæus, Syst. Nat., Ed. X, 292, 1758 (no locality; and of the early copyists).

Serranus scriba Cuv. & Val., Hist. Nat. Poiss., I, 214, 1828; Günther, I, 103, 1859 (and of most recent writers).

Perca marina Linnæus, Syst. Nat., Ed. X, 290, in part (based properly on a fish from Norway—*Sebastes marinus*—the *Perca lineis*, etc., of Artedi being included in the synonymy).

Holocentrus fasciatus Bloch, Ichthyol., taf. 240, 1790.

Holocentrus marocannus Bloch & Schneider, Syst. Ichth., 320, 1801 (Morocco).

Lutjanus scriptura Lacépède, Hist. Nat. Poiss., IV, 229, 1803 (Mediterranean).

Holocentrus argus Spinola, Ann. du Mus., X, 372, 1807.

Serranus papilionaceus Cuv. & Val., VIII, 471, 1831 (Gorea; Canary Islands); Günther, I, 114 (copied).

Habitat.—Mediterranean Sea and neighboring waters, including the Azores and Canary Islands.

Etymology.—*Scriba*, a writer, from the script-like markings.

Our specimens of this common species are from Palermo and Venice.

99. SERRANUS ATRICAUDA.

Serranus atricauda Günther, Ann. Nat. Hist., XIII, 1874, 230 (Mogador, Morocco; Azores; Madeira; Teneriffe); Hilgendorf, Die Fische der Azoren, 1889, 206 (Azores).

Habitat.—Ocean northwest of Africa.

Etymology.—*Ater*, black; *cauda*, tail.

We know this species from descriptions only.

100. SERRANUS CABRILLA.

(SERRAN; SERRANO; CABRILLA.)

Perca cabrilla Linnæus, Syst. Nat., I, Ed. X, 294, 1758 (no locality, and of most early authors and copyists).
Serranus cabrilla Cuv. & Val., II, 1828, 223, Pl. XXIX; Günther, I, 106, and of authors generally.
Pseudoserranus cabrilla Klunzinger, Fische des Rothen Meeres, 1884, 7.
? *Labrus chanus* Forskål Descr. Anim., 1775, 36 (Constantinople).
? *Labrus hiatula* Bonnaterre, Encycl., Méthod., 1788, 116 (after Willoughby).
Holocentrus argentinus Bloch, Ichthyol., IV, 473, Taf. 235, f. 2, 1790 (according to Peters).
Lutjanus serranus Lacépède, Hist. Nat. Poiss., IV, 205, 1803.
Holocentrus flavus Risso, Ichth., Nice, 293, 1810.
Holocentrus serran Risso, *l. c.*, 294.
Perca channus Couch, "Lond. Mag. Nat. Hist., V. 19, f. 6, 1832" (Cornwall).
Serranus novemcinctus Kner, Novara, Fische, 17, f. 1 ("Capstadt" and St. Paul's Island); Sauvage, Archiv. Zool. Expér., VIII, 1880, 7.
Pseudoserranus bicolor "Kossman & Räub, Ergebn. Reise Rothen Meere, 7, t. 1, f. 1" (Red Sea).

Habitat.—Mediterranean Sea, Azores Islands, coasts of southern Europe and northern Africa.

Etymology.—*Cabrilla*, Spanish diminutive of *cabra* (Latin *caper*, goat).

This well known species is represented in our collection by specimens from Palermo, Italy. Its synonymy offers no special difficulty.

It seems to us evident that the generic name *Serranus* must always remain with this species. *Serranus* is a latinization of the French name "Serran," and this species is mentioned as the "Serran properly so called" by Cuvier, the author of the genus *Serranus.*

Genus XXIII.—PRONOTOGRAMMUS.

Pronotogrammus Gill, Proc. Ac. Nat. Sci. Phila., 1863, 81 (*multifasciatus*).
Hemianthias Steindachner, Ichth. Beiträge, I, 4, 1874 (*peruanus*).

TYPE.—*Pronotogrammus multifasciatus* Gill.

Etymology.—*Πρό*, before; *νῶτος*, back; *γραμμή*, line, in allusion to the upward curve of the lateral line.

This genus, as understood by us, contains four American species, relatives of the type of *Anthias*, but differing in the naked top of head, crown, and maxillary. The comparative study of a large number of species will be necessary before these genera of *Anthiinæ* can be put on a firm foundation. The species treated in the present paper form but a small part of the whole group, and the foreign species we have had no opportunity to study.

Hemianthias, distinguished by the smaller scales and by the smaller canines, seems to us a section of *Pronotogrammus* rather than a distinct genus.

ANALYSIS OF SPECIES OF PRONOTOGRAMMUS.

a. Scales rather small, about 56 in the lateral line; canines small; head and body moderately compressed (*Hemianthias* Steindachner).

b. Pectoral fin short, $1\frac{2}{3}$ in head; middle rays of caudal as long as head; body compressed, rather deep, deepest behind the head; head compressed, almost as deep as long; anterior profile nearly straight, moderately steep; mouth moderate, very oblique, the lower jaw projecting, its tip entering the profile; preorbital narrow, as broad as pupil, its edge roughened with mucous tubes; maxillary 2 in head; eye very large, $4\frac{1}{4}$ in adult; maxillary naked, very broad at tip, its width three-quarters eye; snout 4½ in head; snout and forehead and top of head naked; teeth very small, in very narrow bands; two canines each directed outward, in front of lower jaw, a smaller one turned backward before middle of side of jaw; upper jaw with a single short canine directed forward on each side in front; interorbital region flattish, with two bony ridges and a median depression; smooth area of frontal region of skull short and small, broader than long; occipital crest high and long; preopercle sharply serrate, its angle a right angle; gill-rakers very long, slender, and close set, x + 23, the longest three-fifths eye; branchiostegals 7 (8 according to Steindachner); dorsal spines rather low, slender, only the third produced in a long, stiffish filament, which reaches the third soft ray; soft dorsal naked, the last rays very high, 1⅔ in head; caudal very long, with a narrow fork, the middle rays as long as head and 1⅔ in the longest; anal high, its spines moderate, graduated; ventrals elongate, the third ray longer than head; pectorals shortish, pointed, 1⅗ in head; scales moderate; lateral line complete, running abruptly upward and backward to below sixth dorsal spine, then gradually curving downward; color rose red, with small diffuse golden-brown spots on body and on soft dorsal, caudal, and anal. Head, 3½ in length; depth, 3. D. X, 14; A. III, 8. Scales, 5-56-20 .... PERUANUS, 101.

aa. Scales large, 30 to 50 in the lateral line; canine teeth rather strong, conspicuous; body lanceolate, compressed (*Pronotogrammus*).

c. Scales not large, about 50 in the lateral line; second anal spine a little shorter than third; ventrals longer than pectorals; profile convex to the occiput, straight anteriorly; mouth very oblique, the maxillary extending to below pupil, 2⅛ in head; lower jaw with a canine in front on each side directed forward and outward; a canine hooked backward in front of middle of side of jaw; upper jaw with a canine directed forward on each side in front; eye longer than snout, 3 in head; vertical margin of preopercle serrate, the serræ larger below; a short, strong, flat spine at the angle; lower limb entire or serrate; top of head naked from the occiput forward; five series of scales on cheek; dorsal spines rapidly graduated to the fourth, which is nearly half head; several of the spines ending in long, fragile dermal filaments; the filament of the fourth spine longest, sometimes reaching caudal; caudal very deeply forked, some of the outer rays produced, sometimes half length of body; anal spines graduated, the second 3½ in head; pectorals short, 1½ in head; ventrals produced, extending beyond origin of anal; lateral line on third row of scales; gill-rakers very numerous, long and slender; color carmine, deepest on the back, becoming a clear violet on sides; back and sides everywhere freckled with golden olive, this on the sides becoming reticulations around the violet; a bright golden stripe from eye to base of pectoral above; another from tip of snout along lower border of eye to middle of pectoral; dorsal carmine, the rays tinged with golden; caudal similar; anal golden; pectoral carmine; ventrals red and yellow. Head, 3½ in length; depth, 3¼. D. X, 14 or 15; A. III, 7 or 8. Scales, 3-48-16 ..... VIVANUS, 102.

cc. Scales medium, about 38 in the lateral line; body elongate, the head thick, the lower outline nearly straight; mouth oblique; tip of lower jaw fitting into a notch of upper, not entering profile; maxillary broad, reaching middle of pupil, 2⅓ to 2½ in head; teeth in a narrow band above, in one series below; one or two canines directed forward and outward in front of each jaw; a pair on sides of jaw turned backward and inward; no teeth on tongue; interorbital space somewhat concave, the supraocular ridges being elevated; preorbital narrow, about one-third pupil; eye very large, 3 in head; angle of preopercle slightly projecting, its serræ coarser; gill-rakers long, slender, x + 30, the longest half orbit; dorsal emarginate, the spines slender and pungent, the sixth longest, 3⅓ in head, 1½ times tenth; each spine with a short filament near its tip, as usual in this genus; soft dorsal high; anal similar, its second spine shorter than third, which is 3⅔ in head. Caudal forked, the middle rays two-thirds the outer, which are not produced; pectorals short, reaching a little beyond front of anal; scales large, ctenoid, extending forward from occiput on top of head to middle of orbit; snout and maxillary naked; scales on cheek in six rows; dorsal and anal naked; lateral line very high on the third row of scales. Rose-red, silvery below, the fins light yellow; a dark spot above the middle of each eye and two V-shaped olive marks behind head, the apex of the one at the nape, the other at front of dorsal; lining of gill cavity and peritoneum silvery. Head, 2½ to 2⅔ in length; depth, 2⅔ to 3. D. X, 15; A. III, 8. Scales, 2½-38-X .... EOS, 103.

ccc. Scales very large, 31 in the lateral line; second anal spine longer than third; ventrals rather shorter than pectorals (in the young); depth about 4 (to end of middle caudal rays); head 3 in same distance; eye 3 in head; snout less than half eye; four upper front canines; two lower front and two lateral canines; dorsal spines rapidly increasing to the fourth, which is about 7 in length of body, thence decreasing to the last, which is 11 in length; longest soft ray about equal to longest spine; median caudal rays 6⅔ in length, longest greater than depth of body; color reddish, the young with numerous dark rufous bands, descending nearly to the middle. D. X, 15; A. III, 7. Scales 2-31-12............MULTIFASCIATUS, 104.

101. PRONOTOGRAMMUS PERUANUS.

Anthias (Hemianthias) peruanus Steindachner, Ichth. Beiträge, I, 1874, 4 (Payta; Trujillo).

Habitat.—Coast of Peru and Chili.

Etymology.—*Peruanus*, Peruvian.

Of this species we have examined two of Dr. Steindachner's original types (10232, M. C. Z.), from Payta, Peru. The largest of these is 15 inches in length and is now in poor condition. A specimen which we suppose to belong to the same species is also in the U. S. National Museum from Chili. This species reaches a larger size than the others of our *Anthiinæ*. It must be a very handsome fish in life.

102. PRONOTOGRAMMUS VIVANUS.

Anthias vivanus Jordan & Swain, Proc. U. S. Nat. Mus., 544, 1884 (Pensacola); Jordan, Cat. Fish. N. Am., 83, 1885.

Habitat.—West Indian fauna, north to Pensacola.

Etymology.—From the Red Snapper or *Vivanet*, from the stomach of which this species was first taken.

All the known specimens of this brilliantly colored species have been taken off the Snapper Banks between Pensacola and Tampa. Nearly all of them have come from the spewings of the speckled "Hind," *Epinephelus drummond-hayi*.

103. PRONOTOGRAMMUS EOS.

Anthias eos Gilbert, Proc. U. S. Nat. Mus., 1890 (Station 2996).

Habitat.—Pacific coast of tropical America.

Etymology.—Ἠώς, sunrise.

This species is known from several examples dredged by the *Albatross* at Station 2996, off the west coast of Mexico.

104. PRONOTOGRAMMUS MULTIFASCIATUS.

Pronotogrammus multifasciatus Gill, Proc. Ac. Nat. Sci. Phil., 81, 1863 (Cape San Lucas).
Anthias multifasciatus Jordan & Gilbert, Proc. U. S. Nat. Mus., 360, 1882 (Cape San Lucas); Jordan, Cat. Fish. N. Am., 83, 1885; Jordan, Proc. U. S. Nat. Mus., 377, 1885 (Cape San Lucas).

Habitat.—Pacific coast of Mexico.

Etymology.—*Multus*, many; *fasciatus*, banded.

This species is known only from the original type, a very young example taken at Cape San Lucas by Mr. John Xantus.

Genus XXIV.—ANTHIAS.

Anthias Bloch, Ichthyologia, 1792 (*sacer* = *anthias*).
Aylopon Rafinesque, Caratteri di alcuni Nuovi Generi, etc., Sicilia, 52, 1810 (*anthias*) (substitute for *Anthias*, said to be preoccupied).

TYPE.—*Anthias sacer* Bloch; *Labrus anthias* (Linnæus).

Etymology.—'Ανθίας, ancient name of some large fish, perhaps the Albicore; probably from ἄνθος, a flower.

We retain the generic name of *Anthias* for *Anthias anthias* and its immediate relatives, letting *Pronotogrammus*, *Odontanthias*, and other closely related groups stand for the present as distinct genera. None of the species of *Anthias* are American, and *Anthias anthias* is the only one of them which we have been able to examine.

We find no warrant for Rafinesque's statement that the name *Anthias* is preoccupied. We find the name *Anthia* among the insects, bearing date of 1801.

ANALYSIS OF EUROPEAN SPECIES OF ANTHIAS.

a. Maxillary with about five series of large scales; ventral fins very much produced, the second ray reaching entirely beyond base of anal fin; third dorsal spine elevated, twice as high as any of the others, about as long as head; body oblong ovate, strongly compressed; head compressed; profile convex, slightly depressed between the eyes; eyes large, 3¼ in head; mouth large, oblique; maxillary very broad posteriorly, its greatest width nearly three times the width of the narrow preorbital; teeth in both jaws uniserial laterally, in bands in front; one or two strong recurved canines on each side of lower jaw; a straight antrorse canine on each side in front; canines of upper jaw short, turned forward; no teeth on tongue; posterior edge of preopercle finely serrate, with larger spines at the angle; preorbital and lower jaw naked, rest of head scaly; scales on top of head very small, extending beyond nostrils. Dorsal spines long and slender, the third much elevated; soft dorsal with some elongate rays; caudal very deeply forked, the lobes produced; second and third anal spines subequal; third soft ray longer than longest soft dorsal rays; pectorals short, not reaching beyond front of anal; color red; head with three yellow bands radiating from eye; body freckled with greenish or yellowish spots; two bands on side of occiput, and a series of spots along base of dorsal; fins brownish green. Head, 3⅓ in length; depth, 2⅘. D. X, 15; A. III, 7. Scales, 5–38–16 .... ANTHIAS, 105.

105. ANTHIAS ANTHIAS.

(BARBIER; IMPERADOR.)

Labrus totus rubescens cauda bifurca Artedi, Synonomia, 54, 1737 (Mediterranean).
Labrus anthias Linnæus, Syst. Nat., Ed. X, 282, 1758 (after Artedi) (and of copyists).
Perca pennanti Bloch, "Schrift. naturforschender Freunde, X, pl. 9, f. 1, 1782."
Anthias sacer Bloch, Ichthyologia, Taf. 375, 1792; Cuv. & Val., II, 250; Günther, I, 88, and of nearly all recent writers.
Aylopon ivicæ Guichenot, Index Generum ac Specierum Anthiadidorum, 2, 1868 (Ivica; Malta).
Aylopon hispanus Guichenot, *l. c.*, 2 (Spain).
Aylopon rissoi Guichenot, *l. c.*, 3 (Nice).
Aylopon nicæensis Guichenot, *l. c.*, 4 (Nice).
Aylopon canariensis Guichenot, *l. c.*, 5 (Canaries; Madeiras).
Aylopon algeriensis Guichenot, *l. c.*, 5 (Algiers).

Habitat.—Coasts of southern Europe and northern Africa.

Etymology.—'Ανθίας, ancient name of some large fish.

This handsome fish is rather common in waters of moderate depth in southern Europe. The specimens before us were collected by Professor Doderlein at Palermo, in Sicily.

The nominal species of Guichenot are based on slightly differing proportions of parts of the head and body, characters too trivial to merit notice from naturalists.

Genus XXV.—ODONTANTHIAS.

Odontanthias Bleeker, Sur les Espèces Indo-Archip. d'Odontanthias, etc., 1872, 1,* (*borbonius*).

TYPE.—*Anthias borbonius* Günther.

Etymology.—ὀδούς, tooth; *Anthias*, a related genus.

This genus contains three East Indian species and the following from America. As compared with *Anthias*, it seems to differ in no important respect, except in the presence of a band of small teeth on the tongue.

Allied to *Odontanthias* is the genus *Holanthias* Günther (*H. fronticinctus* Gthr., from St. Helena). In this genus the caudal fin is rounded, and none of the fin-rays are produced.

ANALYSIS OF AMERICAN SPECIES OF ODONTANTHIAS.

a. Dorsal rays X, 15.

b. Third dorsal spine higher than any succeeding ones; ventral fins scarcely elongate, shorter than head; body oblong; head obtuse; profile almost straight, somewhat depressed in front of the eye; eyes large, scarcely equal to the interorbital area, 3 in head; maxillary broad, with five or six rows of large scales, its length $2\frac{1}{4}$ in head; mouth very oblique, the lower jaw projecting; snout 5 in head; preopercle finely serrate, with coarser teeth at the angle, which is salient; four canines in upper jaw, the outer turned forwards, the inner recurved; six other canines in the lower jaw, the middle two extending forward and outward; those on the sides recurved; no lateral canines; an oval patch of minute teeth on the tongue; third dorsal spine one-third longer than the fourth; ventrals shorter than pectorals, $1\frac{2}{3}$ in head; pectorals equal to length of head; caudal lunate, the lobes equal, scarcely exceeding the height of the head; head above and both jaws closely scaled; five or six rows of large scales on cheeks; color "golden red, little paler below, many lustrous green spots on the back; fins all unspotted and more or less yellow; upper part of head red." Head, $3\frac{1}{3}$ in length; depth, 3. D. X, 15; A. III, 7. Scales 4-35-14 .... MARTINICENSIS, 106.

bb. [Third dorsal spine not longer than those following it, the spines being graduated; ventrals extremely elongate, their filiform tips reaching nearly to base of the caudal fin; body rather elevated and compressed; the depth $2\frac{1}{4}$ in length; head 3; head short, very obtuse; eye large, longer than snout, about 3 in head; head everywhere scaly; mouth very oblique, the maxillary suddenly widening behind; proorbital narrow, half as broad as the maxillary; crown of head convex; preopercle finely serrate, with coarser teeth at the angle; tongue with an oval patch of teeth; jaws with anterior canines, and a lateral canine on the mandible; scales large; lateral line strongly arched; caudal deeply forked, the lobes half length of body; dorsal spines all graduated, the last more than twice diameter of eye; soft dorsal and anal elevated, but without exserted ray; pectoral long, reaching soft portion of anal; color red, with parallel oblique and longitudinal golden streaks; head with two oblique bands. D. X, 15; A. III, 7. Scales, 4-37-17.] (*Günther.*) .... ASPERILINGUIS, 107.

aa. [Dorsal rays X, 12 (teeth on tongue unknown), closely allied to *Anthias anthias*, but with rather stronger teeth on the preopercle, and the ventral fins longer. D. X, 12; A. III, 6.] (*Cuv. & Val.*) .... TONSOR, 108.

* "Les espèces d' *Anthias* à dents linguales, et à caudale fourchue pourraient donc être réunies comme appartenant à un type distinct sous le nom d' *Odontanthias*. L' *Anthias borbonius* Günther est de ce type et les *rhodopeplus* et *chrysostictus* y appartiennent aussi." (Bleeker.)

106. ODONTANTHIAS MARTINICENSIS.

Aylopon martinicensis Guichenot, Anthiani, Ann. Linn. Soc., vol. X, 1868 (Martinique).

Habitat.—West Indian fauna.

Etymology.—*Martinicensis*, living in Martinique.

This species is known to us only from the original type, examined by Dr. Jordan in the museum at Paris.

107. ODONTANTHIAS ASPERILINGUIS.

Anthias asperilinguis Günther, Cat. Fish. Brit. Mus., I, 89, 1859 (South America).

Habitat.—"South America."

Etymology.—*Asper*, rough; *lingua*, tongue.

We know this species from the original description only. In the form of its dorsal it appears to differ widely from *Odontanthias martinicensis*, but its dentition is that of an *Odontanthias*. In the type of *Odontanthias* the third dorsal spine is produced.

108. ODONTANTHIAS (?) TONSOR.

Serranus tonsor Cuv. & Val., Hist. Nat. Poiss., II, 262, 1828 (Brazil).
Anthias tonsor Günther, I, 91, (copied).

Habitat.—Coast of Brazil.

Etymology.—*Tonsor*, a barber; from *barbier*, the French name for *Anthias*.

The scanty description of this species gives no hint as to whether it belongs to *Odontanthias* or to *Anthias*. For the present we refer it, with the other American species, to the former. If it be an *Anthias*, it should be distinguished from *A. anthias* by the fewer fin-rays, D. X, 12.

The type of this species seems to have been lost. Mr. Alexandre Thominot, assistant in the museum at Paris, has searched in vain for it, and it is not mentioned in Guichenot's paper on the species of *Anthias* in the museum.

Genus XXVI.—BATHYANTHIAS.

Bathyanthias Günther, Shore-fishes Challenger Exp., 1880, 6 (*roseus*).

TYPE.—*Bathyanthias roseus* Günther.

Etymology.—*Βᾶθύς*, deep (water); *Anthias*, an allied genus.

This genus is based on a single specimen, a small fish allied to *Pronotogrammus*, but with none of its fin-rays produced. The operculum is said to be without spine, a character rarely found among the Serranidæ.

ANALYSIS OF SPECIES OF BATHYANTHIAS.

a. [Body oblong, moderately compressed, the snout less obtuse than usual in *Anthias*; eye as long as snout, 3½ in head; interorbital area flat, narrow; maxillary scaleless, reaching middle of eye; preopercle evenly rounded, very finely serrated; no spine on opercle; anal scaly; soft dorsal naked; lateral line running very high; dorsal spine feeble, not filamentous, the third slightly longer than the rest, 3 in head, caudal subtruncate; pectorals falciform, not quite as long as head, reaching anal; ventrals half as long as pectorals. Color uniform rose-red, with two paler longitudinal streaks. Head, 3; depth, 3. D. IX, 14; A. III, 8. Scales, 2–58–18.] (*Günther.*) .... ROSEUS, 109.

109. BATHYANTHIAS ROSEUS.

Bathyanthias roseus Günther, Shore-fishes of the Challenger Exped., 1880, 6, pl. 1, f. B (off Pernambuco, "30 or 350 fathoms").

Habitat.—Coast of Brazil.

Etymology.—*Roseus*, rosy.

This species is known from a single specimen, 4½ inches long.

Genus XXVII.—CALLANTHIAS.

Callanthias Lowe, "Supplementary Synopsis Madeira Fishes, 76, 1839," and Fishes of Madeira, 13, fig. 3 (*paradisœus* = *peloritanus*).

TYPE.—*Callanthias paradisœus* Lowe = *Bodianus peloritanus* Cocco.

Etymology.—*Κάλλος*, beautiful; *Anthias*, an allied genus.

This genus differs from *Anthias* in the absence of armature on the preopercle and in the direction of the lateral line. The lateral line, especially elevated in all the members of this group, reaches the extreme in this genus, running along the highest series of fully developed scales and disappearing under the last dorsal ray.

But two species of this interesting genus are as yet known: *Callanthias peloritanus* and *Callanthias allporti* Günther, from Australia.

ANALYSIS OF EUROPEAN SPECIES OF CALLANTHIAS.

a. Body rather elongate, compressed, the outlines of the back and belly nearly parallel; anterior profile blunt; interorbital space broad and flat; supraoccipital crest high; eye large, 2¾ in head; maxillary narrow, scaly, 2¼ in head; mouth oblique, the lower jaw included; snout very short, half length of eye; teeth as in *Anthias anthias*; preorbital very narrow; preopercle entire; gill-rakers long, slender, close-set, X + 20; scales large; head everywhere scaly except on front of preorbital; lateral line ascending abruptly in front, running very close to the edge of the back, on the first row of scales; lateral line ceasing under last rays of soft dorsal, covering about 23 scales; dorsals subequal, the first two or three shorter; about the fifth soft ray of dorsal elongate, often reaching caudal; anal spines slender, graduated, the soft rays subequal; caudal deeply forked, the lobes attenuate, the upper the longer; pectorals short, 1½ in head; ventrals moderate, reaching anal. Color rose-red, paler below; throat pearly white; opercles and spot before pectoral pearly; dorsal and anal yellow, tinged with rose at base and tips; caudal scarlet, the borders and tips yellow; other fins reddish. Depth, about 3 in length; head, 3⅗. D. X (or XI), 9; A. III, 9 or 10. Scales, 38........................PELORITANUS, 110.

110. CALLANTHIAS PELORITANUS.

(*Bird-of-Paradise-fish; Imperador do Alto.*)

Bodianus peloritanus Cocco, "Giornale Sci. Sicilia, Palermo, 1829, 138" (Madeira).
Callanthias peloritanus Günther, I, 87 (Madeira).
Anthias buphthalmos Bonaparte, Faun. Ital., Pesci, about 1839.
Callanthias paradisœus Lowe, "Suppl. Syn. Mad. Fishes, 76, 1839" (Madeira); Lowe, Fishes Madeira, 13 (Madeira).

Habitat.—Mediterranean; coasts of Spain; Madeira.

Etymology.—*Peloritanus*, perhaps from *Peloris*, a genus of mollusks.

This species is known to us through the plate and very full description of Lowe, and also from a specimen (24601, M. C. Z) from Messina in the museum at Cambridge.

Note on Liopropoma and Chorististium.

Two singular genera. *Liopropoma* (*aberrans*) and *Chorististium* (*rubrum*) have been made known by Poey from single specimens of small size, taken in deep water. We have examined the type of *Chorististium rubrum.* It seems to us more nearly related to *Cheilodipterus* and other *Apogonidæ* than to any of the *Serranidæ.* We therefore omit these two genera from our account of this family. A third peculiar genus, *Gramma* Poey—also known from a single young specimen—has been referred by Bleeker and Gill to the *Pseudochromididæ*, where it may belong, although it bears some slight resemblance to the *Anthiinæ.*

Genus XXVIII.—LATES.

Lates Cuvier & Valenciennes, Hist. Nat. Poss., II, 89, 1828 (*niloticus*).
Plectropoma Bleeker (*calcarifer*, this being the first species of "*Plectropome*" originally mentioned by Cuvier; not *Plectropoma* as restricted by later writers).

TYPE.—*Perca nilotica* Gmelin.

Etymology.—*Lates* or *Latos* (λάτος), the name of the typical species with both the ancient and modern Egyptians.

This genus includes two or three species, fishes of very large size, found in the mouths of the Nile, Ganges, and other rivers of the Old World. We have not studied any of the species of *Lates*, and it is possible that they have no real affinity with *Morone.*

ANALYSIS OF SPECIES OF LATES.

a. [Body robust, the back somewhat elevated, the anterior profile steep and nearly straight, the snout sharp, the lower jaw much projecting; maxillary broad, reaching posterior edge of pupil; serræ on preorbital retrorse; second dorsal spine short, the third longest, 1½ in head; anal spines short, the second longest, 4½ in head; pectorals and ventrals short; soft parts of vertical fins somewhat scaly. Color silver-gray, much marbled with darker in life, the markings disappearing after death. Head 3, depth, 3. D. VII-I, 12; A. III, 8. Scales 10–66–19.] (*Steindachner.*) .... NILOTICUS, 111.

111. LATES NILOTICUS.

Perca nilotica Gmelin, Syst. Nat., 1788, 1312, and of the copyists.
Lates niloticus Cuv. & Val., II, 89; Günther, I, 67; Steindachner, Fische des Senegals, 1869, 4.

Habitat.—Basins of the Nile and Senegal; a fresh-water species, entering the sea.

Etymology.—*Niloticus*, pertaining to the Nile.

We have not seen this species; our knowledge of it is chiefly drawn from the description and excellent figure of Steindachner.

Genus XXIX.—KUHLIA.

Kuhlia Gill, Proc, Ac. Nat. Sci. Phila., 1861, 48 (*ciliatus*).
Moronopsis Gill, Proc. Ac. Nat. Sci. Phila., 1863, 82 (*marginatus*).
Paradules Bleeker, Nederl. Tijdschr. v. Dierkunde, I, 257 (*marginatus* = *ciliatus*).

TYPE.—*Perca ciliata* Kuhl & van Hasselt.

Etymology.—Named for the discoverer of the typical species, which was found in the streams of Java.

This peculiar and interesting genus is represented by three East Indian species, well described by Bleeker in his paper "Sur le genre *Moronopsis*," besides the two following.

The relations of the genus have been much in doubt. From the resemblance of the species to those of *Xenichthys* and *Xenistius*, Dr. Gill has concluded that it has sparoid affinities, and has placed it near the *Xenichthyinæ*.

But *Kuhlia* has a very narrow and serrated preorbital not at all sheathing the maxillary, its ventrals are destitute of the axillary scale, and the opercle has two strong spines. All these are characters of the *Serranidæ* and not found in the *Sparidæ*. We therefore place *Kuhlia* in the former family. Among the genera of *Serranidæ* it seems to be nearest *Morone*, as the synonym *Moronopsis* would also indicate. In technical characters it agrees with the group we have called *Latinæ;* but, as we have already stated, we are not sure that *Lates* and *Morone* are not representatives each of a different subfamily. In this case *Kuhlia* would represent still another.

ANALYSIS OF AMERICAN SPECIES OF KUHLIA.

a. Eye rather small, 3⅗ in head; body rather deep and compressed, the anterior profile straight or slightly concave; depth 2⅘ in length; head 3⅘, maxillary 2⅘ in head, reaching front of pupil; gill-rakers slender, X + 21; pectorals 1⅗ in head; ventrals 1⅗; fifth (longest) dorsal spine 1⅘. D. IX, I, 11, A, III, 11. Scales, 7–51–12. L. 6 inches. Bluish above; sides bright silvery; caudal fin cream-colored with two oblique black bars on each lobe, these convergent backwards; an oblique black bar upward and backward across soft dorsal; fins otherwise pale ...... ARGE, 112.

aa. Eye very large, 2⅗ in head; body deep, compressed; depth 2⅘ in length; head 3½; maxillary barely reaching front of pupil; gill-rakers long and slender, 9 + 24; pectorals 2¼ in head; ventrals scarcely reaching vent; longest dorsal spine 1½ in head. D. IX, I, 11; A. III, 11. Scales, 51. Color olivaceous above, silvery below; caudal fin plain .... XENURA, 113.

112. KUHLIA ARGE.

Kuhlia arge Jordan & Bollman, Proc. U. S. Nat. Mus., 1889 (Chatham Island, Galapagos Archipelago).

Habitat.—Galapagos Islands; Revillagigedos.

Etymology.—ἄργυρος, silver.

This species was first known from several specimens taken by the *Albatross* at Chatham Island. It has since been taken in great abundance by Dr. Gilbert about Clarion Island. It is very close to *K. tæniura*, of the waters of Java, Sumatra, and Buro, but the latter species has the eye larger, 2⅗ to 3 in head. Comparing our specimens with the full description of the latter species given by Dr. Bleeker, we are able to detect no other difference, and it is very likely that our species will prove to be a variety of *K. tæniura*.

113. KUHLIA XENURA.

Xenichthys xenurus Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 454 (supposed to come from San Salvador).

Kuhlia xenura Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 376 (locality questioned).

Habitat.—Probably San Salvador; possibly China.

Etymology.—ξένος, strange; οὐρά, tail, the tail being more deeply forked than in *Xenichthys*.

Of this species two specimens are in the U. S. National Museum, bearing the label "San Salvador. J. M. Dow." But for certain reasons it is uncertain whether they belonged to Dow's collection, and they may have been brought by Dr. Stimpson from

China. Until the species is again found—either in China or in Central America—its habitat must remain uncertain. The discovery of a species of *Kuhlia* on the west coast of tropical America renders it more likely that *K. xenura* is an American fish.

Genus XXX.—MORONE.

Morone Mitchill, Fishes of New York, 18, 1814 (*rufa=americana*).
Morone Gill, Proc. Ac. Nat. Sci. Phila., 1860, 111 (*americana*).

TYPE.—*Morone rufa* Mitchill=*Perca americana* Gmelin.

Etymology.—Unexplained.

This genus or subgenus contains two known species, both American.

ANALYSIS OF SPECIES OF MORONE.

COMMON CHARACTERS: Lower margin of preopercle simply serrate or entire, the serræ not greatly increasing in size toward the angle, and none of them developed as antrorse hooks. Base of tongue without teeth; edge of tongue with linear patches of teeth; dorsal fins more or less connected by membrane; second anal spine much enlarged, not shorter than third; anal rays III, 8 or 9; lower margin of preopercle finely serrate; lower jaw slightly projecting; body not elongate; vertebræ 11 + 14 = 25 (*americana*).

a. Color in life brassy yellow, with about seven very distinct longitudinal black lines, those below the lateral line interrupted posteriorly, the posterior part alternating with the anterior; body oblong-ovate, the back much arched; head depressed, the snout somewhat pointed, the anterior profile concave; eye large, as long as snout, 4½ in head; preorbital finely serrate; suprascapula serrate; mouth small, somewhat oblique, the maxillary nearly reaching middle of orbit, about 3 in head; maxillary somewhat scaly; gill-rakers moderate, x + 13; dorsal and anal spines very robust, the longest dorsal spine 1⅔ in head, the longest anal spine 2½; dorsal fins slightly connected. Head, 3 in length; depth, 2⅔. D. IX, I, 12; A. III, 9. scales, 50 .... INTERRUPTA, 114.

aa. Color olivaceous, varying to dark green; sides silvery or olivaceous, with faint, paler streaks; body oblong-ovate, the back elevated, but less so than in the preceding; head depressed above eyes; the snout rather pointed; mouth small, the maxillary not reaching middle of orbit, 2⅔ in head; preorbital entire; eye moderate, scarcely as long as snout, 4 in head; gill-rakers 4 + 14, rather long; dorsal and anal spines moderate, the longest dorsal spine 2 in head; the second anal spine 2½; dorsal fins considerably connected. Head, 3 in length; depth, 3. D. IX, I, 12; A. III, 8 or III, 9. Scales, 8–50–9 .... AMERICANA, 115.

114. MORONE INTERRUPTA.

(THE YELLOW BASS.)

Labrax chrysops Girard, Pacific Railroad Expl., 29, pl. XI, figs. 1–4, 1859 (St. Louis; New Orleans) (not of Rafinesque).

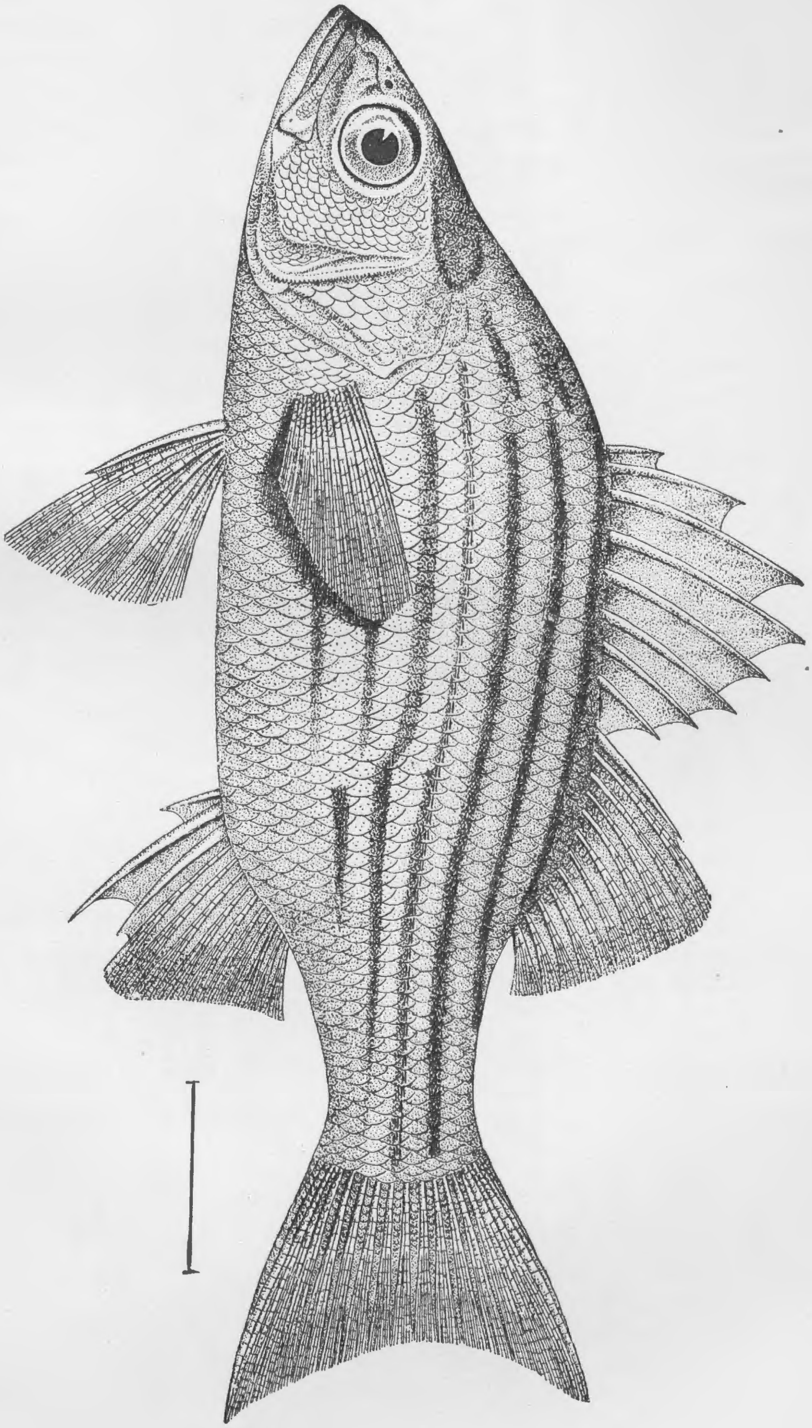
Morone interrupta Gill, Proc. Acad. Nat. Sci. Phila., 1860, 118 (St. Louis; New Orleans); Jordan, Annals N. Y. Ac. Sci., IV, No. 4, 97, 1876 (Miss. R.); Gill, Ichth. Rep. Capt. Simpson's Sur. Great Basin Utah, 398, 1876; Jordan & Brayton, Bull. U. S. Nat. Mus., 1878, 83 (Ohio and Illinois Rs.); Jordan & Gilbert, Syn. Fishes N. A., 530, 1883; Nelson, Bull. Ills. Mus. Nat. Hist., 1876, 36; Jordan, Fishes Ills., 1877, 44 (Illinois R.; Mackinaw Creek; Cairo, Ills.); Jordan, Man. Vert. E. U. S., 137, 1888.

Roccus interruptus Jordan, Geol. Sur. Ohio, 956, 1882; Jordan, Nat. Hist. Aquat. Ans., 431, 1884 (not *Perca mitchilli interrupta* Mitchill = *Roccus lineatus*).

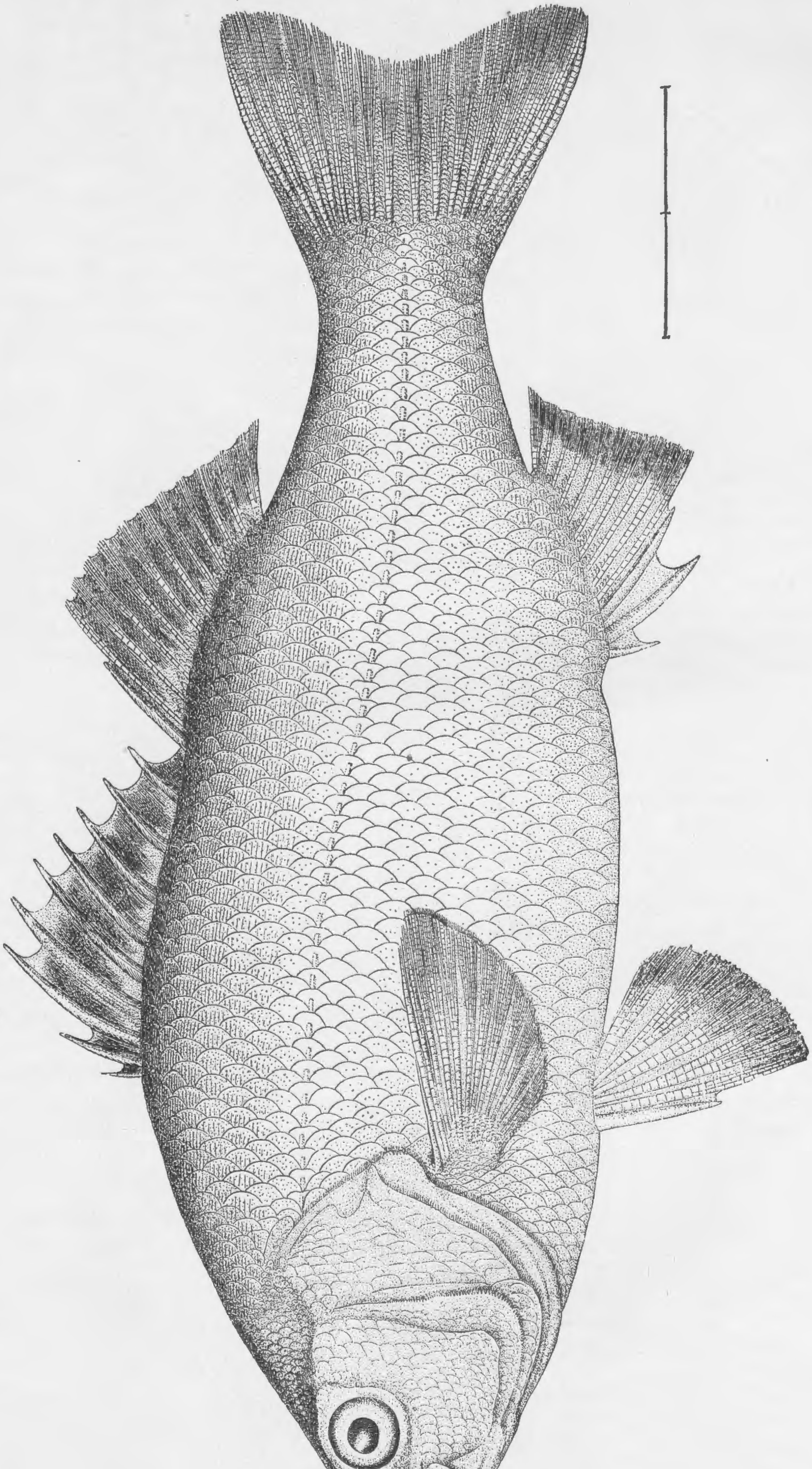
Morone mississippiensis Jordan & Eigenmann, Proc. Ac. Nat. Sci. Phila., 1887 (substitute name for *interrupta*, regarded as preoccupied).

Habitat.—Lower Mississippi Valley, north to Cincinnati and St. Louis, chiefly in the channels of the larger streams.

Etymology.—*Mississippiensis*, pertaining to the Mississippi.



MORONE INTERRUPTA Gill. The Yellow Bass.
(No. 3467, U. S. National Museum; from Saint Louis, Missouri.)



MORONE AMERICANA (Gmelin). The White Perch.

(No. 15681, U. S. National Museum; from New York City.)

The Yellow Bass is rather common in river channels and ponds in the southern part of the basin of the Mississippi. It reaches a length of about a foot, and is considered a good food-fish. Our specimens are from St. Louis and from the White Water River, at Brookville, Indiana.

As the name *interrupta* was given by Mitchill to a variety of *Roccus lineatus*, a species of the same genus *Morone*, as then understood by us, the name *Morone interrupta* given to this species by Gill was replaced by a later name, *mississippiensis*. If, however, *Morone* and *Roccus* are regarded as distinct genera, the name *interrupta* is tenable for a species of the former group.

115. MORONE AMERICANA.

(THE WHITE PERCH; WHITE SEA-BASS.)

The River Perch of New York Schœpf, Schrift. der Gesells., nat. Freunde, VIII, 159, 1788 (New York).
Perca americana Gmelin, Syst. Nat., I, III, 1308, 1788 (after Schœpf.) (and of the various copyists).
Labrax americanus Holbrook, Ichth. S. C., ed. 1, 21, pl. 3, f. 2, 1856 (Charleston).
Morone americana Gill, Ichth. Rep. Capt. Simpson's Sur. Great Basin Utah, 397, 1876; Jordan, Annals N. Y. Ac. Sci., IV, No. 4, 97, 1876 (east-coast streams); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 380 (New and Neuse Rs., N. C.).
Roccus americanus Gill, Proc. U. S. Nat. Mus., 1883, 366; Goode, Nat. Hist. Aquat. Anim., IV, 31, 1884.
Perca immaculata Walbaum, Artedi Genera Piscium, 330, 1788.
Morone rufa Mitchill, Rep. Fishes N. Y., 18, 1814 (New York).
Bodianus rufus Mitchill, Trans. Lit. and Phil. Soc. N. Y., I, 420, 1815 (New York).
Labrax rufus De Kay, Nat. Hist. N. Y., Fishes, 9, pl. 3, f. 7, 1842 (New York); Storer, Syn. Fishes N. Am., 22, 1846; Günther, I, 65, 1859 (Boston; New York).
Perca mucronata Rafinesque, Am. Month. Mag. and Crit. Rev., II, 205.
Labrax mucronatus Cuv. & Val., Hist. Nat. des Poissons, II, 86, pl. 121, 1828; Storer, Rep. Ichth. Mass., 8, 1839 (Boston and vicinity); Ayres, Boston Journ. Nat. Hist., IV, 257, 1842 (Setauket, Greenport, and Riverhead, Long Island); Baird, Rep. Fishes N. J. Coast, 8, 1854 (Cape May County, N. J.; Sing Sing, N. Y.; Croton R., N. Y.; Potomac R.).
Labrax nigricans De Kay, Nat. Hist. N. Y., Fishes, 12, pl. 50, f. 160, 1842 (Long Island); Storer, Syn. Fishes N. Am., 1846.
Morone pallida Mitchill, Rep. Fishes N. Y., 18, 1814 (New York).
Bodianus pallidus Mitchill, Trans. Lit. and Phil. Soc. N. Y., I, 420, 1815 (New York).
Labrax pallidus De Kay, Nat. Hist. N. Y. Fishes, II, Pl. I, f. 2, 1842 (New York); Storer, Syn. Fishes N. Am., 22, 1846; Günther, I, 67, 1859.

Habitat.—Atlantic coast of the United States, from Nova Scotia to South Carolina, ascending streams and frequently land-locked in ponds.

Etymology.—*Americana*, American.

This species is one of the most abundant and characteristic of the brackish waters and river mouths of our Atlantic coast. It is the smallest in size of the species of *Morone*, rarely reaching a length of a foot. It is a very excellent pan-fish, and it is everywhere known on the coast as the "White Perch." Our specimens are from Wood's Holl, New York, and Washington. Those from Wood's Holl represent the variety called *nigricans*, very dark green in color, scarcely paler below, the body deeper* and the spines lower and shorter than in the common White Perch.

* Head, $3\frac{1}{3}$ in length; depth, $2\frac{3}{4}$; fourth dorsal spine, $2\frac{2}{3}$ in head; second anal spine, $3\frac{1}{3}$. A. III, 9.

Genus XXXI.—ROCCUS.

Roccus Mitchill, Fishes of New York, 25, 1814 (*striatus* = *lineatus*).
Lepibema Rafinesque, Ichthyologia Ohiensis, 23, 1820 (*chrysops*).
Roccus Gill, Proc. Ac. Nat. Sci. Phila., 1860, 111.
Lepibema Steindachner, substitute for *Morone* and *Roccus*.

TYPE.—*Roccus striatus* Mitchill = *Sciæna lineata* Bloch.

Etymology.—From the vernacular, Rock-fish.

This group contains two species, about equally allied to *Morone* and to *Dicentrarchus*.

ANALYSIS OF SPECIES OF ROCCUS.

COMMON CHARACTERS: As in *Morone* except as follows:
Base of tongue with one or two patches of teeth; anal spines graduated; dorsal fins entirely separate; anal rays, III, 11 or 12; supraoccipital crest scarcely widened above; lower jaw projecting; spines rather slender.

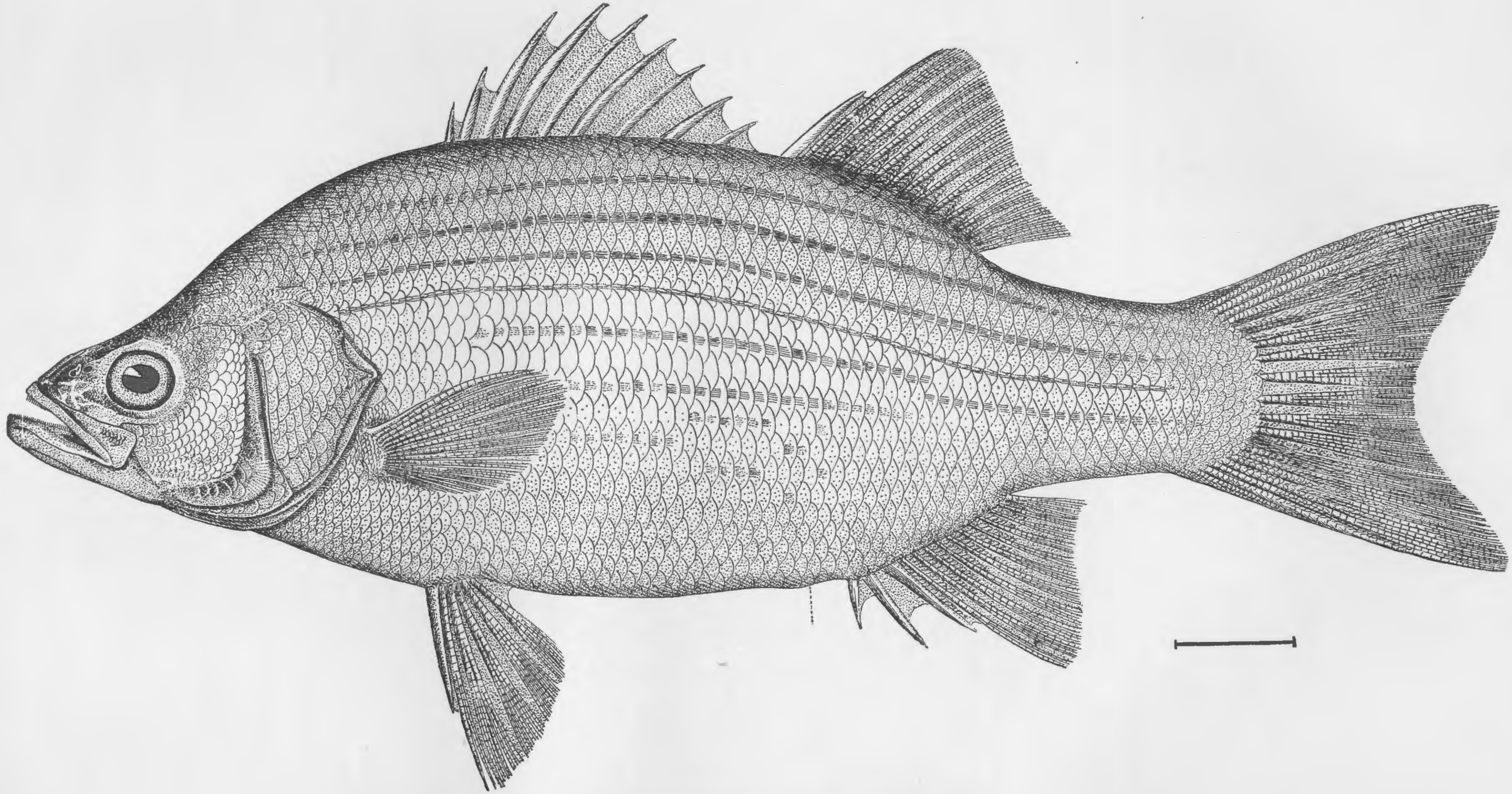
a. Teeth on base of tongue in a single series; body rather deep and compressed, the depth more than one-third the length; back considerably arched (*Lepibema* Rafinesque); head subconical, slightly depressed at the nape; mouth moderate, nearly horizontal, the lower jaw little projecting; eye large, as long as snout, about 5 in head; maxillary reaching middle of pupil, $2\frac{2}{5}$ in head; margin of subopercle with a deep notch; gill-rakers rather long and slender, x + 12; longest dorsal spine 2 in head; second anal spine 3; color silvery, tinged with golden below; sides with narrow, dusky lines, about five above the lateral line, one along it, and a variable number below it, these sometimes more or less interrupted or transposed. Head, $3\frac{1}{2}$ in length; depth, $2\frac{1}{2}$. D. IX—I, 14; A. III, 12 .... CHRYSOPS, 116.

aa. Teeth on base of tongue in two parallel patches; body rather elongate, little compressed, the depth less than one-third the length; back little arched (*Roccus* Mitchill); head subconical; mouth large, oblique, the maxillary reaching to below middle of orbit, $2\frac{1}{2}$ in head; eye about half the length of the rather sharp snout, 7 in head; margin of subopercle entire; suprascapula entire; maxillary naked; gill-rakers long and slender, 4 + 12; spines slenderer than in any other species; longest dorsal spine $2\frac{1}{2}$ in head; second anal spine 5; color olivaceous, silvery, often brassy-tinged; sides paler, marked with seven or eight continuous blackish stripes, one of them along the lateral line. Head, $3\frac{1}{3}$ in length; depth, $3\frac{1}{2}$, varying considerably with age, the young being more slender. D. IX-I, 12; A. III, 11; Scales, 8-67-11....... LINEATUS, 117.

116. ROCCUS CHRYSOPS.

(THE WHITE BASS. WHITE LAKE-BASS.

Perca chrysops Rafinesque, Ichthyologia Ohiensis, 22, 1820 (Falls of the Ohio).
Labrax chrysops Gill, Proc. Ac. Nat. Sci. Phila., 1860, 20.
Roccus chrysops Gill, Proc. Ac. Nat. Sci. Phila., 1860, 113 (Racine; Toronto; southern Illinois) (not *Labrax chrysops* Girard; not *Labrax multilineatus* Günther, I, 501); Gill, Ichth. Rep. Captain Simpson's Sur. Great Basin Utah, 391, 1876; Cope, Proc. Ac. Sci. Phila., 1865, 83 (Saginaw Bay); Milner, Rep. U. S. Fish Com., 1872-'73, 76; Jordan, Man. Vert., 1876, 226; Nelson, Bull. Ills. Mus. Nat. Hist., 1876, 36; Jordan & Copeland, Bull. Buffalo Soc. Nat. Hist., 1876, 136; Jordan, Fishes Illinois, 44, 1877 (Lake Michigan; Quincy; Henry); Jordan & Gilbert, Klippart's Rept. Fish Commissioner Ohio, 1878; Jordan, Man. Vert., Ed. II, 1878; Jordan, Geol. Sur. Ohio, 955, 1882; Jordan, Annals N. Y. Ac. Sci., IV, No. 4, 97, 1876 (Lakes Winnebago, Erie, and Michigan; Fox and Miss. Rivers); Jordan & Brayton, Bull. U. S. Nat. Mus., 1873, 83 (Ohio and Illinois Rivers.); Jordan, Nat. Hist. Aquat. Anim., 428, 1884; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1886, 12 (Washita and Saline Rivers, Arkansas).
Labrax multilineatus Cuv. & Val., Hist. Nat. des Poissons, III, 488, 1830 (Wabash River); Kirtland, Boston Journ., Nat. Hist., V, 21, pl. 7, f 1, 1845; Storer, Syn. Fishes N. Am. 22, 1846; Günther, I, 67, 1859 (Lake Erie; Ohio River).



ROCCUS CHRYSOPS (Rafinesque). The White Bass.

(No. 10326, U. S. National Museum; from Sandusky, Ohio.)

Labrax notatus (Hamilton Smith) Richardson, Fauna Boreali-Americana, III, 8, 1836; Storer, Syn. Fishes N. Am., 22, 1846; Günther, I, 67, 1859.

Labrax albidus De Kay, Nat. Hist. N. Y., Fishes, 13, pl. 51, f. 165, 1842 (Buffalo); Storer, Syn. Fishes N. Am., 23, 1846.

Labrax osculatii Filippi, Rev. et Mag. de Zoologie, 2d series, V. 164, 1853; Günther, I, 65, 1859.

Habitat.—Great Lake region, Upper Mississippi and Ohio Valleys, and northward.

Etymology.—*Χρυσός*, gold; *ωψ*, eye.

The White Bass is generally abundant in the Great Lakes, where it reaches a length of from 10 to 15 inches. In the Ohio and Mississippi Rivers it is less common, although it is frequently taken. It is more abundant northward, its southernmost limit being, so far as our collections show, the Washita River, in Arkansas. It frequents deep or still waters, seldom ascending small streams.

117. ROCCUS LINEATUS.

(STRIPED BASS; ROCK-FISH; ROCK.)

Sciæna lineata Bloch, Ichthyologia, IX, 53, pl. 305, 1792.

Labrax lineatus Cuv. & Val., Hist. Nat. des Poissons, II, 79, 1828 (New York); Richardson, Fauna Boreali-Americana, III, 10, 1836; Storer, Report Fishes of Mass., 7, 1839 (Boston and vicinity); Ayres, Boston Jour. Nat. Hist., IV, 707, 1842 (Long Island); De Kay, Zoöl. of N. Y., Fishes, 7, pl. 1, f. 3, 1842 (Long Island); Linsley, Cat. Fishes Conn.; Storer, Syn. Fishes N. Am., 21, 1846; Baird, Rep. on Fishes of N. J. Coast, 7, 1854 (Chesapeake Bay, Potomac, and Susquehanna Rivers); Holbrook, Ichth. S. C., 17, pl. 4, f. 2, 1855; Günther, I, 64, 1859.

Roccus lineatus Gill, Proc. Ac. Nat. Sci. Phila., 112, 1860; Gill, Ichth. Rep. Capt. Simpson's Sur. Great Basin Utah, 391, 1876; Jordan, Annals N. Y. Ac. Sci., IV, No. 4, 97, 1876 (Delaware and Potomac Rivers); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 380 (Beaufort, N. C., and vicinity); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 145 (Pensacola and vicinity); Goode, *op. cit.*, 115 (St. John's River, Fla.); Goode, Nat. Hist. Aquat. Ans., 425, 1884; Bollman, Proc. U. S. Nat. Mus., 1886, 465 (Escambia River).

Perca Rock-fish vel *Stricked Bass* Schœpf, Schrift. der Gesells. nat. Freunde, VIII, 160, 1788 (New York).

Perca saxatilis Walbaum, Artedi, Genera Piscium, 330, 1788 (after Schœpf).

Roccus saxatilis Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 599; Bean, Proc. U. S. Nat. Mus., 1883, 365.

Perca septentrionalis Bloch & Schneider, Systema Ichthyol., 90, pl. 70, 1801 (New York); Jordan, Proc. U. S. Nat. Mus., 1885, 72.

Roccus striatus Mitchill, Rep. Fishes N. Y., 25, 1815 (New York); Bean, Proc. U. S. Nat. Mus., 1884, 243 (Montgomery, Ala.).

Perca mitchilli Mitchill, Trans. Lit. and Phil. Soc., N. Y., I, 413, pl. 3, f. 4, 1814 (New York).

Lepibema mitchilli Rafinesque, Ichthyologia Ohiensis, 23, 1820.

Perca mitchilli interrupta Mitchill, Trans. Lit. and Phil. Soc. N. Y., 415, 1815 (New York).

Perca mitchilli alternata Mitchill, *l. c.*, 415, 1815 (New York).

Labrax schœnleini Peters, Berliner Monatsberichte, 1865, 95 (Celebes). (This is later stated by Peters to be probably identical with *Labrax lineatus*. If so, it certainly did not come from Celebes.)

Habitat.—Atlantic coasts of the United States, from New Brunswick to Pensacola, Florida, ascending all rivers in spring for the purpose of spawning. Occasional in Lake Ontario (Lewiston, Roosevelt). Introduced into California by the U. S. Fish Commission.

Etymology.—*Lineatus*, striped.

This species is one of the most important of the food-fishes of America. It is very abundant. It reaches a large size. Its flesh is excellent, and firm enough to bear transportation and exposure to the air. It reaches a weight of 30 to 40 pounds. The largest one ever reported, according to Goode, was taken at Orleans, Massachusetts, and weighed 112 pounds.

The synonymy of the species admits of little doubt. It has been thought by some, the writers among the number, that the *Sciæna lineata* of Bloch was intended for *Dicentrarchus labrax* rather than for the present species. This opinion was based on the large size of the lower serræ on the preopercle as shown in Bloch's figure.

A later recomparison has convinced us that this species is really Bloch's *lineata.* It should therefore retain the name *lineatus* rather than the later *septentrionalis.*

Our specimens of *Roccus lineatus* are from Wood's Holl, Massachusetts; New York; Washington; and Pensacola, Florida. There is no doubt of its frequent occurrence in the Escambia River near Pensacola, and that the account given by Stearns (Nat. Hist. Aquat. Anim., 425) really belongs to this species.

Genus XXXII.—DICENTRARCHUS.

Labrax Klein, Missus, V, 25, 1749 (non-binomial).

Labrax Cuvier, Règne Animal, Ed. 2, 1829 (*lupus* = *labrax*) (not *Labrax* Pallas, 1810 = *Hexagrammus* Steller.)

Dicentrarchus Gill, Proc. Ac. Nat. Sci. Phila., 1860, 111 (*elongatus* = *labrax*).

TYPE.—*Perca elongata* Geoffroy = *P. labrax* L.

Etymology.—*Δίς*, two; *κέντρον*, spine; *ἀρχός*, anus, the typical species being wrongly described as having two anal spines.

All the European and American species of the *Latinæ* (*Labracinæ*) have been usually referred to a single genus, for which the oldest binomial name is that of *Morone.* This genus was based originally on three species, erroneously supposed by Mitchill to differ from the genus *Perca* in having the ventral fins abdominal. These species are those now known as *Morone americana*, *Perca flavescens* and *Lepomis gibbosus.* The name has been newly defined by Dr. Gill and restricted to the first of these species, and according to current rules it has priority over all the other names applied to this group. The name *Labrax* is inadmissible in any event, unless the early names of Klein be admitted, because it has been previously used for a genus of fishes in another family.

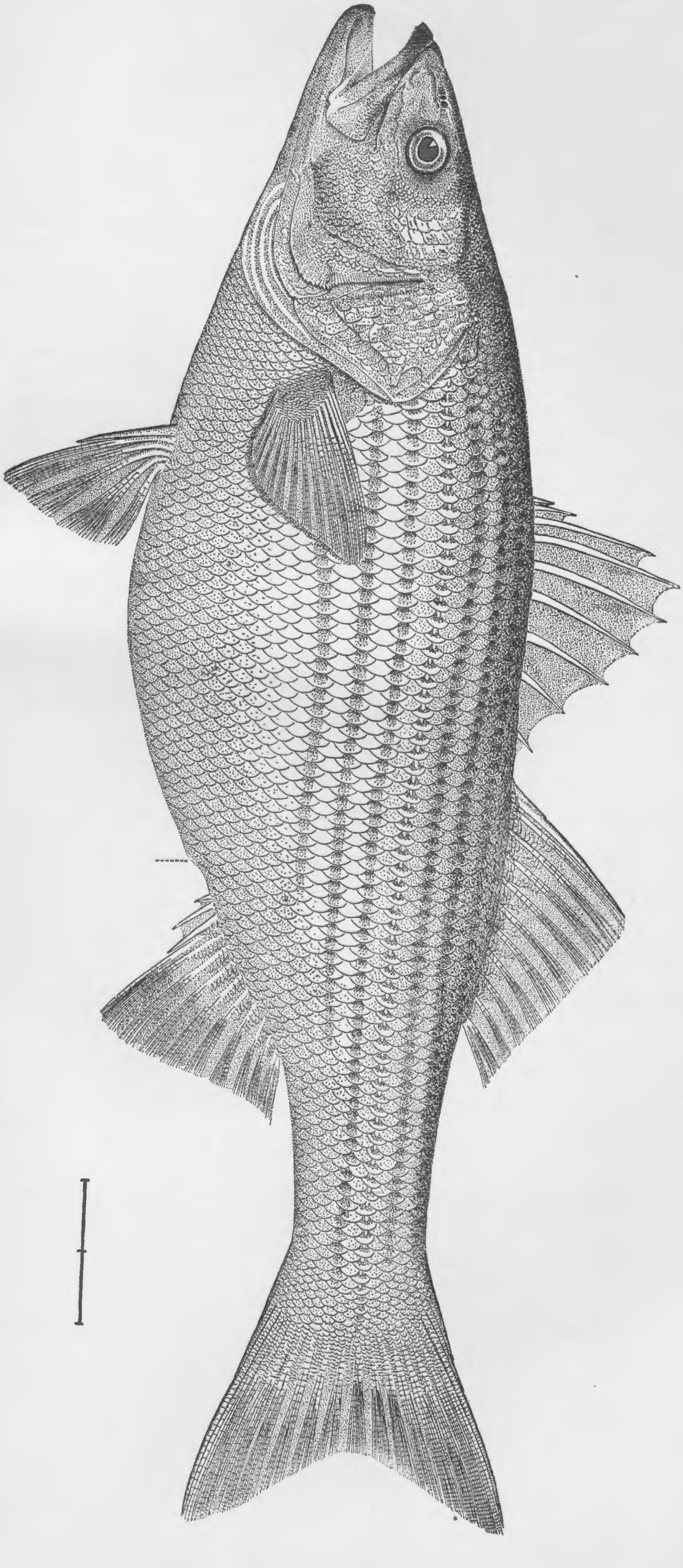
Dr. Gill has taken the three principal groups or subgenera of *Morone* (called by us *Morone*, *Roccus*, and *Dicentrarchus*) as distinct genera. These groups are readily defined, but the actual differences are small. It is most convenient, on the whole, to regard them as distinct genera, at least for the purposes of the present paper.

The laws of priority render it necessary to retain for the European species the inappropriate name of *Dicentrarchus.*

ANALYSIS OF SPECIES OF DICENTRARCHUS.

COMMON CHARACTERS: Lower margin of preopercle with about three strong antrorse spines; supraoccipital crest broadened at its upper margin with a median groove; interorbital region broader and flatter than in the preceding; teeth on tongue in three long patches, one in the middle and one on each side; dorsals separate; anal spines graduated; dorsal spines slender; lower jaw slightly projecting; body rather elongate, the depth less than one-third the length; vertebræ $12 + 13 = 25$ (*labrax*).

PLATE LXIX.



ROCCUS LINEATUS (Bloch). The Striped Bass.
(No. 25219, U. S. National Museum; from Washington, D. C.)

a. Vomerine teeth forming a simple subcrescentic transverse band (-shaped); without backward prolongation on the median line; back not arched; mouth large, oblique, the maxillary reaching to below front of pupil, 2$\frac{2}{3}$ in head; eye 1$\frac{1}{2}$ in snout, 5 to 6 in head; spines on preopercle strong, gradually increasing to angle, three or four below angle larger, directed downward and forward; gill-rakers x + 14, long and slender; longest dorsal spine 2 in head; second anal spine 5 to 6; color olivaceous, the sides silvery, with narrow silvery streaks along the rows of scales; a large dusky shade on upper posterior margin of opercle; young with numerous round dusky spots. Head 3$\frac{2}{5}$ in length; D. IX–I, 12 or 13; A. III, 11; Lat. l. 66 to 74 .... LABRAX, 118.

aa. Vomerine band of teeth with a backward prolongation on median line; back and sides with round black spots, which do not disappear with age.

b. [Vomerine band of teeth -shaped, with a very short backward prolongation on the median line; back and sides covered with small black spots; scales large. D. IX–I, 13; A. III, 11 or 12. Scales 57.] (*Günther.*) .... ORIENTALIS, 119.

bb. [Vomerine band of teeth in a nail-shaped -patch, the backward prolongation on the median line being very long; eye about 5 in head; snout sharply pointed; preopercle as in *D. labrax;* longest dorsal spine 2 in head; pectoral nearly 2; color olivaceous, with very distinct round black spots, somewhat diffuse on their edges, more or less regularly arranged, and not disappearing with age. Head 3$\frac{1}{2}$ in total length; depth about the same, D. IX-I, 13 or 14; A. III, 12. Scales 10–60–15.] (*Steindachner.*) .... PUNCTATUS, 120.

118. DICENTRARCHUS LABRAX.

(SEA BASS OF EUROPE; BASS; ROBALO; VAILA.)

Perca radiis pinnæ dorsalis secundæ 14, etc, Artedi, Genera Piscium, 41, 1734.
Perca pinnis dorsalibus distinctis, etc., Gronow, "Act. Upsal., 1750, f. 39, t. 4."
Perca labrax Linnæus, Syst. Nat. Ed. X, 1758 290 Ed. 12, 482 (after Gronow and Artedi) (and of the early authors).
Sciæna diacantha Bloch, III, tafel 302.
Labrax diacanthus Gill, Proc. Ac. Nat. Sci. Phila., 1860, 110.
Centropomus lupus Lacépède Hist. Nat. Poiss., IV, 418, 1803.
Labrax lupus Cuvier, Règne Animal, Ed. 2, 1829; Cuv. & Val., II, 56, pl. 11; Günther, I, 64, and of Steindachner, Day, and nearly all recent European writers.
Perca elongata Geoffroy St. Hilaire, "Descr. Égypte, Poiss., pl. 19, f., 1."
Labrax elongatus Cuv. & Val. II, , 77.
Dicentrarchus elongatus Gill, Proc. Ac. Nat. Sci. Phila., 1860, 111.

Habitat.—Coasts of Europe, ascending rivers, ranging from the Mediterranean northward to Norway.

Etymology.—*Λάβραξ*, the ancient name, from *λάβρος*, gluttonous, the species being called the sea-wolf, or *lupus.*

The Bass of Europe is a very good food-fish, having habits very similar to those of our Striped Bass. It reaches a weight of ten or fifteen pounds.

119. DICENTRARCHUS ORIENTALIS.

Perca punctata Geoffroy St. Hilaire, Descr. Égypte, Poiss., pl. 20, f. 2 (Egypt) (not of *Linnæus*).
Labrax orientalis Günther, Am. Mag. Nat. Hist., 1863, 174 (Alexandria).

Habitat.—Shores of Egypt.
Etymology.—*Orientalis*, Oriental.

We have not seen this species and know it from Günther's description only.

120. DICENTRARCHUS PUNCTATUS.

Sciæna punctata Bloch, Ichthyologia, V, 64, 1793, taf. 305 (not *Perca punctata* L., which is *Bodianus fulvus*).

Perca punctata Bloch & Schneider, Syst. Ichth,. 1801, 91 (not of Linnæus, nor of Gmelin, who are quoted in synonymy)

Labrax punctatas Günther, Ann. Mag., Nat. Hist., 1863, 174 (Gibraltar); Brito Capello Jorn. Sci., Math.Phys. Lisboa, II, 154, 1867 (Lisbon); Steindachner, Ichthyol. Berichte, I, 1867, 5, (Porto, Lisbon, Cadiz, Malaga, Teneriffe); Steindachner, Fisch-fauna des Senegals, 1869, 3 (St. Louis, Senegal; Gorea).

Habitat.—Mediterranean Sea and adjacent waters.

Etymology.—*Punctatus*, dotted.

We have not studied this species and we draw our knowledge of it chiefly from the accounts of Günther and Steindachner. The specific name *punctatus* may be retained in spite of the fact that the name *Perca punctata* had been earlier applied by Gmelin to *Morone labrax.* This use of the name, *Perca punctata*, by Gmelin is evidently the result of a misprint. By some means the original description of *Perca punctata* L. has been left out, as also the name of the species next in order, *Perca labrax* L. By this means the name *Perca punctata* is left to stand over the description belonging to the other fish.

Genus XXXIII.--PERCICHTHYS.*

Percichthys Girard, Proc. Ac. Nat. Sci., 1854, 197 (*chilensis*).

Percosoma Gill, Proc. Ac. Nat. Sci. Phila., 1861, 51 (*melanops*).

TYPE.—*Percichthys chilensis* Girard.

Etymology.—*Perca* (πέρκη, perch); ἰχθὺς, fish.

This genus is composed of fresh-water fishes inhabiting the rivers of Chili. We have studied but one of the species, and are not quite certain of the relations of the genus. Its external characters are similar to those of the *Latinæ*, though the general form of the body is remarkably like that of *Perca.* The following analysis of the species is chiefly a compilation, and it will probably be found of little value.

ANALYSIS OF SPECIES OF PERCICHTHYS.†

a. Branchiostegals seven; caudal peduncle long and slender, its length nearly three times its least depth; maxillary reaching to below middle of eye, $2\frac{2}{3}$ in head; snout moderately pointed, $3\frac{2}{5}$ in head; second dorsal spine $3\frac{1}{4}$ in head; second anal spine scarcely equal to eye; color olivaceous brown, more or less spotted with darker; preorbital, suborbital, mandible, and preopercle cavernous. D. XI-I, 13; A. III, 10. Scales, 9-66-16 .... TRUCHA, 121.

* The distinction of the species of this genus has been questioned by Dr. Steindachner, who says: "In den Anden entspringenden Flüsse des südlichen und mittleren Theiles von Chile und Patagonien mit mehreren (wahrscheinlich nur zwei) Arten der *Perca*-ähnlichen Gattung *Percichthys* und *Percilia* bevölkert sind." (Ichth., Beitr., VII, 24.) Peters (Berl. Monatsber., 1866, 708) takes a very different view. He says: "Im Allgemeinen kann man wohl sagen dass Chile arm an Süsswasserfischen ist, indessen ist ihre Zahl doch weit betrachtlicher als man bisher geglaubt hat. Im Werk von Gay ist von Percoiden die einzige *Perca trucha* aufgeführt, welche Girard in der United States Naval Astronomical Expedition als *Percilia chilensis* genauer beschreibt und abbildet. Derselbe fügt aus dieser Familie *Percichthys melanops* und *Percichthys gillissii* hinzu. Zwei andre Arten dieser Familie habe ich als *Perca pocha* und *P. segethi* beschrieben, und kann jetzt noch eine zweite Art *Percilia* hinzufügen so dass mir jetzt anstatt einer Percoidee deren sechs aus den Flüssen Chiles bekannt sind, ich glaube aber, dass es noch mehrere Arten *Percichthys* gibt."

† We are unable to find the description of *Perca pocha* and *Perca segethi* Peters, species of this group described by Professor Peters from Chili.

aa. Branchiostegals, 6; bones of lower part of head still more cavernous; caudal peduncle shorter and deeper.

c. [Caudal peduncle moderately long; opercular spine strong; maxillary reaching just past front of pupil; snout long, blunt in profile; soft dorsal and anal high, much higher than spinous part; second dorsal spine highest, about $2\frac{1}{4}$ in head; second anal spine longer than third; color yellowish brown, covered all over with small spots, one occupying the base of each scale. Head $2\frac{1}{3}$ in length; depth, $3\frac{2}{5}$. D. IX–I, 11; A. III, 9. Scales, about 65.] (*Jenyns*.) .... LÆVIS, 122.

cc. [Caudal peduncle short and thick; opercular spine small; maxillary reaching front of eye. Color whitish, minutely and densely dotted with black, the dots crowded in a blotch on the center of each scale. D. X–I, 10; A. III, 9. Scales, 10–59–22.] (*Girard*.) .... MELANOPS, 123.

121. PERCICHTHYS TRUCHA.

(TRUCHA OF CHILI.)

Perca trucha Cuv. & Val., IX, 429, 1833 (Rio Negro, Patagonia); Guichenot in Gay, Historia de Chile, Zool., II, 146, pl. 16, f. 1 (Chili); Girard, Proc. Ac. Nat. Sci. Phila., 1854, 197.

Percichthys chilensis Girard, U. S. Nav. Astron. Exped., II, Zool., 231, pl. 29, f. 1–4 (Chili); Günther, I, 61, 1859.

? *Perca segethi* Peters (description not seen by us).

Habitat.—Rivers of Chili.

Etymology.—*Trucha*, the Spanish name, meaning trout (low Latin, *trutta*).

We know this species from a single specimen sent from the Museum of Comparative Zoölogy, and from others in the museum at Cambridge.

The following description is taken from specimens in the museum at Cambridge, labeled, whether correctly or not, *Percichthys trucha*. These specimens are No. 4836, M. C. Z., Santiago, Chili (ten specimens, 5 to 11 inches in length), and No. 10372, M. C. Z., Curicó, Chili (two specimens, 8 and 9 inches long). (C. H. E.)

Body oblong, deepest below first dorsal spine; maxillary reaching to below anterior half of pupil, $2\frac{4}{5}$ to 3 in head. Maxillary and mandibulary teeth in similar bands, broadest in front and tapering backwards; a few of the inner teeth in front of lower jaw slightly enlarged, the rest subequal; teeth on vomer in a triangular patch; palatine bands of teeth much longer than those on vomer, separated from the latter, and placed almost at right angles with them. Head covered with scales forward to the anterior nostril, a short linear naked area, always present, at or near the base of the supra-occipital keel. Scales on cheeks in twelve to fifteen irregular series; scales on opercle as large as those on body, in about six series. Eye large, $1\frac{2}{5}$ to $1\frac{3}{5}$ in snout, 5 to $5\frac{3}{5}$ in head; about equal to inter-orbital space. Mouth subterminal, the lower jaw slightly included. Profile straight, from tip of occipital process to premaxillary processes, then abruptly decurved.

Preorbital with strong teeth directed downward and backward, strongest in young examples, largest near posterior angle of maxillary; entire vertical margin of preopercle with fine teeth, largest below; lower margin of preopercle with larger, wider-set teeth, the anterior ones directed forward; posterior half of free edge of interopercle and lower half of subopercle with very fine teeth, which become more or less obsolete with age; opercle with a strong spine and a blunt or rounded point above it.

Gill-rakers short, chubby, about two-thirds the length of the pupil, 6 + 13; inner side of the gill-rakers covered with short, stout teeth.

Distance of first dorsal spine from tip of snout, $2\frac{3}{5}$ in length of body. First dorsal spine less than half the length of the second, the second from one-half to two-thirds length of the third spine, which is the highest, $2\frac{1}{5}$ in head, the spines decreasing in height to the ninth; the spinous and soft dorsals connected. Caudal in the young slightly emarginate; in the adult emarginate, the upper part truncate, lower rounded. First anal spine inserted under second dorsal ray, the spines graduated, the second strongest; highest ray 2 to $2\frac{1}{4}$ in head. Ventral inserted below the base of lower pectoral rays, the second divided ray longest, $2\frac{1}{5}$ to $1\frac{4}{5}$ in head. Pectoral 2 to $1\frac{4}{5}$ in head.

Scales of body of about uniform size, becoming very much smaller on breast and top of head. Scales strongly ctenoid on sides, becoming cycloid on head.

Small scales on the caudal membrane at its basal third. Anal and dorsal without scales.

Color olivaceous yellow, with peppery black dots, aggregated in spots on the back; the scales along base of dorsal and the upper half of caudal peduncle with a brownish spot at their base, spots forming more or less regular longitudinal lines; membrane of soft dorsal with minute brownish dots, aggregated in places into rather large spots. Membrane of caudal dusky; anal with brownish dots along the middle of the membranes; pectorals and ventrals with similar, but fewer, spots. Head, $3\frac{2}{5}$ in length, to base of caudal; depth, 4 to $4\frac{2}{5}$. D. X, 11 or 12; A. III, 8 to 10. Scales, 9–66 to 67–17. (C. H. E.)

122. PERCICHTHYS LÆVIS.

Perca lævis Jenyns, Voyage of the Beagle, Fishes, I, pl. 1, 1840 (Rio Santa Cruz, Patagonia).
Percichthys lævis Günther, I, 61, 1859 (copied); Kner, Novara, Fische, I, 11 (Valparaiso).

Habitat.—Rivers of Chili.

Etymology.—*Lævis*, smooth.

This species is known to us chiefly from the figure of Jenyns and the description given by Kner.

123. PERCICHTHYS MELANOPS.

Percichthys melanops Girard, Proc. Ac. Nat. Sci. Phila., 1854, 197; Girard, U. S. Nav. Astron. Exped., II, Zool., 233, pl. 30, figs. 1-5 (Rio Maypu, Chili); Günther, I, 61, 1859 (copied).
Percosoma melanops Gill. Proc. Ac. Nat. Sci. Phila., 1860, 51 (copied).
? *Perca pocha* Peters (description not seen by us).

Habitat.—Rivers of Chili.

Etymology.—*Μέλας*, black; *ὄψις*, appearance, from the dusky coloration.

This species is known to us from descriptions only.

PERCICHTHYS POCHA.

In the museum at Cambridge are sixteen specimens from Curicó, Chili. These are from 5 to 8 inches in length and bear the label *Percichthys pocha*. The following is a description of this species. (C. H. E.)

Body ovate, deepest below first dorsal spine. Maxillary reaching scarcely to vertical from anterior margin of orbit, 3 in head. Teeth of lower jaw in a band widest near tip, and tapering to a single series behind; some of the lateral teeth longer than the others; teeth of upper jaw in a broader band, those of the sides not in a single series; teeth all about equal; teeth on vomer in a very narrow, crescent-shaped patch; those on palatines in a band much narrower and shorter than that on the vomer. Mouth oblique, the jaws subequal, the lower slightly included. Head scaled forward to the anterior nostril; scales on cheek in about eight series, those on opercle about as large as those on body, in about six series. Profile straight, from anterior margin of orbit to tip of occipital crest, rounded in front and behind. Eye $1\frac{1}{2}$ in snout, $4\frac{1}{2}$ to 5 in head; interorbital area a little wider than eye. Preorbital minutely serrated, the serræ weaker than in *P. trucha*. Preopercle with minute teeth on its vertical border, the teeth near the angle sometimes very much enlarged, sometimes little enlarged, more numerous than in *P. trucha*; serration of the subopercle and preopercle scarcely visible; opercular spine placed higher than in *P. trucha*, its tip sometimes incompletely two or three parted; a bluntish projection on opercle above the spine. Gill-rakers very short, about equal to one-third diameter of eye, 6 + 11. Distance of first dorsal spine from snout $1\frac{3}{7}$ to $1\frac{4}{7}$ in length. Height of dorsal spines variable, the first always less than half as long as the second, the third or fourth dorsal spine highest, 2 to 3 in head, the spines decreasing in height to the ninth; spinous and soft dorsal connected. Caudal truncate when spread out, emarginate when closed. Anal inserted below the beginning of the soft dorsal, its spines graduated, the second thickest; highest ray about half as long as the head; ventral $1\frac{6}{7}$ in head; pectoral $1\frac{1}{2}$ to $1\frac{6}{7}$ in head.

Scales on the body of about equal size, less strongly ctenoid than in *P. trucha*, reduced on breast and head. Lateral line much more strongly curved than in *P. trucha*.

Color brownish, golden-yellow below, everywhere with brownish dots; those on the lower half of the body scattered with usually a light (blue ?) center, a dusky spot at the base of each scale on the sides; all the fins dusky, with reddish brown dots; those on the base of the soft dorsal sometimes aggregated into spots. Head, 3 to $3\frac{1}{4}$ in length to base of caudal; *depth* 3 *to* $3\frac{1}{4}$. D. X, 11 or 12; A. III, 9 or 10. Scales, 10 or 11–54 to 58–19 or 20.

This species must be very close to the one called *Percichthys melanops*, if not identical with it.

Genus XXXIV.—PERCILIA.

Percilia Girard, Proc. Ac. Nat. Sci. Phila., 1854, 197 (*gillissi*).

TYPE.—*Percilia gillissi.*

Etymology.—Percilia, a diminutive of *Perca.*

This genus contains a single species in the rivers of Chili. We know it only through imperfect descriptions, and we are not sure that it is really an ally of *Percichthys*. None of the species are in the Museum at Cambridge.

ANALYSIS OF SPECIES OF PERCILIA.

a. [First dorsal with nine spines; snout short and rounded; maxillary reaching front of eye; branchiostegals 5 or 6; teeth small, conical; operculum without spines; a few minute spines along edge of preopercle. Color brownish, spotted with black. D. IX–I, 10; A. III, 8. Lat. l., 35.] (*Girard.*) GILLISSI, 124.

aa. [First dorsal with seven spines; anterior profile evenly and rather strongly curved; back regularly and more gently arched; eye 3½ in head; forehead scaleless; lateral line abruptly bent below second dorsal. Head, 4½ in length with caudal; depth, 5½. D. VII, I, 10; A. III, 7. Scales, large, rough. Color, grayish above, paler below, becoming yellowish anteriorly.] (*Peters.*) GRACILIS, 125.

124. PERCILIA GILLISSII.

Percilia gillissii Girard, Proc. Ac. Nat. Sci. Phila., VII, 1854, 197 (Rio de Maypu, Chili); Girard, U. S. Nav. Astron. Exped., Zool., 235 (Rio de Maypu); Günther, I, 255, 1859 (copied).

Habitat.—Rivers of Chili.

Etymology.—Named for Lieutenant Gilliss, of the U. S. Naval Astronomical Expedition.

This species is known to us from the scanty original description only.

125. PERCILIA GRACILIS.

Percilia gracilis Peters, Berliner Monatsberichte, 1866, 708 (Rio Reine, Santiago de Chili).

Habitat.—Rivers of Chili.

Etymology.—*Gracilis*, slender.

This species is known from Dr. Peters's description only. It is probably identical with *Percilia gillissii.*

REVIEW OF THE SERRANIDÆ.

RECAPITULATION.

The following is a list of the species of *Serranidæ* recognized by us as occurring in the waters of America and Europe. The distribution in general of each species is indicated by the use of the following letters:

E. Europe.
I. Islands of Eastern Atlantic: Azores, etc.
N. Atlantic coast, north of Cape Hatteras.
S. South Atlantic and Gulf coast.
B. Bassalian Fauna of Atlantic.
W. West Indies.
C. California.
P. Pacific coast of Mexico and Central America.
F. Rivers of North America.
B. Coasts of Brazil.
T. Patagonia, east coast.
A. Rivers of South America, Amazon.
V. Pacific coast of South America.

Subfamily I.—RYPTICINÆ.

Genus I.—RYPTICUS Cuvier.

§ PROMICROPTERUS Gill.

1. *Rypticus bistrispinus* (Mitchill). S.
2. *Rypticus nigripinnis* (Gill). P.

§ RYPTICUS.

3. *Rypticus xanti* (Gill). P. (Perhaps identical with the next.)
4. *Rypticus bicolor* (Valenciennes). V.
5. *Rypticus saponaceus* (Bloch & Schneider). W, S, I, B.
6. *Rypticus arenatus* (Cuv. & Val.) B, W.
7. *Rypticus coriaceus* (Cope). W.
8. *Rypticus nigromaculatus* (Steindachner). W. (Probably a variation of *R. arenatus.*)

Subfamily II.—EPINEPHELINÆ.

Genus II.—POLYPRION Cuvier.

9. *Polyprion cernium* Cuvier. E, A, I, B.
10. *Polyprion oxygeneios* (Bloch & Schneider). V. (Possibly to be called *P. americanus.*)

Genus III.—STEREOLEPIS Ayres.

11. *Stereolepis gigas* Ayres. C.

Genus IV.—HEMILUTJANUS Bleeker.

12. *Hemilutjanus macropthalmos* (Tschudi). V.
13. *Hemilutjanus paytensis* (Lesson). V. (Doubtful species, uncertain as to genus.)

Genus V.—GONIOPLECTRUS Gill.

14. *Gonioplectrus hispanus* (Cuv. & Val.) W.

Genus VI.—GILBERTIA Jordan.

15. *Gilbertia semicincta* (Cuv. & Val.) V.

Genus VII.—ACANTHISTIUS Gill.

16. *Acanthistius brasilianus* (Cuv. & Val.). B.
17. *Acanthistius patachonicus* (Jenyns.) T.

Genus VIII.—ALPHESTES Bloch & Schneider.

18. *Alphestes multiguttatus* (Günther.) P.
19. *Alphestes afer* (Bloch.) W, B.
20. *Alphestes ? pictus* (Tschudi.) V. (Species doubtful.)

Genus IX.—EPINEPHELUS (Bloch.) W, B.

§ EPINEPHELUS.

21. *Epinephelus analogus* (Gill). P.
22. *Epinephelus adscensionis* (Osbeck). S, W, B, I.
23. *Epinephelus catus* (Cuv. & Val.). S, W, B.
24. *Epinephelus drummond-hayi* (Goode & Bean). S, W.
25. *Epinephelus labriformis* (Jenyns). P.
26. *Epinephelus striatus* (Bloch). S, W, B.
27. *Epinephelus niveatus* (Cuv. & Val.). S, W, B.
28. *Epinephelus flavolimbatus* (Poey). S, W.
29. *Epinephelus aspersus* Jenyns. I. (Doubtful species.)
30. *Epinephelus goreensis* (Cuv. & Val.). I.
31. *Epinephelus chrysotænia* (Doderlein). E.
32. *Epinephelus caninus* (Valenciennes). I, E.
33. *Epinephelus alexandrinus* (Cuv. & Val.). E.
34. *Epinephelus æneus* (St. Hilaire). E.

35. *Epinephelus gigas* (Brünnich). E, I, B.
36. *Epinephelus mystacinus* (Poey). W.
37. *Epinephelus morio* (Cuv. & Val.). S, W, B.

§ GARRUPA Jordan.

38. *Epinephelus nigritus* (Holbrook). S.
39. *Epinephelus merus* (Poey). W, B, E. (Probably identical with the preceding.)

Genus X.—PROMICROPS Gill.

40. *Promicrops guttatus* (Linnæus). S, W, B.

Genus XI.—MYCTEROPERCA Gill.

§ MYCTEROPERCA.

41. *Mycteroperca olfax* (Jenyns). V.
    ruberrima Jordan. V.
42. *Mycteroperca rosacea* (Streets). P.
43. *Mycteroperca falcata* Poey. W.
    phenax Jordan & Swain. S.
44. *Mycteroperca calliura* Poey. W.
45. *Mycteroperca tigris* (Cuv. & Val.). W.
    camelopardalis. Poey. W.

§ TRISOTROPIS Gill.

46. *Mycteroperca venenosa* (Linnæus). S, W, B.
    apua (Bloch). S, W, B.
47. *Mycteroperca bonaci* (Poey). S, W, B.
    xanthostiota Jordan & Swain. S.
48. *Mycteroperca jordani* (Jenkins & Evermann). P.
49. *Mycteroperca microlepis* (Goode & Bean). S.
50. *Mycteroperca interstitialis* (Poey). W. (Synonymy rather doubtful.)
51. *Mycteroperca dimidiata* (Poey). W.
52. *Mycteroperca xenarcha* Jordan. V.

§ PAREPINEPHELUS Bleeker.

53. *Mycteroperca rubra* (Bloch). (Possibly includes two species, *ruber* and *acutirostris*.)

Genus XII.—DERMATOLEPIS Gill.

54. *Dermatolepis angustifrons* (Steindachner). W. (Doubtful species, of uncertain relations.)
55. *Dermatolepis inermis* (Cuv. & Val.). W.
56. *Dermatolepis punctatus* Gill. P.

Genus XIII.—BODIANUS Bloch.

§ PETROMETOPON Gill.

57. *Bodianus panamensis* (Steindachner). P.
58. *Bodianus cruentatus* (Lacépède). S, W, B.
    coronatus (Cuv. & Val.). S, W, B.

§ ENNEACENTRUS Gill.

59. *Bodianus tæniops* (Cuv. & Val.). S.
60. *Bodianus fulvus* (Linnæus). S, W, B.
    ruber (Bloch). S, W, B.
    punctatus (Linnæus). S, W, B.

§ MENEPHORUS Poey.

61. *Bodianus dubius* (Poey). W.

Genus XIV.—PARANTHIAS.

62. *Paranthias furcifer* (Cuv. & Val.). W, P.

Subfamily III.—SERRANINÆ.

Genus XV.—HYPOPLECTRUS Gill.

63. *Hypoplectrus lamprurus* Jordan & Gilbert. P.
64. *Hypoplectrus puella* Cuv. & Val. W.
    vitulinus Poey. W.
    pinnivarius Poey. W.
    maculiferus Poey. W.
    guttavarius Poey. W.
    gummigutta Poey. W.
    aberrans Poey. W.
    accensus Poey. W.
    affinis Poey. W.
    chlorurus Cuv. & Val. W.
    nigricans Poey. W, S.
    indigo Poey. W.
    bovinus Poey. W.
65. *Hypoplectrus crocotus* (Cope). W. (Doubtful species.)
66. *Hypoplectrus gemma* Goode & Bean. S. (Doubtful species.)

Genus XVI.—PARALABRAX Girard.

67. *Paralabrax nebulifer* Girard. C.
68. *Paralabrax maculatofasciatus* (Steindachner). C, P.
69. *Paralabrax albomaculatus* (Jenyns). V, P.
70. *Paralabrax humeralis* (Cuv. &. Val.). V.
71. *Paralabrax clathratus* Girard. C.

Genus XVII.—CENTROPRISTIS Cuvier.

§ CENTROPRISTIS.

72. *Centopristis striatus* (Linnæus). N, S.
    atrarius L. S. (Doubtful subspecies.)
73. *Centropristis ocyurus* (Jordan & Evermann). S.

§ TRILOBURUS Gill.

74. *Centropristis philadelphicus* (Linnæus). S.

Genus XVIII.—CRATINUS Steindachner.

75. *Cratinus agassizii* Steindachner. V.

Genus XIX.—DULES Cuvier.

76. *Dules auriga* Cuv. & Val.. B.

Genus XX.—PARACENTROPRISTIS Klunzinger.

77. *Paracentropristis hepatus* (Linnæus). E.

Genus XXI.—DIPLECTRUM Holbrook.

§ DIPLECTRUM.

78. *Diplectrum formosum* (Linnæus). S, W, B.

§ HALIPERCA Gill.

79. *Diplectrum euryplectrum* (Jordan & Bollman). P
80. *Diplectrum macropoma* (Günther). P.
81. *Diplectrum radiale* Quoy & Gaimard. W, B, P.
82. *Diplectrum conceptione* Cuv. & Val. V.

Genus XXII.—SERRANUS Cuvier.

§ PRIONODES Jenyns.

83. *Serranus subligarius* (Cope). S. (Possibly not a distinct species.
84. *Serranus flaviventris* (Cuv. & Val.). W, B.
85. *Serranus annularis* (Günther). B.
86. *Serranus atrobranchus* (Cuv. & Val.). B.
87. *Serranus æquidens* Gilbert. P.
88. *Serranus fusculus* (Poey). W.
89. *Serranus phœbe* (Poey). W, S.
90. *Serranus psittacinus* (Valenciennes). P, V.
91. *Serranus tigrinus* (Bloch). W.
92. *Serranus tabacarius* (Cuv. & Val.). W.
93. *Serranus flavescens* (Cuv. & Val.). W. (Species imperfectly known.)
94. *Serranus peruanus* (Lesson). V. (Species imperfectly known.)

§ MENTIPERCA Gill.

95. *Serranus stilbostigma* Jordan & Bollman. V.
96. *Serranus castelnaui* Jordan. B. (Species imperfectly known.)
97. *Serranus luciopercanus* (Poey). W.

§ SERRANELLUS Jordan.

98. *Serranus scriba* (Linnæus). E, I.
99. *Serranus atricauda* (Günther). I.

§ SERRANUS.

100. *Serranus cabrilla* (Linnæus). E, I.

Subfamily IV.—ANTHIINÆ.

Genus XXIII.—PRONOTOGRAMMUS Gill.

§ HEMIANTHIAS Steindachner.

101. *Pronotogrammus peruanus* (Steindachner). V, P.

§ PRONOTOGRAMMUS.

102. *Pronotogrammus vivanus* (Jordan & Swain). S.
103. *Pronotogrammus eos* Gilbert. P.
104. *Pronotogrammus multifasciatus* Gill. P.

Genus XXIV.—ANTHIAS Bloch.

105. *Anthias anthias* (Linnæus). E, I.

Genus XXV.—ODONTANTHIAS Bleeker.

106. *Odontanthias martinicensis* (Guichenot). W.
107. *Odontanthias asperilinguis* (Günther). B.
108. *Odontanthias? tonsor* (Cuv. & Val.). (Species of uncertain genus.)

Genus XXVI.—BATHYANTHIAS Günther.

109. *Bathyanthias roseus* Günther. B.

Genus XXVII.—CALLANTHIAS Lowe.

110. *Callanthias peloritanus* (Cocco). E, I.

Subfamily V.—LATINÆ.

Genus XXVIII.—LATES Cuvier.

111. *Lates niloticus* (Gmelin). Nile region.

Genus XXIX.—KUHLIA Gill.

112. *Kuhlia arge* Jordan & Bollman. P.
113. *Kuhlia xenura* (Jordan & Gilbert). P.? Habitat uncertain; may be from China).

Genus XXX.—MORONE Mitchill.

114. *Morone interrupta* Gill. F.
115. *Morone americana* (Gmelin). N.

Genus XXXI.—ROCCUS Mitchill.

§ LEPIBEMA Rafinesque.

116. *Roccus chrysops* (Rafinesque). F.

§ ROCCUS.

117. *Roccus lineatus* (Bloch). N, S, F.

Genus XXXII.—DICENTRARCHUS Gill.

118. *Dicentrarchus labrax* (Linnæus). E.
119. *Dicentrarchus orientalis* (Günther). Nile region.
120. *Dicentrarchus punctatus* (Bloch). E, I.

Genus XXXIII.—PERCICHTHYS Girard.

121. *Percichthys trucha* (Cuv. & Val.) Chili.
122. *Percichthys lævis* (Jenyns). Chili.
123. *Percichthys melanops* Girard. Chili.

Genus XXXIV.—PERCILIA Girard.

124. *Percilia gillissi* Girard. Chili.
125. *Percilia gracilis* Peters. Chili.

UNIVERSITY OF INDIANA, *April* 17, 1890.

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10.—REPORT ON THE PROPOSED INTRODUCTION OF THE JAMAICA MOUNTAIN MULLET INTO THE UNITED STATES.

BY TARLETON H. BEAN.

LETTER OF TRANSMITTAL.

SIR: I inclose herewith such material as I could find bearing upon the experiment of the introduction of the Jamaica mountain mullet. These data have been gathered from various sources and, while they are not in all respects so satisfactory as they might be, they appear to me to justify the proposed acclimatization of the species, and to indicate that the transfer can be successfully and profitably made. After giving a brief differential diagnosis of the genus *Agonostoma*, contrasting it with our marine mullets, I have collated such notes on the habits and characteristics of the Jamaica species as I could find in the publications upon that island.

A general sketch of the Jamaica mountain ranges follows, and after this occur notes upon the character of the rivers, their elevation, and the temperature of the air at various heights, whenever such data were accessible.

The same kind of information has been collected from State reports, atlases, and newspapers concerning the States of North Carolina, South Carolina, and Georgia, in the alpine regions of which States, in my opinion, the experiment will be most likely to succeed. I believe that streams suitable for the undertaking may be found in all of these States, and, perhaps, in some others which contain elements of the Appalachian chain.

In North Carolina favorable results may be expected in the Yadkin, Catawba, Big Pigeon, and French Broad. In this State the Appalachian chain reaches its greatest elevation, and the mountain streams have the general character of Jamaica rivers in which the mountain mullet abounds. Brook trout are indigenous to, and abundant in, streams in the vicinity of Mount Pisgah, in Haywood County, the Big Pigeon and its tributary creeks in particular. Landlocked salmon and rainbow trout have been successfully reared in this Commonwealth. I assume that trout streams will prove suitable for the species of *Agonostoma*.

In South Carolina the Keowee and some of the mountain tributaries of the Congaree would seem to promise the best localities. In 1882 the South Carolina Fish Commission planted 166,000 salmon and some salmon trout in the waters of the State.

In the alpine region of Georgia there are streams tributary to the Tennessee, the Coosa, and the Chattahoochee which appear to be adapted to the experiment. Some of the small tributaries of the Savannah may also offer a suitable home for the species. Particular attention might be given to streams originating in the Rabun Bald and the Brasstown Bald, on the summits of which peaks arctic insects are found.

From a comparison of the data respecting the temperature, elevations, and the nature of the water-courses, it appears to me feasible to introduce the Jamaica mountain mullet into alpine streams of the Southern States above mentioned and, perhaps, into some others. It remains an open question whether or not a supply of a species of *Agonostoma* could be obtained from Mexico instead of Jamaica. If the Mexican species is accessible and sufficiently abundant, there would be the advantage of rapid transportation by rail.

Very respectfully yours,

T. H. BEAN,
Ichthyologist.

Col. MARSHALL MCDONALD,
U. S. Commissioner of Fish and Fisheries.

THE GENUS AGONOSTOMA.

(Mountain Mullet.)

The genus *Agonostoma* belongs to the mullet family and is very closely related to the marine mullets, *Mugil* spp., but its species are characterized by the presence of teeth in the jaws, by a less muscular stomach than that possessed by *Mugil*, and by their fresh-water habitat.

The number of known species is not large, but their range is extensive. They occur in the West Indies, Central America, Mexico, Mauritius, Celebes, Australia, Comoro Isles, and in New Zealand.

Agonostoma nasutum is found in the rivers of Guatemala. *A. monticola* is said to occur in Mexico as well as in numerous rivers of Jamaica. Investigation might show that it would be more convenient to obtain a supply from Mexico than from Jamaica.

Agonostoma, like *Mugil*, feeds upon soft organic materials and very small animals. The intestinal tract is very long and makes many convolutions.

AGONOSTOMA MONTICOLA.

(Mountain Mullet.)

"It is * * * known * * * as the Mountain Mullet on account, it is said, of its being entirely confined to the high water-courses; but this is not true. It is to be seen and is commonly taken by the angler even at the mouths of all our mountain streams as they mingle their waters with the ocean. * * * They are also called the Stream Mullet, on account of one of their habits, viz, swimming in the center or hugging the sides of running sweet waters. It is a very delicate fish; the flesh is remarkably sweet and white, and the roe is a most *recherché* morsel. In general it is found nearly as large as the fish itself. The Mountain Mullet seldom exceeds 10 inches in length, and weighs half a pound, and in some instances above a pound. * * * In the Yallah's, the Buff Bay, the Wag Water, and particularly the Swift and Spanish Rivers they are to be seen in this perfection of their growth. The Stream or Mountain Mullet rises readily at the fly; a black or a red tackle is generally most successful. For bait fishing the scoured earth-worm kept in damp moss, small silver prawns, and half-ripe avocado pears are the best. There are two modes of dressing them for the table. First wrap them up in a plantain leaf and put them in hot ashes and there let them remain for an hour; but the writer prefers them fried. The fine, large, delicious roes should not be treated in any other way for the *gourmet*. It is the best mode of preparing them for the table.

"The Mountain Mullet is entirely confined to the fresh water-courses, even to their final termination in the great and wide sea. As both mandibles of the Stream Mullet are full of very small teeth, some precaution is necessary in angling for them. The material (gut, as it is termed) by which the hook is attached to the line is much abraded and worn after taking a dozen or two of these fishes, and ought to be renewed."

AGONOSTOMA MICROPS?

(Hog-nose Mullet.)

A large species of *Agonostoma*, known as the Hog-nose Mullet, occurs in the Rio Grande. This is described as one of the most palatable of the species. "The length of the Hog-nose Mullet taken out of the Swift River, below the Fish Done, will often measure 23 inches and usually weighs from 2 to 4 pounds. It is designated by this name on account of the elongation or projection of the cartilage of the upper mandible considerably over the lower, ending in a blunt point, with which contrivance it turns up mud, or the fallen leaves frequently found in conglomerated heaps, etc., in search of its ordinary food.

"This fish does not rise to the fly. It is by bait alone that the skillful fisherman can hope to secure so rich, so desirable a prize. The baits most used with success are fresh red earth-worms, small silver shrimps taken out of springs and streamlets in the vicinity of rivers, half-ripe avocado pears, etc. The silver shrimps are preferable; they are the best of all baits. The hook must be attached to fine silver gimp, about 8 or 10 inches long; gut and Indian weed in common use will not answer to secure the fish, by reason of its teeth, which so fret these materials after a few struggles that they break asunder and the captive escapes. * * * This Mullet is easily scared, very sly and retired in its habits, and is rarely seen swimming to and fro like its congener."

JAMAICA MOUNTAIN RANGES.

The surface of the island is extremely mountainous and attains considerable altitudes, particularly in the eastern part, where the central range is known as the Blue Mountains. A great diversity of climate is therefore obtainable; from a tropical temperature of 80° to 86° at the sea-coast the thermometer falls to 45° and 50° on the tops of the highest mountains, and with a dryness of atmosphere that renders the climate of the mountains of Jamaica particularly delightful and suitable to the most delicate constitutions.

The midland parts of the island are of course the highest. Through the county of Surrey, and partly through Middlesex, there runs the great central chain, which trends generally in an east and west direction, the highest part of which is the Blue Mountain Peak, attainin g an elevation of 7,360 feet.

From this range subordinate ridges or spurs run northerly to the north side of the island, and southerly to the south side; these ridges in their turn are the parents of other smaller ridges, which branch off in every direction with considerable regularity and method; and they again throw off other ridges, until the whole surface of the country is cut up into a series of ridges with intervening springs or gullys.

RIVERS OF JAMAICA.

While most of the rivers have generally northerly and southerly directions, it must not be forgotten that the subordinate ridges, which are nearly at right angles to these lines, will produce subordinate streams, meeting the rivers on their eastern and western banks.

In consequence of the great elevations from which most of the rivers flow they are very rapid in their descent, and in times of flood become formidable torrents, sweeping everything before them and operating as dangerous obstructions to the traveler.

Rio Grande River, in the parish of Portland, is one of the finest rivers in the island; it flows from the northern slopes of the Blue Mountains. The Back and Stony Rivers, two of its great affluents, furnish not only some of the loftiest and most picturesque water-falls, but the wildest and most romantic country in the island.

The elevation of the western peak of the Blue Mountains is 7,360 feet.

The mean annual temperature of the air at 7,500 feet is 57.4°.

The upper districts of this region are too cold for coffee, but suitable for cinchona. Lower portions are adapted to coffee and cocoa.

Swift River, in the parish of Portland. It has the same character as the Rio Grande.

Spanish River, in the parish of Portland. It has the same character as the Rio Grande.

Buff Bay River, in the parish of Portland. It has the same character as the Rio Grande.

Agua Alta (Wag Water) River, in the parish of St. Andrew. It rises in the mountains back of Stony Hill; runs through the parishes of St. Andrew and St. Mary, debouching at Annott Bay.

The elevation of Stony Hill, where main road crosses it, is 1,360 feet.

The air temperature of Stony Hill, at an elevation of 1,425 feet, is 75°.

Yallah's River, in the parish of St. Thomas. In consequence of the great elevation from which it flows it is very rapid in its descent, and in times of flood becomes a formidable torrent.

Yallah's Hill is 2,348 feet high.

The mean annual temperature at this elevation is about 72.6°.

The *Hope River* rises in the hills around New Castle, and joins the sea at the sixth mile-stone from Kingston, on the windward road. From this river the city of Kingston is supplied with water.

Willard Nye, jr., informs me that the water at the dam, 6 miles from Kingston, is not too cold for comfortable wading.

New Castle Hospital is at an elevation of 3,800 feet. The mean annual temperature of the air at this height is 68°.

NORTH CAROLINA.

MOUNTAINS.

For 40 miles behind the flat region there extends as far as the lower falls of the rivers a belt of land of a surface moderately uneven, with a sandy soil, of which pitch-pine is the natural growth. Above the falls the surface is undulated, and still farther, beyond the Yadkin and the Catawba, is an elevated region, forming part of the great central plateau or table-land. On the border, between this State and Tennessee, is found the highest land east of the Mississippi River. The two ranges known as the Black and Smoky Mountains are the termination of the Appalachian range; and the highest peak of the first, called Black Dome, rises to a height of 6,707 feet, while the highest peak of the second attains an elevation of 6,306 feet, and is known as Roan Mountain.

RIVERS.

Among the rivers which would seem to be best adapted for the experiment with the mountain mullet are the Catawba, the Big Pigeon, and the French Broad. The latter two may have some advantage over the first, as they fall into an elevated basin in the mountains of eastern Tennessee, and mingle finally with the waters of the Gulf of Mexico. The Yadkin may also be a suitable stream for the purpose. There are many streams in western North Carolina in which the brook trout abounds, and it is highly probable that trout streams would be entirely suitable for the mountain mullet. In the American Field, beginning March 10, 1888, and continuing to the present time (April 14), is a series of articles on trout fishing in western North Carolina. The writer of these articles fished the Pigeon River, in Haywood County; also Crawford's Creek, a tributary of the Big Pigeon; Shining (or Shinning) Creek; and Hungry Creek. In Crawford's Creek and Shining Creek he found trout abundant. These streams are in the vicinity of Mount Pisgah.

Pigeon River, in this locality, is a very rocky and rapid stream. "There are long riffles, deep pools, and big overhanging rocks almost without number, and it is the very ideal of a trout stream. It would be a splendid stream for salmon, I should think, but I do not know if they could get up there from the ocean. Salmon have been planted in the lower waters of the Pigeon, but I do not think they can make the journey to the sea. Perhaps the land-locked salmon might thrive in that river, but I think the fish would die in attempting a journey up and down the Mississippi."

SOUTH CAROLINA.

"The alpine region of South Carolina occupies the extreme northwestern border of the State; commencing at King's Mountain, in York County, it extends westward throughout Spartanburgh, Greenville, Pickens, and Oconee Counties, widening in the three last named until it embraces a tier of the most northern townships, two or three deep. This wedge-shaped area has a length of 114 miles, and a width varying from 8 to 21 miles.

"The physical features of this region present a rolling table-land, broken or hilly on the margin of the streams, but scarcely anywhere inaccessible to the plow. It has a general elevation above the sea-level of 1,000 to 1,500 feet. The gently undulating surface extends to the mountains, whose rock-bound walls often rise suddenly to their greatest height.

"The boundary line of South Carolina reaches the most easterly chain of the Appalachian Mountains, known here as the Saluda Mountains, near the corner of Greenville and Spartanburgh Counties, and follows the summits of the ridge for 50 miles (30 miles in an air line), until it intersects the old Cherokee Indian boundary line. From this point the mountain chain, here called the Blue Ridge, curving a little to the north, passes out of the State, and the boundary line pursues a more southerly and a straight course to where the east branch of the Chatuga intersects the thirty-fifth degree of north latitude. The Chatuga flowing westward to its junction with the Tugaloo River, which in turn becomes the Savannah River, flowing to the southeast, are the northwestern and western boundaries of the State. The mountain chain divides the waters of the State flowing to the Atlantic Ocean from those flowing northward, which eventually find issuance to the southwest through the Tennessee and Mississippi Rivers into the Gulf of Mexico. Considering the water-shed of South Carolina alone, the culminating point whence the rivers of this section flow is to be found in the horseshoe curve of the mountain chain north of the straight boundary line referred to as uniting the Chatuga and the Blue Ridge. Hence the numerous sources of the Keowee, Whitewater, Toxaway, Jocassee, and other creeks take their rise and flow nearly due south. The main stream of the Saluda sweeps away to the east, and the Chatuga hurries westward.

"The elevation above the mean level of the sea of the following points in western South Carolina were determined by the U. S. Coast and Geodetic Survey:

"King's Mountain, 1,692 feet; Paris Mountain (near Greenville), 2,054 feet; Cæsar's Head, 3,118; Mount Pinnacle (near Pickens, the highest point in South Carolina), 3,436 feet.

"The bracing and healthy climate of this region, its beautiful scenery, the bold mountain outlines, the rich luxuriance of every growth, no stunted plant on mountain side or summit, every part, even the crevices of the rocks, covered with trees or shrubs of some kind, all full of life and vigor; the clear, soft streams that everywhere leap in a succession of cascades from crag and cliff and sparkle in their course along the narrow but fertile valleys, have made it for generations a health and pleasure resort during summer."

CLIMATE.

According to the physical charts of the Ninth United States Census, and the rain-charts of the Smithsonian Institution, second edition, 1877, this region has a mean annual temperature corresponding with that of Kansas or New Jersey. The more mountainous portions have, however, a mean annual temperature that corresponds with that of Montana, or the lower region of the Great Lakes. The mean of the hottest week in 1872, taken at 4.35, p. m., was 90° Fah. The mean of the coldest week of 1872–'73, taken at 7.35, a. m., was 25° Fah.

South Carolina springs.

Locality.	Time of observation.	Temperature.	
		Air.	Water.
		°	°
Poinsett Spring, in Greenville, near North Carolina line	June 7, 7.30 a. m.	72.050	56.86
Spring on Jones' Gap Road, near turnpike gate	June 16, 2 p. m.	75.74	57.56
Cold Spring, or Cæsar's Head	June 29, 9.30 a. m.	80.60	55.40
House Spring, Cæsar's Head	June 29, 10.30 a. m.	78.80	57.56

In 1882 the South Carolina Fish Commission released 166,000 salmon in the waters of the State, besides some salmon trout.

It seems important in this connection to call attention to the numerous lakelets or springs in the pine barrens of South Carolina which have no outlets or are believed to communicate through fissures in the limestone rock with a subterranean stream or lake many miles in extent. The water in these lakelets is of crystalline clearness with a depth of 12 to 15 feet, and abounds in all the species of fresh-water fish common to the locality, including eels and alewives. Something similar to this is observed in Jamaica.

GEORGIA.

MOUNTAINS.

"The great Appalachian chain forms by far the leading topographical feature of the long line of the Atlantic States. In its relation to this great feature Georgia has its entire northern boundary among mountain ranges extending beyond her limits into Alabama on the west and South Carolina on the east. No peak in Georgia is a mile high, Mount Enotah, in Towns County, the highest, being 4,796 feet. The most noted mountains are the Rabun Bald, Blood, Tray, Yonah, Grassy, Walker's, Lookout, and the Stone Mountain, the largest mass of solid granite in the world."

RIDGES.

"The great ridge runs from the St. Lawrence River through the Atlantic States to Cape Sable, in Florida. This ridge, of which the culminating points are mountains, passes almost centrally through Georgia. It is for three-fourths of its length the long, irregular eastern edge of the great Mississippi basin.

"The second great ridge separates the Mississippi Valley from the Gulf slope. This, the southern edge of the Mississippi basin, also passes through northern Georgia. The two ridges meet near the corner of Rabun, Towns, and White Counties.

"At this critical point a man standing with an umbrella in a shower sheds the water so that one part reaches the Atlantic near Savannah, a second part the Gulf at Apalachicola, while a third enters the Gulf below New Orleans, having passed successively through the Hiwassee, the Tennessee, Ohio, and Mississippi Rivers."

RIVERS.

"In Georgia, which partakes of three great slopes, the rivers run in all directions, southeast, southwest, west, and north. They run as from the apex of a cone."

CLIMATE.

The annual mean temperature in summer is 79.7°, which is about the same as the lowlands of Jamaica. The winter mean is about 50°. In northern Georgia the summer mean is about 75.3°, the winter mean about 42.8°. In south Georgia the annual mean is 67.7°—summer, 81.3°; winter, 53.6°. In middle Georgia the annual mean is 63.5°—summer, 79.2°; winter, 47.2°.

The mean temperature of Atlanta corresponds with that of Washington City, Louisville, and St. Louis. The extremes are seldom as great as in the Northern States, and sun-strokes are less frequent. On the whole, the range of changes in climate is very wide, from the invigorating climate of the mountain to the rather debilitating climate of the South, modified, however, by the sea-breeze.

"The mountainous parts of the State lie in one degree of latitude, north of the thirty-fourth parallel.

"The Appalachian chain enters the State with several parallel lines of elevations; the highest of these, the Blue Ridge, has an altitude of over 3,000 to nearly 5,000 feet.

"The Cohutta range continuous with the Unaka of Tennessee, 3,000 feet in altitude, with an abrupt escarpment toward Oostanaula on the west, lies about 20 miles west of the Blue Ridge.

"Next in order on the northeast comes the Lookout and Sand Mountain, table-lands belonging to the Alleghany system. Between the principal ranges of mountains here enumerated are numerous minor elevations or ridges observing a general parallelism. These decrease in height towards the southwest, and ultimately die out, the most easterly ranges disappearing first, and the others in succession. The Blue Ridge, as an unbroken chain, extends only about one-third the distance across the State, terminating abruptly. The Cohutta range continues into Alabama in a low elevation, known as Dugdown Mountain, while the table-land mountains, with their associated ridges, extend with decreasing altitudes many miles into Alabama."

DRAINAGE.

"The streams of the State flow either into the Atlantic Ocean or into the Gulf of Mexico. The divide between these water-sheds runs from the Okefinokee Swamp a northwesterly direction to Atlanta, whence it follows the Chattahoochee ridge a northeast direction to Habersham County, when it curves to the north, extending to Union County.

Of the Gulf drainage the larger part flows directly to the Gulf through the Chattahoochee and the Coosa Rivers and their tributaries, while some smaller streams near the northern line of the State belong to the Mississippi drainage system. The divide between these systems runs a zigzag course, often crossing the trend of mountains and valleys from near the northwest to the northeast corner of the State, dipping into the States of Tennessee and North Carolina at several points.

"On the summits of some of the mountain peaks, as the Rabun Bald and Brasstown Bald, arctic insects are found. Of this belt Georgia has but a bare patch, however, extending into North Carolina."

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11.—THE TRANSPLANTING OF LOBSTERS TO THE PACIFIC COAST OF THE UNITED STATES.

BY RICHARD RATHBUN.

INTRODUCTION.

This paper has been prepared chiefly for the purpose of recording in convenient form for reference the several attempts that have been made to introduce the American lobster (*Homarus americanus*) on the western coast of the United States. It seems appropriate, however, that the detailed account of the shipments should be preceded by a few general remarks.

The genuine lobsters of the North Atlantic Ocean have no true representatives on the Pacific coast of the North American continent, where the only crustacean north of Point Conception, California, now deemed worthy of commercial recognition is the large crab (*Cancer magister*). South of Point Conception we find the so-called spiny lobster, or salt-water cray-fish (*Panulirus interruptus*), which ranges southward to Mexico. This species, which is very unlike the Eastern lobster, occurs abundantly in some localities, where it is much sought for as an article of food, supplies also being sent to the San Francisco markets. The omission of the true lobster from the aquatic fauna of the Pacific coast has been considered by the inhabitants of that region a great misfortune, and while its absence causes neither suffering nor affliction, it is much desired both as an article of commerce and as an added variety to the food supply. Demands have been made upon the Government to attempt its colonization there, and the State of California has several times lent its aid in the matter, both by independent action and by co-operation with the U. S. Fish Commission. The scheme has received the approval of high authorities, and the benefits to be derived from the introduction of so useful a species is generally admitted.

Before engaging in so difficult and expensive an enterprise it is important that it should have careful consideration both as to its utility and its promises of success, and this it has received, especially since the matter was taken in hand by the General Government. Some persons not acquainted with the facts have deprecated the transplanting of the east-coast species on the assumption that the west coast already has its lobster in the *Panulirus*, already referred to. The so-called spiny lobsters, or *langoustes* of the French, form a large and conspicuous group distributed throughout the warmer parts of the globe. In the North Atlantic we have two well-known species, one inhabiting southern Europe, the other the Southern United States, the West Indies, etc. Both of these are highly prized for food, but the American species does not, in its range, overlap that of the true lobster, nor compete with the latter in any of our markets. On the Pacific coast the spiny lobster is confined to the southward of Point Conception, which to some extent marks the dividing line between a warmer and a colder fauna. The same influences (temperature mainly) which thus restrict the range of *Panulirus* to the south of Point Conception would limit the distribution of the true lobster to the north of the same point, providing its introduction on the Pacific coast was attended with success. There would be no more conflict between the two species than now occurs on the Atlantic side, but the same condition of affairs would be expected to exist. The comparison may perhaps be strengthened by imagining the extinction of the true lobster on the coasts of the Middle and New England States and the British Provinces. Its place could scarcely be filled by the Southern species.

Admitting the expediency of stocking the Pacific coast with lobsters, the question of their adaptability to that region next requires investigation. The North Atlantic and North Pacific Oceans have much in common with respect both to their physical and their biological characteristics. Identical species of fishes and marine invertebrates inhabit the northern parts of both oceans, and the number of related forms in the two regions is very great. The natural resorts of lobsters on the eastern coast, rocky, gravelly, and sandy bottoms, covered in places with kelp and rock-weed, and with an abundance of aquatic life suitable for food, occur throughout the North Pacific region from California to Alaska. Temperature, however, is probably to be regarded as the most important factor determining the fitness of the region for this new food product, and it is the only one which we can now pretend to measure although we have little data respecting it for the western coast.

On the Atlantic coast the lobster ranges from Delaware to Labrador, being most abundant between the Cape Cod region of Massachusetts and the Gulf of St. Lawrence and Newfoundland. Its bathymetrical distribution is from the littoral zone (in some localities) to depths of probably 50 and 60 fathoms, but the fishery is chiefly carried on inside of a depth of 30 fathoms. It apparently does not migrate up and down the coast to an appreciable extent, but moves off into deeper water with the approach of winter in order to escape the severe cold.

The continuous temperature observations in the possession of the Fish Commission relate mainly to the surface waters, but in the shallow areas where they were taken there is generally not much difference in this respect between the surface and the bottom. Delaware Breakwater, practically the southern point in the range of the American lobster, which occurs here only in small numbers, is located between the light-ships at Winter Quarter Shoal, Virginia, and Five Fathom Bank, New Jersey, the distance between these light-ships being about 56 miles. At the former the annual range of water temperature is from 35° to 76° Fahr., at the latter 37° to 76°, there being practically no difference between the two.* Above Five Fathom Bank light-ship, on the New Jersey coast, lobsters become somewhat more abundant on several off-shore banks, the range of temperature at Sandy Hook light-ship, just to the north of these banks, being from 33° to 74° Fahr. In Long Island Sound, where several important fishing localities exist, the range, as determined at Bartlett's Reef and Stratford Shoal light-ships, is from about 33° to 70° Fahr. The middle portion of Vine-

* In all of these records the observations for January, February, and the first part of March are omitted.

yard Sound, farther to the eastward, has the same range of temperature. The region adjacent to Block Island, the Elizabeth Islands, and Martha's Vineyard, is the most important one for lobsters south of Cape Cod, and here the range of surface temperature as observed at Brenton's Reef and Vineyard Sound light-ships is from about 32° to 69° Fahr.

At Pollock Rip light-ship, off the southern end of Cape Cod, the range is reduced to from 32° to 62° Fahr., and in the Gulf of Maine we find the same range by combining the results of observations at all stations, although in some places the maximum is only 54° Fahr.

For comparison with these observations we have continuous records for only two localities on the Pacific coast; namely, San Francisco, California, and Cape Disappointment, at the mouth of the Columbia River. At the former place the surface range is from about 51° to 61°, the bottom temperature being seldom more than a degree lower at any time; at the latter the surface temperature ranged from 40.5° to 65.75° and the bottom from about 42° to 65° The higher maximum at Cape Disappointment is due to the fact that the observations were taken in shallower water on the inner side of the cape, in the vicinity of Fort Canby; they are also limited to a period of two years, while at San Francisco the records extend through six years.

The lobsters transplanted to the Pacific coast in 1888 and 1889 were all obtained in the Vineyard Sound region, and chiefly in the vicinity of Vineyard Sound light-ship. The shipment of 1888 was mostly planted at Monterey, California, about 75 miles south of San Francisco, the balance going to the vicinity of Trinidad light-house, in the same State, about 200 miles north of San Francisco. The water temperature at Monterey is probably not very different from that at San Francisco, while Trinidad light-house is intermediate in position between San Francisco and Cape Disappointment. At both of these observing stations the records indicate ranges of temperature falling within those of the New England coast, and therefore presumably favorable to the existence of lobsters.

In order to furnish the means of readily comparing the New England water temperatures with those of northern California we have introduced a graphic chart (Plate LXX) on which the temperature curves for San Francisco and the Vineyard Sound light-ship are plotted conjointly. The description of the chart will be found at the end of this introduction. By reference to the chart it will be seen that the temperature is far more equable at San Francisco than in Vineyard Sound, having a range of only about 10° in the one case and of over 30° in the other. The yearly range at San Francisco corresponds to that in Vineyard Sound from May 20 to the last of June and from the first part of October to the middle of November, seasons during which the lobsters are on the in-shore grounds, the former being also the regular hatching season. In case lobsters become colonized on the coast of northern California it will therefore be interesting to observe if the more equable temperature of that region has any influence in bringing about a change in their customary habits. Will their off-shore migrations be less pronounced and their breeding season prolonged? Another matter which this temperature comparison suggests is as to whether the more severe cold of the Eastern winters is essential to their welfare or not. There is nothing to prove the case one way or the other, but the fact that lobsters seek shelter from the extreme cold would rather indicate that they might not suffer from its absence. An additional question of interest to the biologist concerns the effect upon the existing fauna of the introduction of the Eastern lobster upon a large scale. Will it, to any extent, disturb the general balance of life in that region, reducing the prominence of some species and perhaps aiding others in their struggle for existence? Only the future can decide this matter, but in any event the addition of the lobster to the Pacific waters could produce no harm for which the inhabitants would suffer.

An erroneous notion prevails among many persons with respect to the difficulties attending the transplanting of lobsters and the delays incidental to their introduction upon a new coast. It has indeed been a perplexing problem to determine the best methods of shipping them long distances over land, but even with that point decided, if we may so consider it, the task is still far from being accomplished. The lobster is, to the best of our knowledge, a slow-growing species, not attaining a length of 10 inches within at least five or six years from the time of leaving the egg, and by some it has been computed that the growth is even less rapid. The five hundred and sixty-five lobsters recently planted on the coasts of California and Washington can not in themselves be regarded as a direct addition to the food supply. They are only a breeding stock, and any increase in their numbers must be derived from the growth of their progeny, also taking into account the young embryos placed in the water off Monterey in 1888. The number of embryos planted by the Fish Commission was about 100,000. Supposing that they all lived, we could not at the end of five or six years have an addition of more than that number of adult lobsters in the Monterey region, and until that time there would be no additions to the original stock of breeding lobsters. At the end of the first year, or during the first breeding season following their introduction, a maximum of 1,800,000 eggs and embryos would be all that could be expected from the original lot of females planted, under the most favorable circumstances, and providing they all lived that long. Prolonging these conditions, the maximum number of eggs would not be increased from year to year before the fifth or sixth year. It is probable, however, that the original stock of adult lobsters will not keep entirely together, and some will undoubtedly become the prey of fishes. Moreover, lobster embryos are subject to great mortality, and only a very small percentage reach maturity. If at the end of six or even ten years a few thousand only compose the colony off Monterey, the experiment may be considered as successful, but when once it has been firmly established on so large a basis the annual increase will be much more rapid.

The above remarks, perhaps at the first sight discouraging to some of the promoters of the scheme of introducing this important crustacean in the Pacific Ocean, but not appearing so to the Fish Commission, have been written with a special object in view. The General Government has, at considerable expense, made several plants of breeding lobsters in excellent condition upon favorable parts of the Pacific coast. Other shipments may be made in the future, but here the power of the Government ceases, and it rests entirely with the people in whose districts the plantings have been made to give the experiment a fair trial. The grounds which the lobsters are observed to inhabit for the purposes of feeding and spawning should not, under any circumstances, be molested. The taking of lobsters purposely by any fishing method should be prohibited not simply for a specified term of years, but until there are positive indications that they have become firmly established upon the coast, and all lobsters accidentally captured should be returned to the water at once. It is incumbent upon the authorities not only to enact laws covering this matter, but also to provide that they be executed promptly and impartially. Without such co-operation on the part of those whose interests are most at stake it can not be expected that the transplanting will result successfully.

Information received from Monterey since this report was first written indicates, however, that the fishermen of that region thoroughly appreciate the necessity of protecting the lobsters to the full extent of their ability, and we feel assured that the experiment is receiving their earnest support. A few of the adult lobsters deposited there have been observed during 1889, crawling upon the bottom in shallow water, but none have been captured in any of the nets. Young lobsters, measuring about 4 inches long, have also been reported from time to time, but until specimens have been examined by some one competent to identify the species, we can not give full credence to the statements concerning them, as other kinds of crustaceans resembling small lobsters occur on the California coast.

The relative merits of the several methods of shipping live lobsters across the continent which have been followed up to the present time can best be decided after reading the accounts of the different trials given in the following pages. The subject has to be considered from at least two stand-points. While one method may insure safe transportation it may, at the same time, be too cumbersome to permit of the carrying of a sufficient number of individuals to do any good. On the other hand, any method that allows too large a percentage of loss must be uneconomical and unprofitable. The successful planting of a region must depend upon the bringing together of large colonies of individuals in favorable localities, and large cargoes must therefore be provided for.

In comparing the different shipments we are obliged to omit the first one, made in 1873, which ended in a railroad accident near the middle of the continent. On the second trial the lobsters were packed with straw and sponges in narrow box compartments, and were constantly sprinkled with sea water. Some were transferred, however, during the journey, to a large tank of sea water. Out of the one hundred and fifty lobsters with which the car started, only four survived the journey. The published accounts of the trip are too meager to explain the causes of the failure in all particulars. The packing about the lobsters in the compartments was probably too dense, and the temperature of their surroundings may have been at fault, while fresh water entered the boxes from the melting ice. The packing materials were also probably not suitable for the purpose, the straw tending rapidly to decay.

On the third trial the lobsters—twenty-two females with eggs—were carried in three large tanks of sea water, maintained at a low temperature. No record has been left us of the amount of space taken up by the tanks and by the 1,000 surplus gallons of water carried along to make changes on the way, but it must have been considerable. Only one lobster died during the journey and the remaining twenty-one were planted in the vicinity of Bonito light-house, off San Francisco. It is curious to note, however, that only female lobsters were included in this, as well as in the two former shipments, and unless some of the embryos contained in the eggs planted with them reached maturity, no breeding could subsequently have taken place.

By the time of the fourth and fifth shipments the means of transporting live fish had been greatly improved, and cars were in existence built specially for that purpose. The seasons of the year in which the shipments were made, however, were both unfavorable, but there had been no opportunity for a choice, as at other times the cars were needed for other branches of the work. The methods of packing followed proved entirely satisfactory, and the results of both trials were eminently successful. A loose packing of moist rock-weed was placed about the lobsters, which were carried in open trays, and the temperature of their surroundings was kept as nearly as possible between 42° and 45° Fahr. The shipment consisted of both males and females, and both sexes were planted in each locality. The lobsters were in excellent condition when returned to the sea, and unless some mishap shall befall them, they will probably be heard from again. In addition to the adult lobsters, 102,000 active embryos were planted off Monterey and 2,000 in San Francisco Bay.

The accounts of the five shipments are given below.

EXPLANATION OF THE CHART COMPARING THE TEMPERATURE AT SAN FRANCISCO, CALIFORNIA, AND VINEYARD SOUND, MASSACHUSETTS.

This chart represents by curved lines the average surface and bottom temperature at San Francisco, California, for six years (1878, and 1882 to 1886, inclusive) and the surface temperature at Vineyard Sound light-ship, Massachusetts, for seven years (1881 to 1887, inclusive). The San Francisco temperatures are shown by the continuous lines, the heavier line corresponding to the surface temperature and the lighter one to the bottom temperature. Only surface temperatures were taken at the Vineyard Sound light-ship, as indicated by the line composed of dashes.

The construction of the chart scarcely requires explanation. It is divided by the heavy vertical lines into ten-day periods, with the exception of one fifteen-day period at the end of the year. The interspaces between the horizontal lines represent, each, one degree Fahrenheit. The temperature curves are drawn with reference to the lighter vertical lines in the middle of each ten-day period, and are based upon the mean reductions of ten days' observations in each year. At San Francisco one observation was taken daily, so that each point with reference to which the curves are drawn represents sixty observations for the six years. In the case of Vineyard Sound light-ship, however, where two observations were taken daily for the seven years, each point is the equivalent of one hundred and forty observations.

The temperatures at Vineyard Sound light-ship for January, February, and the first part of March are omitted on account of the occasional erroneous reading of the thermometer during that period.

Vineyard Sound light-ship is anchored on the western side of the southern entrance to Vineyard Sound, Massachusetts, about 2½ miles southwest by west of Cuttyhunk Island, in a depth of 15 fathoms. The temperature observations were taken by the light-house keepers. Important lobster fisheries have been carried on in this region for many years. At San Francisco the observations were made by an observer of the Signal Service at different wharves along the bay front, as follows: Foot of Vallejo street, foot of Washington street, foot of Jackson street, and foot of Broadway, the depth of water varying from 15 to 42 feet according to the locality and the state of the tide.

FIRST TRIAL—JUNE, 1873.

The first attempt to carry live lobsters to the Pacific coast was made in June, 1873, under the supervision of Mr. Livingston Stone, and in the joint interests of the State of California and the United States. The lobsters, one hundred and sixty-two in number, formed but a small part of the shipment, which consisted of several species of fresh-water and marine fishes from the eastern side of the continent. A fruit car, furnished by the Central Pacific Railroad Company, was specially fitted up for the purpose with a large stationary fresh-water tank, a large ice chest, and the means of carrying an abundance of salt-water. The lobsters were contained in six large cases at one end of the car, but the manner of storing and caring for them is not described in Mr. Stone's report. The specimens were obtained partly at the Boston market and partly at Wood's Holl, Massachusetts. The car left Charlestown, New Hampshire, where most of the fish had been brought together for convenience of shipment, June 3.

PLATE LXX.

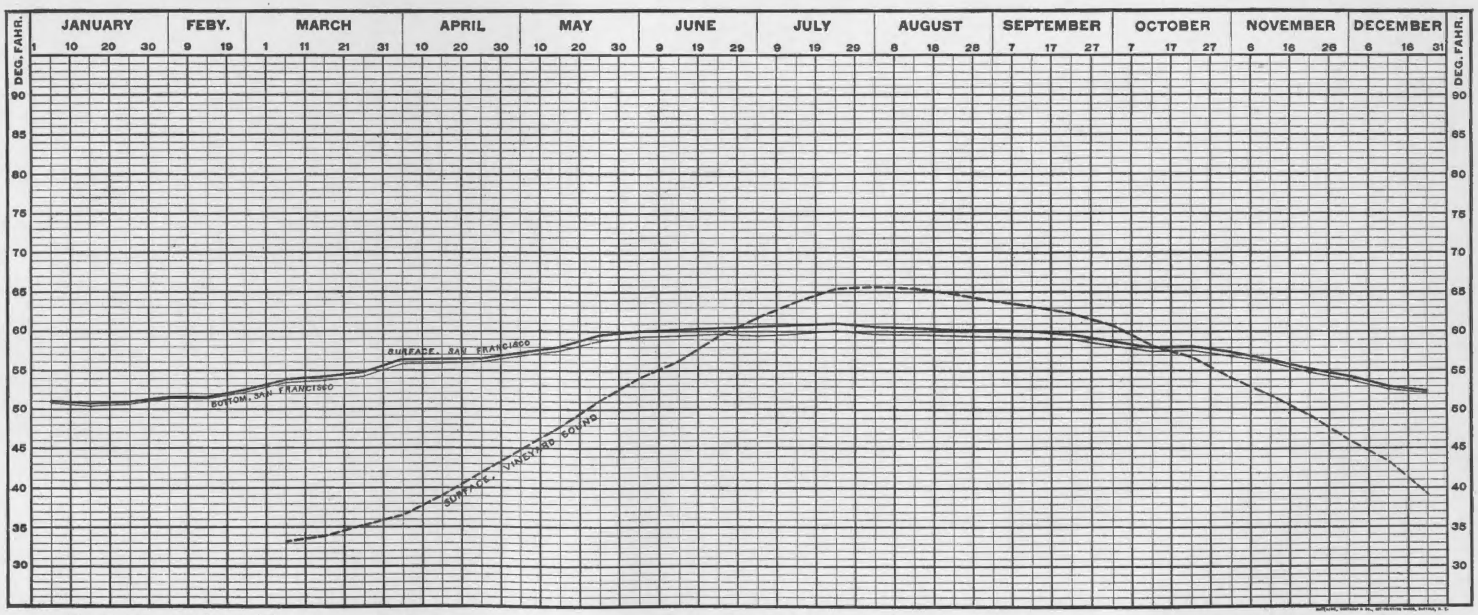
UNITED STATES COMMISSION OF FISH AND FISHERIES.

COMPARISON OF THE OCEAN TEMPERATURES

AT

SAN FRANCISCO, CAL., AND VINEYARD SOUND, MASS.

TO ACCOMPANY A REPORT ON THE TRANSPLANTING OF LOBSTERS TO THE PACIFIC COAST.



The heavier continuous line represents the average surface temperature at San Francisco, based upon daily observations for six years, 1878, and 1882 to 1886, inclusive.
The fainter continuous line represents the average bottom temperature for the same place and period.
The broken line represents the average surface temperature at the southern entrance to Vineyard Sound, based upon two observations daily during seven years, 1881 to 1887, inclusive.

Bull. U. S. F. C. 1888.—(To face page 458.) Rathbun. Transplanting of Lobsters.

It had on board 180 gallons of ocean water, but this was to be used only in part for the lobsters, there being also several other species of salt-water fish. Omaha was reached on the sixth day out, at which time only forty lobsters remained alive. Just after leaving Omaha, however, a serious accident happened to the train, and the special car with its contents was precipitated into the Elkhorn River. The first attempt, therefore, ended in misfortune, but even with the crude method of handling the lobsters which was followed, one-fourth of the total number was carried safely during a period of time which in the present days of rapid travel would have taken the car nearly to San Francisco.

SECOND TRIAL—JUNE, 1874.

The second trial took place just a year subsequent to the first one, the car leaving Charlestown, New Hampshire, June 4, 1874. This shipment was made by Mr. Stone under the sole auspices of the California State Fish Commission. As in the first instance, the consignment consisted of a number of Eastern species, from both salt and fresh water, there being one hundred and fifty specimens of lobsters, all of which were adult females, bearing eggs. Two lobsters were planted in Great Salt Lake, on the way, and only four reached San Francisco alive. The following account of the manner in which the lobsters were cared for is abstracted from the report of Mr. M. L. Perrin, assistant to Mr. Stone: *

The lobsters were obtained in Boston, of Messrs. Johnson & Young, and were shipped to Charlestown, New Hampshire, June 3, on a special car. They were packed in seven pine boxes, each of which measured 3½ feet long, 15 inches wide, and 15 inches deep. A horizontal partition divided the boxes into two compartments, an upper and a lower, making two tiers, in each of which, except one, eleven lobsters were stored, being laid directly upon the wooden bottoms, with a packing of sponges over and around them. The ocean water was transported from Boston to Charlestown in six casks, containing 149 gallons each, or 894 gallons in all. This water was obtained outside of Boston Harbor, and upon arriving at Charlestown was mostly transferred to two salt-water tanks on board the aquarium car. These tanks were made of hard wood and were smeared with a mixture of resin and tallow in order to render them water-tight. During a part of the journey they were used for salt-water fishes, and one of the original casks of sea-water was therefore carried on the car intact, to serve for the lobsters during the latter part of the journey.

In preparing for the trip to Charlestown the sponges were wet with salt-water, and then so packed around the lobsters that the latter were completely hidden. During the trip salt-water was poured upon the lobsters and the sponges were again saturated. At Charlestown, on the morning of June 4, the day of starting on the long journey, the lobsters were all repacked in twelve boxes, subdivided into twelve compartments, each of which was just large enough to admit one lobster, and about 6 inches deep. There were no covers to the boxes, and each compartment had an auger hole bored in the bottom to furnish drainage. Wet straw was laid upon the bottom under the lobsters, which were then covered with sponges as in the first instance. The boxes were stacked against the side of the car in two piles of six boxes each.

The lobsters were examined twice a day. The sponges were removed and squeezed

* Report U. S. Fish Commissioner, Part III, 1873,-'74, 1874-'75, p. 259.

out over them, and then, being soaked again with the sea-water, were arranged about them as before. Broken ice was also placed over each compartment to reduce the temperature, and pailfuls of salt-water were often poured over the boxes as they lay piled against the side of the car. No lobster died during the trip from Boston to Charlestown, but during the first two or three days after leaving the latter place a few were found dead at each examination.

June 6, sixty lobsters were put into one of the large tanks with marine fishes, the water being continually aerated by a stream of air forced through a hose, and kept at a low temperature by ice piled upon the top of the tank. The next afternoon the lid of the tank was found to have fallen in, and all the lobsters and other fish it contained were dead, but the precise cause of the mortality was not discovered.

From this time on, a large quantity of ice was kept piled upon the boxes containing the remainder of the lobsters, but the mortality was very great, being generally equal to one-third or one-half the number at each examination. On June 8, the fifth day of the trip, only twenty-five out of the one hundred and fifty with which the trip began were living. The reserve cask of 149 gallons of water was opened on this day, and they began to use the water from it instead of from the tank. June 9, the straw was taken from beneath the lobsters and they were packed entirely with sponges. This appeared to have a beneficial effect upon the few surviving specimens, and Mr. Perrin thinks that had this change not been made no lobsters would have reached San Francisco alive. June 11, when the water brought with them had become exhausted, a large supply of salt-water reached them from the Pacific coast, and gave them the means of treating the eight specimens then living with liberal doses and frequent changes. Two specimens were planted in Great Salt Lake, at Salt Lake City, and four specimens were put into the sea at Oakland Wharf, San Francisco Bay, June 12, just nine days after they had been taken from the water at Boston. These lobsters were all females and two were said to have been well supplied with spawn.

Mr. Perrin's report is full of useful suggestions, and it is interesting to note that some of the most important desiderata which he mentions in connection with his trip were supplied in the case of shipments four and five described below, and undoubtedly conduced to their successful issue. Mr. Perrin was obliged to place his ice partly inside and partly on top of the lobster crates, in order to keep the temperature sufficiently reduced, but in these positions more or less of the fresh water resulting from the melting was absorbed by the sponges, and the lobsters were not constantly surrounded by the denser salt-water, which seems to be essential to their welfare, as proved by subsequent experiences. Mr. Perrin also refers to the currents of warm air which struck the sides of the boxes, especially when the car doors were open, and made it difficult to maintain a uniform temperature. A serious mistake noted by Mr. Perrin was the subdividing of the boxes into narrow compartments, which entirely restricted the movements of the lobsters. A still more serious error, probably, was the use of straw and sponges for packing. While the latter is undoubtedly preferable to the former, in view of Mr. Perrin's experiments, it packs too closely and prevents the circulation of air, which is now deemed necessary. Had rock-weed been used upon this trip instead of sponges it is probable that the results would have been much more gratifying. It is unfortunate that we have no record of temperatures in connection with this experiment, but it probably would have been difficult to have taken reliable temperature observations in boxes exposed as these were.

THIRD TRIAL—JUNE, 1879.

The third attempt was also made under the direction and personal supervision of Mr. Stone, and was more successful than either of the preceding ones. A special car was not provided, but the specimens were carried in the ordinary baggage cars, making it necessary to transfer the lobsters at the termination of each railroad. The expedition left Albany, New York, which had been made the point of rendezvous for the different kinds of fishes, at midnight of June 12, 1879, with twenty-two female lobsters carrying about 400,000 eggs nearly ready to hatch. In fact, about 40,000 eggs hatched on the road between Boston and Albany, giving that number of embryos to be cared for on the way. In order to test the efficacy of the methods that were followed, before beginning the trip a number of lobsters were subjected, during about a fortnight previous, to practically the same conditions which they would encounter on the journey. The salt-water taken along was also obtained sometime in advance, and allowed to stand until the microscopic organisms it contained had died and they and all the other impurities had settled to the bottom. The clear water was then decanted and remained pure during the entire journey.

The lobsters were carried in three large open tanks of water, and every effort was made to keep the water clear and cold in the manner described below. This was a radical departure from the methods followed in 1873 and 1874, and although the shipment was attended with much greater proportionate success, there was this disadvantage that comparatively few lobsters could be carried in the same or in even a much greater space. Frequent changes of water were also required, necessitating the taking of a large reserve stock, the expedition starting with nearly a thousand gallons, some of which, however, was early spoiled, due to its having been stored in unclean casks.

For reducing the temperature of the water three methods were employed, as follows: (1) Putting ice and salt in large stone jugs and hanging the jugs in the tanks; (2) Putting the freezing mixture in a vessel surrounding another vessel containing the water to be cooled, this water being afterwards transferred to the tanks; (3) Filling a large earthen drain-tile with the freezing mixture and keeping it in a reserve tank of water from which the water, when sufficiently cool, could be exchanged for the warmer water in the lobster tanks. The second method described was found to work best in actual practice. Aeration was produced by dipping up the water and allowing it to fall back into the tank, this operation having to be kept up without intermission.

Respecting the temperature in the lobster tanks, Mr. Stone wrote as follows: "It was easy enough to manage the temperatures of all the tanks except those containing the lobsters; but these gave us a good deal of trouble, because they could only be cooled by exchanging the water on the lobsters with the water in the coolers, and by using the stone jugs containing the freezing mixture. On very warm days it was extremely difficult to reduce the temperature in the lobster tanks as fast as the heat of the day raised it. With great pains, however, we succeeded in preventing it from rising high enough to do any mischief." The temperature in the lobster tanks was maintained during the entire journey at between 45° and 56° Fahr., never rising above 49° on the last three days.

Only one lobster died during the trip. It was taken out at Omaha, and was found to be the same whose spawn had hatched between Boston and Albany. It was evidently not in good condition at the start. The remaining twenty-one reached the west coast alive, the trip having consumed about six days from Albany. "The lobsters were carried to Oakland Wharf by the writer," says Mr. Stone, "where they were met by a steamer chartered for the purpose, which took them to the Bonito light-house, under the shadow of which, in a sheltered bay a few miles outside the Golden Gate, I had the pleasure of placing them with my own hands—the first lobsters ever introduced into the Pacific Ocean. They were all in splendid condition except one, and had with them over a million eggs nearly ready to hatch."

EXPERIMENTS PRECEDING THE FOURTH SHIPMENT.

In accordance with instructions from Professor Baird, Capt. H. C. Chester, then superintendent of the Wood's Holl station of the Fish Commission, made a series of experiments during the spring of 1886, with the view of devising some means of transporting live lobsters long distances without the use of a large supply of sea-water. His experiments were directed mainly in one line, that of packing them in moist rock-weed, and reducing the temperature of their surroundings. It is needless to describe his experiences in detail, but the following method was found to give the most satisfactory results:

A zinc box (tin or galvanized iron would answer as well), measuring 22 inches long by 18 inches wide and 13 inches deep, was inserted in a wooden box of sufficiently large size to allow an interspace between the two all around of about 5 inches. Each of these boxes was separately drained at the bottom by means of a small pipe, and the inner one had a central opening above large enough to afford ventilation and facilitate the packing. The interspace between the boxes was completely filled with powdered ice. The lobsters were packed in the zinc box in one layer between two layers of rock-weed. The temperature was maintained as nearly as possible between 42° and 44° Fahr. The rock-weed was moistened in the beginning, and on the third, sixth, and ninth days a quart of sea water was sprinkled over it. This was all the wetting the lobsters received, but on the eleventh day, when they were removed, they were apparently in as good condition as when taken from the water. A second lot was kept in the box nine days, with only a single wetting and without injury, seeming to require only moist air for respiration when the temperature is low. The eggs adherent to the swimmerets of the female also remained that length of time in good condition.

It was Captain Chester's idea that in making a distant shipment a number of these cases should be used. The facilities for shipping offered by the special cars of the Fish Commission, however, rendered it unnecessary to make use of these somewhat complicated appliances, as explained farther on. One of the most interesting results of his experiments was the information that rock-weed could be kept fresh, by slight wetting, a long period of time, remaining as sweet and elastic as when first cut from the rocks.

FOURTH TRIAL—JUNE, 1888.

Fish Commission car No. 3, in charge of Mr. J. F. Ellis, with the Commissioner, Col. Marshall McDonald, and the writer on board, reached Wood's Holl, Massachusetts, on the afternoon of June 14, 1888, for the purpose of beginning the fourth shipment of lobsters to the California coast. The superintendent of the Fish Commission station at that place had previously been advised of the proposed shipment and was instructed to have everything in readiness. Upon our arrival we found that about nine hundred medium-sized lobsters of both sexes were being cared for in floating cars, while a large quantity of the common rock-weed (*Fucus*) had been collected from the neighboring shores. The next day being Saturday it was decided to begin the packing and loading early in the morning, in order to start the car westward before Sunday.

In car No. 3 the compartments for carrying live fish consist of two large tanks or refrigerators under the floor of the car and extending its entire length between the trucks. Access to these tanks is had through large openings in the floor, separated only by the width of the floor timbers, and furnished with trap-doors, closing them completely.

The method of shipping the lobsters, as determined by the Commissioner, was to pack them in shallow trays or crates which could easily be handled, and in which the lobsters could be examined in small lots at a time during the progress of the journey. The dimensions of the trays were regulated in part by the size of the openings to the tanks, through which they would have to be passed for storage. They were made of rough boards, and measured on the outside 22 inches long by 17 inches wide and 6 inches deep. The bottoms consisted of five or six narrow slats, separated by comparatively wide interspaces to permit of circulation and free drainage. No covers were provided. A tray of these dimensions would hold six lobsters of the average size without undue crowding, and it was estimated that one hundred of the trays could be conveniently accommodated in the car.

The packing was done at the Fish Commission wharf, whence the trays were carried by water in two lots to the railroad station, about a quarter of a mile distant, and immediately placed in the large car tanks. The lobsters were transferred from the floating cars to the trays with as short an exposure as possible to the open air, and none but active and apparently hardy individuals were selected. First a layer of the moist rock-weed of sufficient thickness to form a soft and yielding cushion was spread over the bottom of the tray, and upon this six lobsters were laid in two rows facing the ends of the trays, their backs being upward, and no precautions being taken to fasten the claws or restrain their movements. They very rarely attack one another, and to plug the claws, as was done on all or nearly all of the former shipments, causes serious injuries, from which they may not recover. Over the lobsters a second, loose layer of rock-weed was placed, but care was taken that it should not be thick enough to reach above the level of the top, in order that it might not pack solidly when the trays were piled one upon the other. No attempt was made to separate the males from the females, but an accurate record of the sexes was kept during the packing. The lobsters were not fed during the journey, and it is doubtful if they would have eaten much under the peculiar conditions of their imprisonment. The introduction of food would, moreover, have resulted in the accumulation of decayed matter among the rock-weed, doing more harm than good.

The total number of lobsters packed in the one hundred trays was 610, of which 250 were males and 360 females, eight of the latter having spawn attached to the swimmerets. In size they ranged mainly from 8 to 12 inches in length, a few only being slightly over 12 inches long. About one-half were under 10 inches long, and one-half over 10 inches. Four lobsters were also placed in a large tin pail with a small amount of rock-weed, and carried in the ice box.

In addition to the lobsters, about 150,000 loose eggs cut from the swimmerets were arranged on twelve small cloth-bottom trays, which were tied together in one package and stored in the ice-box close by the ice, being sprinkled twice daily with salt-water during the trip. The eight egg lobsters mentioned above died before reaching San Francisco, and their eggs were taken from them and added to those on the trays, making about 196,000 loose eggs that were carried across.

On the evening of June 15, the day on which the car reached Wood's Holl, a quantity of ice was placed in the carrying tanks to reduce its temperature. The first of the trays were packed in the tanks about noon on the 16th, but by that time the temperature was not as low as was desired. The second and final lot of trays was placed in the tanks about the middle of the afternoon of the same day. Fifty trays were arranged on each side of the car in piles of two and three, open spaces being left at the ends and in the middle of the tanks for the storage of ice. These spaces were completely filled with ice, and several thermometers were inserted at different places to record the temperature. The covers to the tanks were then lowered, and were only opened thereafter for the purposes of inspection or for wetting the lobsters. The tanks, however, received some ventilation from the ends, especially when the car was in motion.

The following necessary supplies were taken along: About 200 gallons of sea-water that had been filtered through raw cotton to remove all impurities. It was contained in twelve acid carboys and two large milk-cans, and remained pure to the end of the journey. A large quantity of coarse salt for making a freezing mixture with the ice, and also for preparing a brine to be used upon the lobsters in case the supply of sea-water became exhausted. The refrigerator was filled with ice before starting, and this necessary commodity had to be replenished at frequent intervals during the journey.

Mr. John Jansen, of the Fish Commission station at Wood's Holl, whose long experience in the handling of lobsters made his services invaluable in that particular, was detailed to accompany the car to San Francisco. The writer also made the journey as far as Chicago. The shipment was in charge of Mr. J. F. Ellis, assisted by Mr. R. S. Johnson and Mr. J. D. Trenholm, and to their unremitting labors is due the success of the undertaking.

All the arrangements having been completed in time, the car left Wood's Holl with the 4.10 p. m. train for Boston, where it arrived about 7.30 p. m. At Boston the car was attached to the Chicago express leaving at 9 p. m., and proceeding via the Boston and Albany, New York Central, Lake Shore and Michigan Southern Railroads. At the time of departure everything seemed auspicious, although the weather was rather warm. The lobsters had been thoroughly sprinkled with water just before leaving Wood's Holl. There appeared to be an abundance of ice in the tanks, but no salt was mixed with it, as it was thought that the temperature could be kept sufficiently low without its use. This proved to be not the case, however. The bottom of the carrying tanks being only a few inches above the bed of the railroad, which had been greatly heated during the day, was too much influenced by the temperature outside, especially as some of the superheated air entered through the ends of the tanks in the manner already explained.

The first inspection of the lobsters was made immediately after breakfast on the morning of June 17, between Syracuse and Rochester, New York. It occupied about two hours, a much longer time than had been anticipated, and the fact was soon recognized that the overhauling had been left until too late in the day, on account of the extreme heat the thermometer already recording over 80° Fahr. in the shady parts of the car. Subsequently all examinations were begun at day-break, and the tanks were never opened later in the day excepting to add water, ice, or salt.

About half a dozen trays were lifted out at a time, that being the number stored in each compartment, the rock-weed was partly removed, and each lobster was examined to ascertain its condition. The dead lobsters were removed, the rock-weed was replaced, and the trays were sprinkled with water and returned to the tanks as rapidly as possible. The water used for moistening the trays on this and all subsequent occasions was first kept in the ice-chest for several hours in order to reduce its temperature to near the freezing-point of fresh water. It was exceedingly interesting to note its revivifying effect upon the lobsters, which seemed to recognize instinctively their native element even though it was doled out to them in such small quantities. Some of the lobsters which appeared to be lifeless on a first examination were entirely restored by plunging them into the nearly ice-cold sea-water and allowing them to remain there several minutes. The wetting of the trays was done by means of an ordinary garden sprinkler, and although the precise quantity of water used on each tray was not measured, the supply was so apportioned that there was no danger of its becoming exhausted before the end of the journey. In order also that the water might reach as far as possible, the trays were generally returned to the tanks before wetting, so that the drippings from the upper ones might serve to moisten the lower ones. The two wettings a day were sufficient to maintain the rock-weed constantly moist, and it remained sweet and fresh during the entire trip.

At the first inspection, the mortality was found to be forty-five lobsters, of which twenty-two were males and twenty-three females; twenty-four were under 10 inches long and twenty-one over 10 inches,—showing that the mortality was about equally distributed with respect to sex and size. This high death-rate—between 7 and 8 per cent. of the entire number—was undoubtedly due directly to the high temperature of the tanks during the night. No salt had been used upon the ice, it being supposed that the large quantity of ice employed was sufficient to bring the temperature down to about 45°, when, in fact, it never fell below 50°, and was sometimes as high as 60°. Judging from subsequent inspections, however, it is certain that the heat alone can not be held accountable for the heavy losses which occurred from day to day. The condition of the lobsters, moreover, furnishes sufficient proof of this. All the dead lobsters taken out on the first two days were carefully examined, and there is no doubt that a large percentage of them were far advanced toward shedding, the new shell in some being fully formed and of the dark color which it assumes just before the old shell breaks away. Of the twenty-three females which died the first night fourteen also showed traces of recently hatched eggs, and it is now generally considered by naturalists that the crustacea molt soon after losing their spawn. Lobsters about to shed are always regarded by the fishermen as in poor condition for the market, as they will not stand handling. The great mortality on the present trip was therefore probably due primarily to the weak condition of the lobsters, although at the time of packing they were certainly very hardy in appearance. It would, moreover, be impossible to obtain a better supply at this season of the year, and future shipment should preferably be made in the spring or fall. Some deaths also occurred among the lobsters which were in contact with the ice or close to it, due probably to the intense cold, although the fresh water formed by the melting of the ice may have had something to do with it. However, the less hardy individuals were weeded out during the journey, and those which survived at San Francisco were in excellent condition for planting.

It was found to be injudicious to attempt the taking of frequent temperature observations in the tanks, for every time the tanks were opened the temperature was sensibly increased. Before closing them on the morning of June 17 large quantities of salt were thrown among the powdered ice. At Buffalo, which was reached about noon on the same day, the temperature was 48° in the bottom of the tanks and 65° at the top. More ice and salt were added at Buffalo and Cleveland, and the ice was broken into much finer pieces than before. At 8 p. m. the trays were again thoroughly sprinkled with water at 32°, and three dead lobsters were removed from the upper tiers.

On the morning of June 18 the second inspection was made between 4 and 6 a. m., and the mortality was found to have been greater than on the first day. The total number of dead lobsters was fifty-four, as follows: Under 10 inches long, thirty-four; 10 inches long and over, twenty; males, twenty-four; females, thirty. The condition of this lot with respect to shedding was the same as the previous one. The temperature in the bottom of the tanks had, however, been lowered to 44°, and the live lobsters remaining seemed to be in much better shape than on the day before. They were more active, and, after receiving a thorough wetting, appeared not to have suffered from the journey.

At Chicago a much larger supply of ice than usual was procured, and every large interspace between the trays was closely packed with small pieces mixed with salt. Several pieces of galvanized sheet-iron were also obtained, and being laid upon the upper trays were covered with ice and salt. The four lobsters carried in the ice-chest were still alive, although they had received only one bath of sea-water since leaving Wood's Holl, and the loose eggs on the cloth trays had apparently suffered no injury up to this time. The writer left the car at Chicago and returned to Washington.

From Chicago the car proceeded to Omaha and thence by the fast express on the Union Pacific Railroad to Oakland, California, where it arrived June 23. On the morning of June 19 only forty dead lobsters were found, and the thermometers placed in the upper trays registered 42°. From this time forward no difficulty was experienced in maintaining the temperature of the tanks at between 40° and 42°, the sheet-iron covers furnishing the means of reducing the temperature around the upper trays.

Near Rawlins, Wyoming, June 20, forty-six dead lobsters were removed, the thermometers registering 40°. When the tanks were opened, near Elko, Nevada, June 21, thirty-nine dead lobsters were found, the temperature being 42°. The car reached Sacramento in the evening of June 22, and was met there by Mr. J. D. Redding and Dr. H. M. Harkness, of San Francisco, both of whom were much interested in the success of the experiment.

The disposition of the lobsters was left to the discretion of Prof. Leslie A. Lee, naturalist, and Lieut. Commander Z. L. Tanner, U. S. Navy, commander of the Fish Commission steamer *Albatross*, then at San Francisco, who were to act in conjunction with Mr. Redding in the matter. By direction of Captain Tanner, observations were made at several places in San Francisco Bay, to determine the salinity of the water. The results reduced to 60° Fahr., according to the Hubbard table, were as follows:

Locality.	Density at surface.	Density at bottom.
One-fourth mile west of Yerba Beuna Island	1.019887	1.021487
One-fourth mile west southwest of Saucilito Wharf	1.019887	1.021487
One-eighth mile off Yellow Bluff	1.018687	1.021687
One-fourth mile south by west of Alcatraz Island	1.019887	1.021487

The average specific gravity of the water of the ocean being about 1.0274, it was decided, leaving the impurities of these localities out of consideration, that the low salinity of the water alone would not warrant the planting of the lobsters in the bay, and that some other place must be selected. The neighborhood of Monterey appeared to offer good advantages for the purpose, and the car, after going to Oakland, was, therefore, dispatched to that place, where it arrived on the evening of June 23, just seven days after leaving Wood's Holl. After leaving Elko, Nevada, fifty-five lobsters had died, making a total loss of two hundred and eighty-two lobsters during the trip. The number remaining on hand was three hundred and thirty-two, and all seemed to be in good condition. Of the 196,000 loose eggs carried on the trays, it was estimated that about 75 per cent. were also in fair shape, only those on the two or three upper trays having died.

It had been intended to place all the lobsters in floating cars for a few days' time before consigning them to the ocean, in order to make sure of their condition, but as these commodities of the Eastern fishermen were unknown in the vicinity of Monterey, none had been provided, and it was considered prudent to plant a part of the shipment without delay. On the evening of arrival, therefore, one hundred and sixty-two lobsters were taken out in a fisherman's boat and dropped into the sea, about three-fourths of a mile off shore, between Pacific Grove and Chinatown, in a depth of 12 fathoms, rocky bottom. Observations made at the same time showed the temperature of the water to be 64°, and its density about 1.025. The remaining lobsters, one hundred and seventy in number, were placed the same evening in several boxes that were floated in the bay. The next day Mr. Ellis had a car constructed, measuring 12 feet long, by 6 feet wide, and 3 feet deep, and to this the lobsters were then transferred. A second plant of ninety-five lobsters was made July 1, 1 mile off Point Lobos, to the south of Carmel Bay, in a depth of 30 fathoms, rocky bottom. Only two had died since they were taken from the railroad car, the remainder being active and feeding well. Seventy-three lobsters were, therefore, left in the car, and of these it had been arranged to send fifty of the best and most hardy by the steamer *Albatross* to the northern part of the California coast. An attempt was made to remove these from the car July 4, while it was still floating, but the lobsters were so active as to elude all efforts with the dip-net. The car was then hauled part way out on the beach, but a heavy swell carried away one of the bottom boards, and through the opening thus formed the lobsters began to beat a hasty and unceremonious retreat. Only thirty were captured, the balance making for the deeper water and getting safely away to sea. Their actions forcibly demonstrated the fact that they were in the very best condition for planting, and their escape at this place can not be regarded as a mishap, although it was somewhat tantalizing to have them assume the initiative.

The *Albatross* left San Francisco July 4, with the thirty lobsters, of which thirteen were males and seventeen females. They were planted the next day in 13 fathoms of water, 1½ miles S. ¾ W. (magnetic) from Trinidad light-house, California, (about 41° north latitude). They were all active but one. The place was selected on the recommendation of Prof. George Davidson, who considered that the conditions of the natural home of the lobster were more nearly realized here than elsewhere on the California Coast. The shore is bold and rocky, the bottom consisting of alternating kelp-covered ledges and sandy patches, and the water being very pure.

The loose eggs were transferred to hatching boxes June 24; they began hatching slowly June 28, and more rapidly July 2. Operations ceased July 7, up to which time 104,000 embryos had been obtained. They were planted in seven lots, as explained below, off Monterey, in Monterey Bay, and in San Francisco Bay, only 2,000 going to the last mentioned locality.

SUMMARY OF RESULTS.

Of the six hundred and fourteen lobsters with which the car left Wood's Holl, June 16, three hundred and thirty-two were carried through safely, two hundred and eighty-two dying on the way. After arriving at Monterey the casualties amounted to only two or three.

One hundred and sixty-two lobsters were planted June 23, directly off Pacific Grove, Monterey.

Ninety-five lobsters were planted July 1, off Point Lobos, to the south of Carmel Bay.

Forty-five lobsters escaped from the floating car, July 4, in Monterey Bay.

Thirty lobsters were planted by the steamer *Albatross*, July 5, off Trinidad light-house on the northern part of the California coast.

One hundred and ninety-six thousand loose eggs were carried across, affording 104,000 embryos, which were planted between July 1 and 7, as explained in the following table:

Deposits of lobster embryos.

Body of water.	Point of deposit.	No. planted.	Condition.	Date of deposit.
Monterey Bay	Off Monterey, California	1,000	Good	July 1.
Pacific Ocean	...do	18,000	...do	July 2.
Do	...do	20,000	...do	July 3.
San Francisco Bay	Off San Francisco, California	2,000	...do	July 4.
Pacific Ocean	Off Monterey, California	25,000	...do	July 5.
Do	...do	30,000	...do	July 6.
Monterey Bay	...do	8,000	...do	July 7.
		104,000		

This first successful large shipment of lobsters across the continent elicited many favorable comments from the press, especially in California. The desirability of making the attempt to establish this useful food species on the Pacific coast was acknowledged by all, and only a few ventured to criticise, in advance, the methods to be pursued in caring for the lobsters. It is now considered, however, that the manner of packing followed in the present case can scarcely be improved upon. The proper regulation of the temperature still presents a difficult problem for experimentation, and, as shown further on, too low a temperature is as much to be dreaded as too high a one. A solution may be found, however, by making the shipments in the spring or autumn.

THE RETURN TRIP.

Arrangements were made through Prof. Leslie A. Lee, of the steamer *Albatross*, to transport a quantity of the large edible California crab (*Cancer magister*) and also of one or more species of California clams to the Atlantic coast, the former species especially being regarded as a desirable one for introduction in New England waters. Much difficulty was experienced in procuring the crabs, as it was not then the season in which they are generally brought to market. A lot of three hundred was finally obtained, however, from one of the fishermen, but the specimens were not in good condition, having been kept too long before they were delivered at the car. They were packed in the crates from which the lobsters had been taken, the rock-weed for the packing and the sea-water for the journey having been collected at a point outside of San Francisco Bay. The car left San Francisco for the East July 14, via the Central Pacific Railroad, with a full load, as follows: Three hundred crabs, 15 bushels of clams, six California terrapin, fourteen Galapagos tortoises, and several cases of specimens obtained on a recent cruise of the steamer *Albatross*. July 15, Mr. Ellis telegraphed from Truckee California, that all the crabs except forty had died. Such a result was not unexpected, in view of their condition when received; but with this report the experiment ended, for on the next morning, at about 5 oclock, the train to which the Fish Commission car was attached was badly wrecked, some 5 miles east of Humboldt, Nevada, car No. 3 being thrown upon its side and dragged some distance. The contents of the car were scattered over the ground, and the car itself was in no condition to continue the journey. Mr. Jansen was severely injured, but the other occupants escaped with only bruises and a thorough shaking up. The Galapagos tortoises and the *Albatross* collections suffered comparatively little damage, and were subsequently brought to Washington on the same car.

THE FIFTH TRIAL—JANUARY, 1889.

The fifth and last trial so far attempted was made during January, 1889, with the same methods followed the previous summer. The destination of the shipment was the coasts of Oregon and Washington, by way of the Northern Pacific Railroad. Car No. 3 was again selected for the work, being in charge, as before, of Mr. J. F. Ellis, assisted by Mr. R. S. Johnson and Mr. Trenholm. The shipment consisted of seven hundred and ten lobsters, as follows: Males, two hundred and seventy-nine; females, with eggs, sixty-three; females without eggs, three hundred and sixty-eight. The crates were made in the same manner and of the same size as on the previous trip, an additional number being required, however, to accommodate the extra quantity of lobsters taken. The car tanks were filled to the very tops, and it is probable that they were over-crowded, preventing a sufficient circulation of air. One hundred and seventy gallons of sea-water were provided in ten carboys, and this quantity met all demands.

The packing was done at Wood's Holl, Massachusetts, January 14, and the car left at 4 p. m. the same afternoon, the thermometer registering 38° at the bottom of the tanks and 48° at the top. Leaving Boston at 9 p. m., the weather grew cold during the night, the thermometer falling to about 20°, the temperature in the tanks reaching 36° at the bottom and 42° at the top. Albany was reached at 4 a. m., January 15, and at 8 a. m. the lobsters were overhauled; this operation requiring three hours. Only two females and one male had died during the night. The temperature in the tanks during this day ranged from 37° to 40° at the bottom, and from 41° to 48° at the top.

The car left Chicago at 6.50 a. m. on the 16th, the examination of the lobsters taking place about two hours later. Eleven were found dead, seven being males and four females. The temperature in the tanks during the day varied from 37° to 47° at the bottom, and from 44° to 51° at the top. Up to this time the prospects were exceedingly encouraging, and it looked as though the trip would be made with only a very slight percentage of loss; but disappointment was ahead and it came in a manner entirely unexpected and unprovided for. The previous summer it had been necessary to fight the extreme heat, and it seemed as though the tanks could not be made too cold. On the present occasion, however, the conditions were precisely the reverse, and a very heavy mortality occurred through the low temperatures which prevailed during the middle part of the journey. In giving the temperatures observed from day to day in the tanks, it should be remembered that they are the readings of the thermometers in only a few positions, the temperature probably varying considerably in different parts of the tanks at the same time.

During the night of the 16th the weather grew colder, and some of the trays were taken from the tanks and placed on the floor of the car to warm them up. At 9.30 on the morning of the 17th the temperature of the air outside the car had fallen to 10° below zero, and at that time the trays were overhauled, with the r sult of finding fifty-five dead lobsters, thirty-seven being males and eighteen females. The trap-doors to the tanks were now left open for the purpose of raising the temperature about the trays, but with no appreciable effect. The car reached St. Paul, Minnesota, at 2 p. m. and left at 4 p. m. At 11.15 the same evening steam was turned into the pipes running through the bottom of the tanks, but the hot air instead of becoming diffused, rose to the top along certain parts of the tanks, superheating some portions and leaving others uninfluenced. A small amount of ice formed during the night on the sides of the tanks toward the wind. During the 17th the thermometer registered from 32° to 37° at the bottom and from 34° to 37° at the top of the tanks.

At 3 a. m., January 18, the temperature outside the car had fallen to 25° below zero. Steam was kept up all night and part of the day, the temperature ranging from 32° to 36° at the bottom of the tanks and from 49° to 52° at the top, this difference between the temperature at the top and bottom resulting from the steam heat. At 8 o'clock in the morning eighty-one dead lobsters were removed, forty-one being males and forty females.

January 19 the outside temperature had risen to 2° below zero, and no steam was used during the day. At 9 o'clock in the morning ninety-seven lobsters, fifty-three females and forty-four males, were found dead, and many of those still living were observed to be in poor condition. The temperature at the bottom of the tanks ranged from 34° to 38°, and at the top from 48° to 52°.

January 20 there was an abundance of snow and the weather was still cold. At

10 a. m., when the trays were overhauled, one hundred and thirteen dead lobsters were discovered, fifty-nine of this number being females and fifty-four males. The car arrived at Spokane Falls at 10.10 a. m., and remained there until 7.10 p. m. About twelve hours were also lost beyond Spokane Falls on account of damage to the railroad track. The temperature during the day ranged from 35° to 38° at the bottom, and from 44° to 47° at the top of the tanks.

January 21 the car arrived at Walla Walla Junction at 10 a. m., the weather being warmer than on the previous day. The number of dead lobsters removed was seventy-six, sixty-one being females and fifteen males. The live lobsters were here re-assorted in the trays, on an average two males and four females being placed in each, to facilitate the handling at the end of the journey. East Portland was reached at 7 p. m. Mr. R. A. Bensell was to meet the car at this place and take charge of a part of the shipment intended for Yaquina Bay, Oregon, but as he did not appear, and delay might be fatal to the balance of the stock, the car was taken on to Portland, where Mr. Johnson was left with twenty-two trays, containing one hundred and ten lobsters, as follows: thirty-two males, twenty-five females with eggs, and fifty-three females without eggs. These were planted, in part, off Cape Disappointment, at the mouth of the Columbia River, and, in part, about 7 miles farther north in Shoalwater Bay.

The car arriving at Tacoma the same day, Mr. Trenholm, together with Judge James G. Swan, who had made arrangements for the northern planting, left at 7 a. m. on the morning of the 22d with the balance of the lot for Port Townsend by steamer. From the latter place the following deposits were made the same afternoon, namely: In Scow Bay, opposite Port Townsend, twenty-four lobsters; off Point Hudson, at the entrance of Port Townsend Bay, twenty-five lobsters; off Wilson's Point, three-fourths of a mile from the light-house, near Port Townsend, seventy-four lobsters, a total of one hundred and twenty-three lobsters. The temperature of the water was 45° Fahr. According to Judge Swan, the summer temperatures in this region range from 50° to 55° Fahr. The places selected for making the plants were rocky and gravelly bottoms, covered with kelp and rock-weed, and with an abundance of animal life.

Nine females with eggs had died on the way over. Their eggs were saved and were deposited in Puget Sound, there being no facilities for hatching them, and the season also being unfavorable for their development.

RÉSUMÉ OF THE TRIP.

Car No. 3 left Wood's Holl, Massachusetts, January 14, 1889, with seven hundred and ten lobsters, destined for the coasts of Washington and Oregon. The trip was made via the Northern Pacific Railroad in seven days, the plants being made on the eighth day after leaving Wood's Holl, namely, January 22. On account of the failure of Mr. Bensell to meet the car at Portland it was impossible to make the proposed planting on the central part of the Oregon coast, but a small number were left at the mouth of the Columbia River, on the north side. The condition of all the lobsters planted was reported good. The results of the shipment are summarized in the following table:

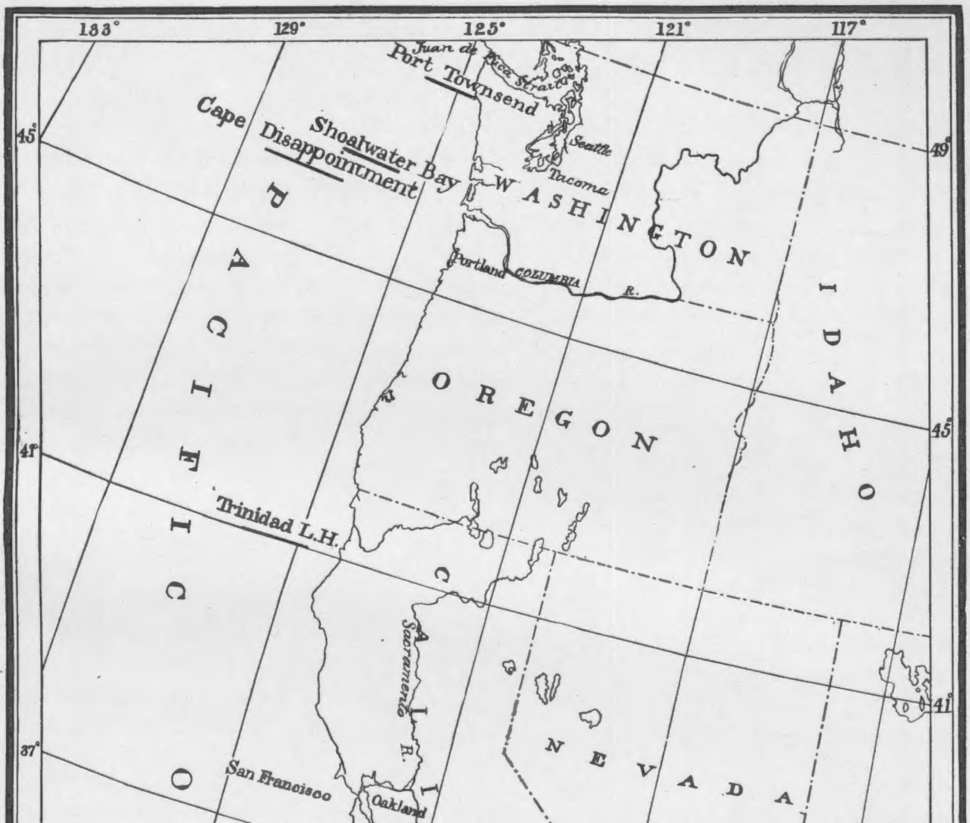
Results of the fifth shipment of lobsters to the Pacific coast.

	Total No. of lobsters.	No. of males.	No. of Females.	Females with spawn.	Females without spawn.
Lobsters taken on board at Wood's Holl	710	279	431	63	368
Lobsters lost during the trip	477	207	270	9	261
Lobsters carried safely through and planted on the coast of Washington	233	72	161	54	107
Plant made—					
Off Cape Disappointment	88	25	63	....	....
In Shoalwater Bay	22	7	15	....	....
In Scow Bay, Puget Sound	24	8	16	....	....
Off Hudson's Point, Puget Sound	25	8	17	....	....
Off Wilson's Point, Puget Sound	74	24	50	....	....

Recapitulation of the five shipments.

Number and date of shipments.	No. of Lobsters taken.	No. of Lobsters lost during journey.	No. of Lobsters planted.	Place of deposit.
First, June, 1873	162	162	....	
Second, June, 1874	150	146	4	California.
Third, June, 1879	22	1	21	Do.
Fourth, June, 1888 *	614	282	332	Do.
Fifth, January, 1889	710	477	233	Washington.
Total	1,658	1,068	590	

* Also, 102,000 embryos planted off Monterey, and 2,000 in San Francisco Bay.



MAP OF THE
Pacific Coast of the United States,
SHOWING THE LOCALITIES
WHERE
LOBSTERS WERE PLANTED IN 1888-89.

The names of the places where plants were made are underscored.

12.—PRELIMINARY REPORT UPON THE INVERTEBRATE ANIMALS INHABITING LAKES GENEVA AND MENDOTA, WISCONSIN, WITH AN ACCOUNT OF THE FISH EPIDEMIC IN LAKE MENDOTA IN 1884.

BY S. A. FORBES.

LAKE GENEVA.

My first visit to Lake Geneva was made in October, 1881, as an incident of work in progress on the Illinois State Natural History Survey, my purpose at the time being to compare the invertebrate fauna and the biological conditions of that lake with those of the much smaller and shallower lakes of the same series in northeastern Illinois. On this visit I hauled the dredge and beam-trawl and the surface net repeatedly in several parts of the lake, both along shore and in the deepest water, and carefully worked the product of the dredge and trawl through a set of assorting sieves, saving in alcohol everything collected. In August, 1887, I improved the opportunity of a casual visit to this lake to make much larger collections with the surface net, ran several lines of soundings across the lake, and collected from deep water, for analysis, the peculiar, soft, fine, mud—largely a chemical precipitate—which covers the bottom there to a great depth.*

* This mud has a peculiar rank, almost offensive, odor, and a soft, greasy feel, and rubs away largely between the fingers. It is of a pale slate-blue color when dry, darker when moist. Under the microscope it has a semi-crystalline appearance, and contains very little vegetable débris and not much sand. It effervesces freely in sulphuric acid, but does not wholly dissolve. A sample of this mud which had been taken from a depth of 20 fathoms was submitted to Prof. William McMurtrie, of the chemical department of the University of Illinois, who reported upon it as follows:

"The following are the results of analysis of lake mud:

	Per cent.
Carbon dioxide (CO_2)	25.00
Calcium oxide (CaO)	27.13
Magnesium oxide (MgO)	3.65
Organic matter	4.80
Insoluble residue	32.20
Ferric oxide (Fe_2O_3)	1.50
Aluminic oxide (Al_2O_3)	4.67

"These are doubtless engaged in combination as follows:

Calcium carbonate ($CaCo_3$)	48.445
Magnesium carbonate ($MgCO_3$)	7.665
Ferric oxide (Fe_2O_3)	1.500
Aluminic oxide (Al_2O_3)	4.670
Organic matters	4.800
Insoluble residue	32.200

"The insoluble residue consists of clay and sand."

Lake Geneva, in Walworth County, Wisconsin, is a clear and beautiful sheet of water about 7 miles long by 1½ in greatest width, with an extreme depth, according to my soundings, of 132 feet. It is a glacial lake, lying in a trough-like valley of the drift, the southern side of which formed part of the terminal moraine of the great Lake Michigan glacier. The valley is continued westward with a very gradual rise beyond the head of the lake, where a small stream empties its clear, cool water. By way of the outlet at its eastern end, its waters pass through Fox River into the Illinois. Its banks are high and rolling, but nowhere bluffy, and there is no rock anywhere in sight. The slopes of the bottom are mostly gradual, but off the "points" they may reach, for the first 500 or 600 feet, a descent of 1 foot in 5; while in the bays this is only about 1 in 50.*

The vegetation of this lake is chiefly confined to a narrow belt along the shore, except in Williams' Bay on the north side and in the shallow water near the outlet. In the deepest parts the bottom is perfectly destitute of living plants higher than diatoms, and there is also a remarkable scarcity and small variety of animal life in this situation.

In the shallow water, from the shore to a depth of 5 fathoms, the most abundant plants observed in 1881 were as follows: *Myriophyllum heterophyllum*, *M. scabratum*, *Ceratophyllum demersum*, *Potamogeton compressum*, *P. lucens*, *P. pauciflorum*, *Anacharis canadensis*, *and Chara contraria*.†

Swimming and creeping among the somewhat scanty growth of these aquatic plants, was a small variety of animals, the most abundant of which were the smallest of our common amphipod crustaceans (*Allorchestes dentata* Smith) and the larvæ of an abundant genus of gnats—*Chironomus*. A partial examination of the material collected by a dozen hauls of the dredge in this shallow water gave me the following imperfect list:

SHALLOW WATER COLLECTIONS, 1881.

INSECTA.

1. *Paraponyx* sp.? An interesting aquatic caterpillar, richly provided with tufted tracheal gills on all surfaces of the body, probably belongs to this genus of pyralid Lepidoptera. Two examples were taken among weeds growing on a gravelly bottom, in water 6 feet deep.
2. *Stenelmis crenatus* Say. Several adult specimens of this beetle were taken in a haul along shore, doubtless from the aquatic weeds.
3. *Dytiscidæ*. A single larva.
4. *Chironomus* sp. Very many specimens of small white larvæ belonging to undetermined species of these very abundant gnats.
5. *Phryganeidæ*. Various caseworms, mostly Leptoceridæ, with sand tubes, either straight and slender or short and curved. Tubes sometimes made of a webbed membrane covered with a thick layer of small spherical colonies of Rivularia or other similar Algæ. A remarkable larva of *Lagenopsyche* frequently occurred, the case transparent and commonly covered with diatoms. A single specimen of Sericostomidæ.
6. *Agrionina* and *Libellulina*. Nymphs of dragon flies.
7. *Ephemeridæ*. Most commonly nymphs of *Cænis*, of an undetermined species.

CRUSTACEA.

8. *Cambarus virilis* Hagen. Cray-fishes were not at all abundant in this lake, but a few young specimens of this species were taken in the dredge.

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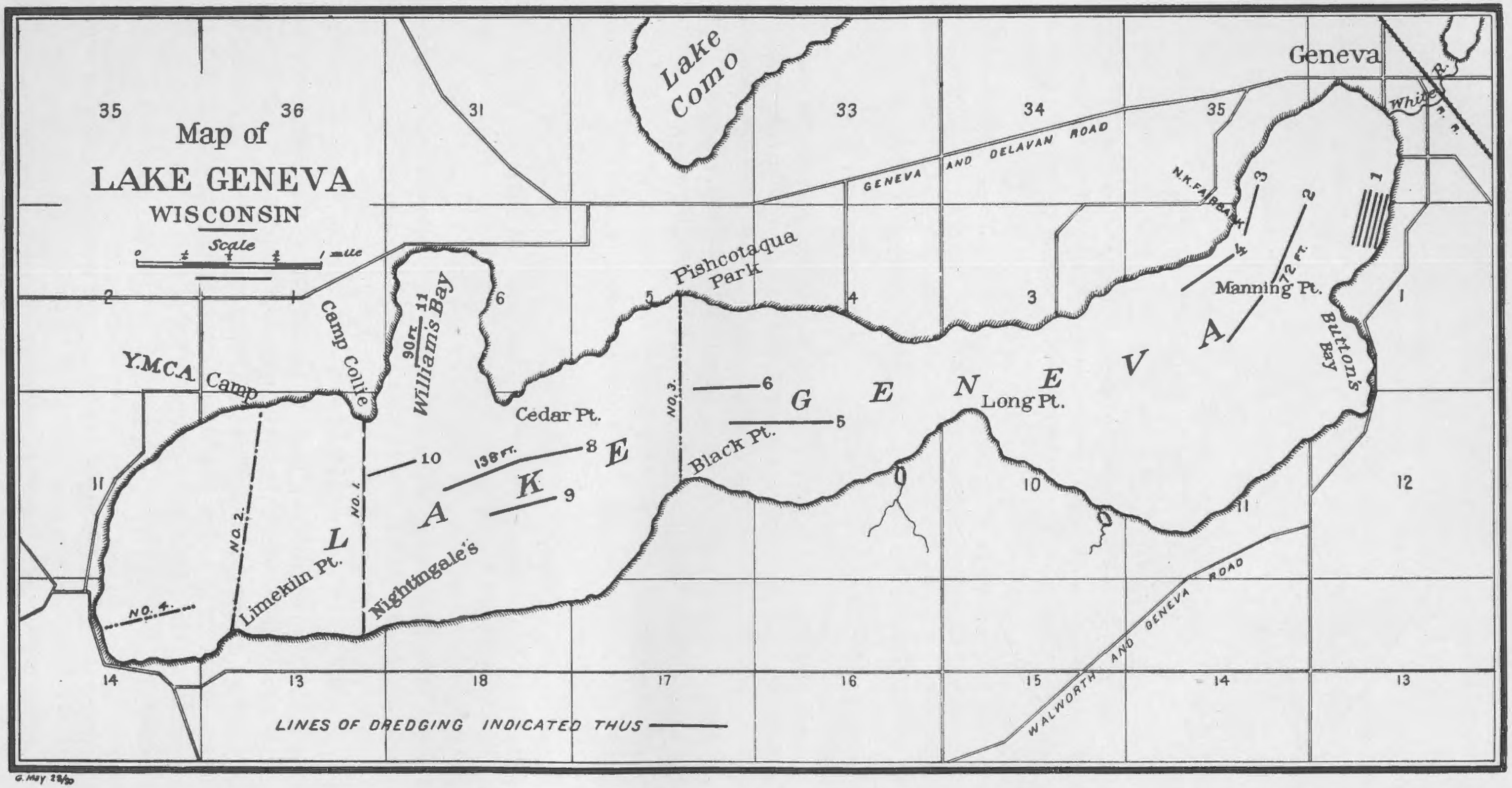
* See profiles, page 476.

† Determined for me by Prof. T. J. Burrill, of the University of Illinois.

Bull. U. S. F. C. 1888.—(To face page 474.) Forbes. Invertebrates.



9. *Gammarus fasciatus* Say. Occasional examples occurred.
10. *Allorchestes dentata* (Smith) Faxon. This was by far the commonest crustacean, and swarmed among the weeds.
11. *Candona elongata?* Herrick. This shelled entomostracan occurred but once in the dredge.

MOLLUSCA.

The common mollusks from my dredgings were *Unio luteolus* and *Anodonta footiana* (neither abundant), *Planorbis campanulata* and other species of that genus, *Pisidium adamsi* Pr.,* *P. compressum*,† *Sphærium solidulum*,† a few Physas and Limneas (the former the commoner), an occasional *Melantho*, a great number of *Amnicola cincinnatiensis*, and many examples of *Valvata tricarinata* and *V. sincera.*

VERMES.

The worms of these inshore collections were limited to a few leeches and planarians, occasional specimens of *Stylaria lacustris* Linn., and an undetermined species of *Pristina.*

Besides the foregoing, I obtained here only a small number of water-spiders (Hydrachnidæ), a few examples of our most abundant darter (*Boleosoma nigrum*), and a common sunfish (*Lepomis*).

DEEP WATER COLLECTIONS, 1881.‡

In the deeper water the collections were not especially different where the bottom was covered with vegetation. A haul of the beam-trawl made on a mud bottom in the eastern end of the lake at a depth of 12 fathoms, among *Ceratophyllum* and *Anacharis*, gave a nearly full assortment of the smaller mollusks of the lake (*Valvata tricarinata*, *V. sincera*, *Amnicola cincinnatiensis*, *Planorbis*, *Physa*, *Sphærium solidulum*, *Pisidium adamsi*, and *P. compressum*), *Physa*, *Sphærium*, and *Valvata sincera* being the most abundant.

Numbers of *Chironomus* larvæ, a dytiscid larva, and a caseworm were the only insects, and *Allorchestes* and *Candona* the crustaceans of the haul. Among the Vermes was a long and slender species (*Limnodrilus*) with four rows of notched or forked setæ arranged in short, transverse, comb-like ranks, each of four to six.

A short haul of the dredge at a depth of 15 fathoms in Williams' Bay, on a bottom of sandy mud covered with dead leaves, yielded a single *Physa*, a small *Planorbis*, a multitude of *Pisidium adamsi*, many *Valvata striatella*, many larvæ of *Chironomus* and pupæ and pupa cases of *Corethra*, a few *Candona elongata*, a multitude of dead branches of a polyzoan (apparently *Fredricella*), many *Limnodrilus*, and a few examples of *Stylaria lacustris.* The more highly organized crustaceans and insect larvæ were here altogether wanting, the principal animals being the smaller mollusks, *Pisidium* and *Valvata*, the worm-like larvæ of gnats, and the slender, reddish worm, *Limnodrilus*, living in the slime.

A single haul on a mud bottom near the eastern end of the lake, at 19 to 20 fathoms, gave only large red *Chironomus* larvæ in considerable numbers, several

* Determined by Mr. H. A. Pilsbry, of the Philadelphia Academy of Sciences.

† Named by comparison with specimens determined by Mr. G. W. Tryon.

‡ For the opportunity to dredge this lake to advantage I was greatly indebted to Mr. N. K. Fairbank, of Chicago, who placed at my disposal for this purpose his steam-yacht and its crew.

examples of *Pisidium adamsi* a single *Gammarus fasciatus* (doubtless taken in lifting the dredge), and one dead shell of *Planorbis campanulatus*.

Finally, two hauls of the trawl and two of the dredge in the middle of the lake, at a depth of 23 fathoms, yielded quantities of the softest black mud with some admixture of dead leaves, an abundance of large red *Chironomus* larvæ, *Pisidium adamsi*, and the undetermined worm (*Limnodrilus*) already mentioned. The only other specimens secured by this deep-water work (which aggregated over a mile of continuous hauling) were two specimens of *Sphærium*, one of *Valvata tricarinata*, one of *V. sincera*, a dead *Physa*, a few pupæ of *Corethra*, and three leeches. No living vegetation was found here except diatoms.

With the surface net, in open water, I secured at this time only a moderate number of a *Daphnia* closely resembling *D. retrocurva* Forbes (and possibly a variety of that species), a few examples of *Epischura lacustris* Forbes, a *Diaptomus* (apparently a variety of *sicilis*), another large copepod, *Limnocalanus macrurus*, and the remarkable cladoceran form, *Leptodora hyalina*.

The material of 1887 was obtained mostly with a towing net, in eighteen collections, made at various points along the margin in shallow water and also in the deepest parts of the lake. The following lists, although not exhaustive, are sufficiently complete to show the dominant and associate species, and the conditions governing their relative abundance.

DEEP-WATER COLLECTIONS, 1887.

Upper end of lake, August 6, deep water, clear weather, sunrise, wind. A surface haul and a small collection, with much small vegetable drift.

1. Larvæ of *Chironomus*.
2. Young neuropterous larvæ.
3. A large hydrachnid, undetermined.
4. *Allorchestes dentata* Faxon. A few females bearing eggs.
5. *Daphnia retrocurva*, var. An occasional specimen.
6. *Daphnella brachyura*.
7. *Sida crystallina*.
8. *Cyclops*, sp.
9. *Epischura lacustris* Several specimens

August 5, deep water, at surface, sunset, calm. A small collection, obtained by dragging the towing net behind a steamer.

1. *Daphnia retrocurva*, var. A few specimens.
2. *Epischura lacustris*. The principal part of the collection.

August 5, deep water, 10 a. m., at surface, cloudy, calm. A small collection.

1. *Chironomus*. A few examples of larvæ and pupæ.
2. *Daphnia retrocurva*, var. The greater part of the collection.
3. *Epischura lacustris*. Several specimens.
4. *Diaptomus sicilis*, var. A few examples.

August 9, deep water (20 fathoms), 10 a. m., sunshine, net hauled about 10 feet below surface. A large collection.

1. *Leptodora hyalina*. Several specimens.
2. *Daphnia retrocurva*, var. The greater part of the collection.
3. *Daphnella brachyura*. A few examples.
4. *Cyclops*, sp. A few examples.
5. *Epischura lacustris*. A few examples.
6. *Diaptomus sicilis* and var. A few.

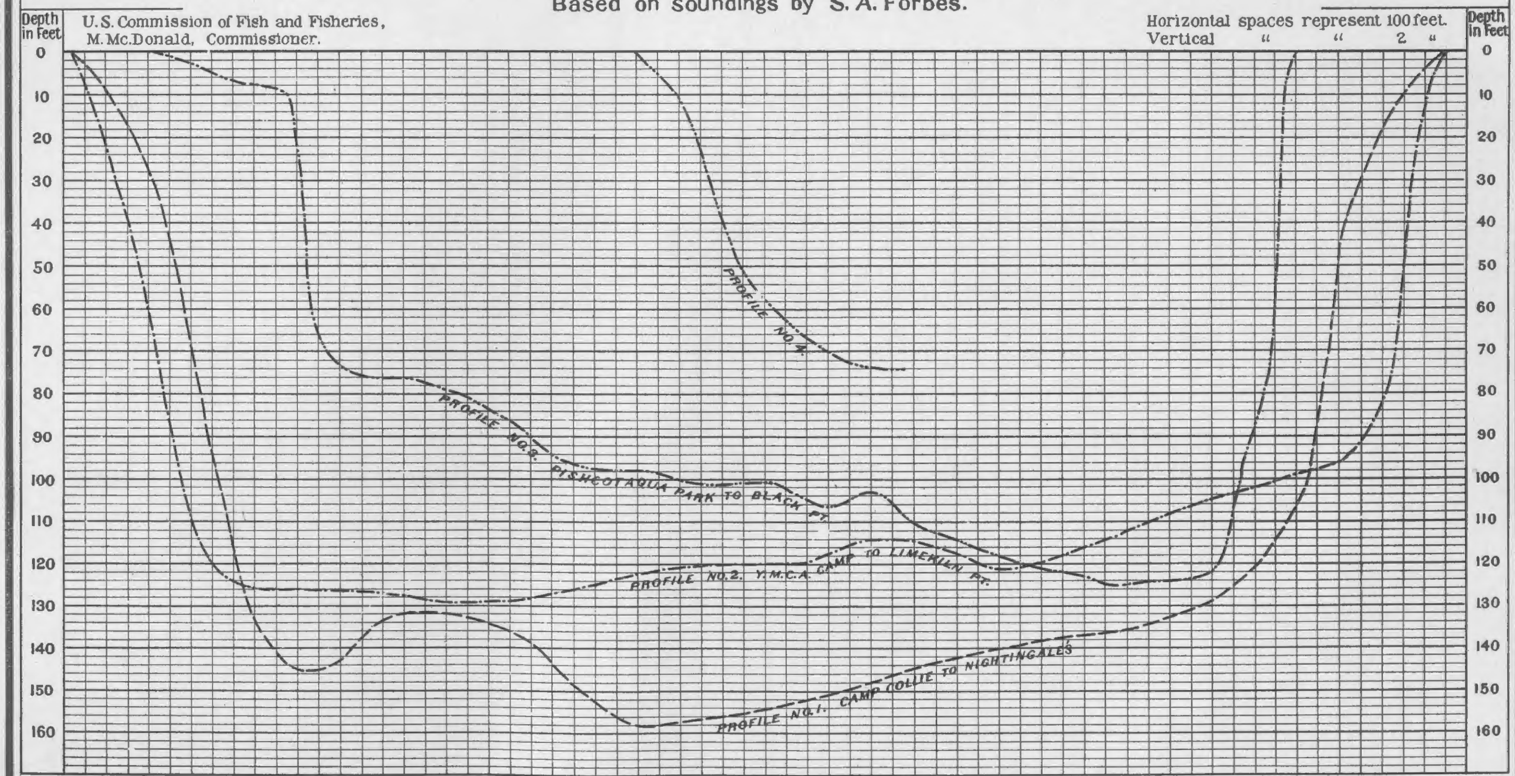
PLATE LXXIII.

DIAGRAM OF PROFILES ACROSS LAKE GENEVA, WISCONSIN.

Based on soundings by S. A. Forbes.

U. S. Commission of Fish and Fisheries,
M. McDonald, Commissioner.

Horizontal spaces represent 100 feet.
Vertical " " 2 "



Bull. U. S. F. C. 1888.—(To face page 476.) Forbes. Invertebrates.

August 9, deep-water, 4 p. m. sunlight, net hauled about 20 feet below surface. A good collection.

1. *Leptodora hyalina.* Several.
2. *Daphnia retrocurva*, var. A great number.
3. *Daphnella brachyura.* Occasional specimens.
4. *Cyclops*, sp. Very few.
5. *Epischura lacustris.* Very abundant.
6. *Diaptomus sicilis*, var. An occasional example.

August 9, 10 a. m., sunshine, deep water, calm, net dragged about 90 feet below the surface. A very large collection.

1. *Leptodora hyalina.* A great number.
2. *Daphnia retrocurva*, var., with obtuse apex to helmet. A very large number.
3. *Epischura lacustris.* Occasionally seen.
4. *Diaptomus sicilis*, var. Not abundant. One female noticed bearing spermatophore.

August 9, deep water, 4 p. m., 10 feet below surface, sunshine, calm. A good collection.

1. *Leptodora hyalina.* A few.
2. *Daphnia retrocurva*, var. The main part of the haul.
3. *Epischura lacustris.* A few examples.
4. *Diaptomus imperfectus.* A few examples.

August 4, upper end of lake, deep water, 9 p. m., moonlight, at surface. Fine and large collection.

1. *Daphnia retrocurva*, var. Many examples.
2. *Daphnella brachyura.* Occasional young.
3. *Epischura lacustris.* The principal part of the catch.

August 7, upper end of lake, deep water, 9 p. m., at surface, stiff breeze. A large collection.

1. *Leptodora hyalina.* Occasionally observed.
2. *Daphnia retrocurva*, var. The greater part of the collection. Females were bearing eggs and young in various stages of development, the germinal disk just forming in some, and others nearly ready to leave the brood cavity. The female usually carries but a single egg. These Daphnias were feeding on unicellular Algæ, as shown by crushing specimens on a slide.
3. *Daphnella brachyura.* A few young examples.
4. *Epischura lacustris.* Many specimens. One male seen with a slender spermatophore partly extruded.
5. *Diaptomus sicilis.* Occasional specimens.

A repetition of the foregoing.

1. *Leptodora hyalina.* A half-grown example.
2. *Daphnia retrocurva.* Only occasionally seen.
3. *Epischura lacustris.* This collection consisted almost wholly of this species. Evidently breeding here rapidly, the ovaries containing ova, as many as ten to fifteen in each female, and the abdomens of all having the spermatophore attached. Many of the ova had a large, central, orange globule, and floated when detached. Most of the males with developed spermatophores.
4. *Diaptomus sicilis*, var. Several specimens .8 to .9^{mm} long. Males with well developed spermatophores.

A single short haul of the towing net in the mud of the bottom, at a depth of 10 fathoms, yielded several specimens of *Pisidium adamsi* (the characteristic deep-water mollusk of this lake), an occasional *Daphnia retrocurva* var., several cyprids (including *Candona elongata*), a few dead branches of Polyzoa (apparently *Fredricella*), and a single *Limnodrilus*—the common mud-worm of the interior of the lake.

SHALLOW-WATER COLLECTIONS, 1887.

Several collections made from the margin of the lake to a depth of 9 or 10 feet gave a much more miscellaneous list than those from the open water.

1. *Corethra.* Pupa.
2. *Chironomus.* Larvæ and pupæ, the former occurring in every haul.

3. *Ephemeridæ.* Nymphs of several species, not determined. Most commonly belonging to the genus *Cænis;* one example closely allied to *Ecdyurus*, and undoubtedly of that group by Eaton's Monograph; another similarly related to *Ephemerella.*
4. *Phryganeidæ.* Undetermined larva.
5. *Hydrachnidæ*, sp.
6. *Allorchestes dentata.* Abundant, especially among the weeds.
7. *Alona*, sp. Several times occurring. One allied to *A. tuberculata* Koch, but probably distinct.
8. *Acroperus leucocephalus.* Noticed but once.
9. *Eurycercus lamellatus.* More abundant.
10. *Ophryoxus gracilis* (?) Sars. Examples of a species of this genus not distinguishable from *gracilis* as described by Sars* were obtained among weeds in water 6 to 9 feet deep. This is apparently identical with *Lyncodaphnia macrothroides* Herrick.
11. *Daphnia retrocurva*, var. Only a single specimen.
12. *Moina rectirostris.* Taken at the margin.
13. *Latona setifera.* Three specimens of this somewhat rare crustacean were taken among weeds in water 6 feet deep.
14. *Sida crystallina.* Rather abundant in our collections.
15. *Cyclops*, sp. Several specimens; not critically studied.
16. *Epischura lacustris.* Only a few examples in one of the hauls at the margin.
17. *Diaptomus sicilis*, var. A few specimens among weeds, in water 9 feet deep.
18. *Stylaria lacustris.* A single example near the margin.
19. *Ophrydium*, sp. A few colonies of this protozoan taken from the weeds along shore.
20. *Arcella*, sp. Taken as above.
21. *Difflugia*, sp. Taken as above.

August 5, among the weeds at outlet, 5 p. m., sun, wind.

1. *Chironomus*, larvæ. Two or three examples.
2. *Agrionina.* A single larva of these dragon flies.
3. *Ephemeridæ.* Several larvæ, mostly of the Ephemerella group. (Eaton's Monograph, Pl. 40, Fig. 18.)
4. *Hydrachnidæ.* Four specimens taken.
5. *Allorchestes dentata.* Not abundant.
6. *Cyprididæ*, sp. Several examples, among them representatives of *Cypris vidua.*
7. *Eurycercus lamellatus.* Several specimens.
8. *Simocephalus*, sp. A dozen specimens similar to *americanus*, but differing apparently in specific characters.
9. *Moina rectirostris.* Two examples.
10. *Daphnella brachyura.* Several examples, including young
11. *Sida crystallina.* A few.
12. *Cyclops pectinifer* Cragin.
13. *Epischura lacustris.* A large number of this species, making, in fact, the chief contents of the collection.
14. *Diaptomus sicilis*, var. A few examples.

August 8, upper end of lake, sandy bottom, with *Chara contraria.*

1. *Chironomus*, larvæ. A slender white species.
2. *Cænis*, sp. A single larva.
3. *Allorchestes dentata.* Several examples.
4. *Leptodora hyalina.* Several examples.
5. *Acroperus leucocephalus.*
6. *Ophryoxus gracilis* (?). Three examples.
7. *Daphnia retrocurva.* A very few.
8. *Latona setifera.* A single specimen.
9. *Sida crystallina.* Several examples.

* Oversigt af de Omgeguen af Christiania iagttagne Crustacea cladocera. Forhandlinger i Videnskabs-Selskabet i Christiania, 1861, p. 158.

10. *Epischura lacustris.* A very few.
11. *Diaptomus gracilis.* Only one specimen.
12. *Ophrydium*, sp. A single colony.

A haul of the towing-net in swift water at the mouth of the inlet, made at 9 p. m., gave the following list:

1. *Corethra*, sp. A few pupæ about ready to emerge.
2. *Corixa*, sp. Several young.
3. *Ephemeridæ.* The collection was largely composed of larvæ of this family, mostly of the genus *Cœnis*. One dissected, had filled the alimentary canal with fine dirt, containing a few filaments of Algæ and occasional diatoms. Other larvæ were allied to *Callibœtis* of Eaton's Monograph. The palpi of the first and second maxillæ had, however, but two joints each. One ally of *Ecdyurus* was also noticed.
4. *Hydrachnidæ.* Several examples.
5. *Allorchestes dentata.* A single one.
6. *Daphnia retrocurva*, var. A few.
7. *Sida crystallina.* Several examples.
8. *Cyclops*, sp. Occasional examples; not determined.
9. *Epischura lacustris.* Several specimens.
10. *Limnodrilus* sp. A single specimen of this mud worm.

A small collection made by turning stones in the water along the shore gave several larvæ of *Psephenus*, probably *lecontei*, but differing noticeably from Kellicott's figure of that curious and interesting animal, as given in the "Canadian Entomologist," Vol. xv., p. 191. A *Cœnis* nymph, another of the Ecdyurus group, and a phryganeid pupa in its sand tube, were the only other insects. A single fresh-water shrimp (*Palæmonetes exilipes*) was taken here, together with a few examples of *Gammarus*—possibly young of *fasciatus*, but too small for determination. Also *Allorchestes dentata*, a single *Gordius*, and several small leeches.

It is evident from the foregoing that even in a lake of so moderate size as this, the smaller inhabitants are quite clearly divided into pelagic and littoral groups, the latter containing the greater number of species, but the former not less numerous in individuals; and a comparison of the results of dredgings shows that this difference applies to the animals of the bottom as well as to those swimming freely above it.

This pelagic group of Entomostraca includes *Leptodora hyalina*, *Daphnia retrocurva*, and *Epischura lacustris*, as its principal species, *Diaptomus sicilis*, another pelagic form, being, apparently, not very abundant in this lake; while the characteristic animals of the *bottom* of the interior parts of the lake are *Pisidium adamsi*, a large red *Chironomus* larva, and a species of *Limnodrilus*—both this worm and the larva just mentioned making tubular burrows in the mud.

It is also apparent from the product of the towing net in deep water under varying conditions, that the pelagic Entomostraca avoid the surface by day, whether it be rough or calm, or the weather cloudy or clear; but that they do not necessarily withdraw to any great depth—hauls 10 feet below yielding "good" or "large" collections when the sun was shining. By night, on the other hand, the yield at the surface was large, even in a high wind.

LAKE MENDOTA.

I first visited Lake Mendota in August, 1884, at the request of Prof. S. F. Baird, U. S. Commissioner of Fish and Fisheries, for the purpose of making a study of a most remarkable mortality among the fishes of a single species in the lake—the common perch (*Perca flavescens* Mitch.).

In August, 1885, I returned, again at Professor Baird's request, with Prof. H. Garman, then my assistant, for some further studies bearing on the same subject.

Fourth Lake, or Lake Mendota, Wisconsin, is the uppermost and largest of a chain of lovely glacial lakes lying about the State capital, finding an outlet through a small stream into Rock River. It measures about 5¾ miles in greatest length, from east to west, and about 3½ in width, from "University Landing" to the head of Catfish Bay. It is thus wider than Lake Geneva, but not so long, and is not nearly so deep. The deepest sounding made by me was but 79 feet, and the average of six soundings, well distributed over the trough of the lake, was 10 feet less. The bottom is more diversified than that of Lake Geneva, showing reefs of rock and of sand, and a large area of weedy shallows. Its waters consequently swarm with fish—especially with the common perch—and the amount and variety of invertebrate life is doubtless greater than in the more uniform Lake Geneva. The bottom in the deeper water is not different in character from that of the other lake, but is covered by the same soft calcareous mud, with its peculiar little group of animal inhabitants.

Catfish Bay, about a mile and a half across, and half as deep, is bordered by an extensive marsh, which is drained by Catfish Creek, the principal feeder of the lake. There are about 80 acres of marsh at other points around the lake, but the shores are otherwise rolling, or even bluffy, especially in the narrower and deeper eastern division of the lake; and here are also several unfailing springs. Many other springs are said to open along the shores, below the water-level. This lake differs from the others of the chain by the fact that it has much the largest drainage area and receives a larger affluent than any other; and this, as already said, drains a swamp. The waters of the lower lakes come mostly from Lake Mendota, in which they must have deposited much of their sediment, and where much of their organic matter must undergo decomposition before they flow off through its outlet. On the other hand, about three-fourths of the sewage of the city goes into Third Lake, or Lake Wenona, the next below.

DREDGINGS.

My general collections from the lake in 1884 were limited, by want of time, to three hauls of the dredge, made with the aid of a small steamer, one in shallow water (8 to 9 feet) on a sandy bottom, one on a rocky reef at a depth of 12 to 18 feet, and a third on a mud bottom at 12 to 12½ fathoms.

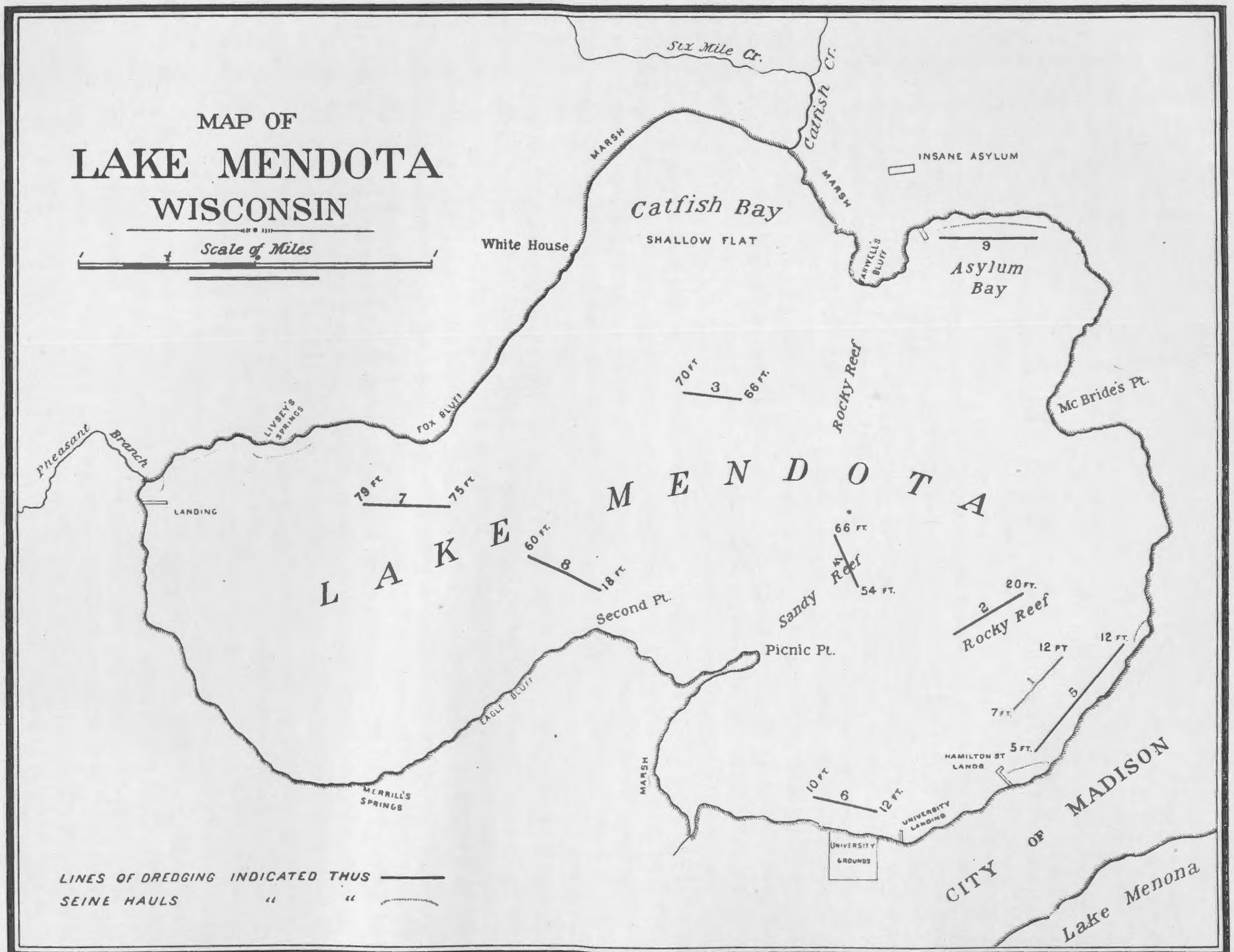
The first haul, on a sandy bottom covered with *Nitella*, yielded a great number of small white larvæ of *Chironomus*, with several small amphipod crustaceans (*Allorchestes dentata*), two or three small mollusks (*Amnicola*), a few worms (*Stylaria lacustris*), a single larval ephemerid (*Cœnis*), and two Entomostraca (*Eurycercus lamellatus* and a species of *Cypris*.) The collection was a small one, the entire product a cubic half-inch.

The haul on a rocky bottom gave only some small mollusks, not yet identified.

The deep-water dredging gave precisely the same group of animal forms as those in the mud of Lake Geneva, namely, a good collection of *Pisidium adamsi* Pr., several large deep red *Chironomus* larvæ, and a species of the tube-making worm *Limnodrilus*.

The principal collections of 1885 were made by nine hauls of the dredge, three of a fine-meshed seine, and seven of the surface net.

Those from the deeper water did not differ in any way from those of the preceding


MAP OF
LAKE MENDOTA
WISCONSIN
Scale of Miles
Six Mile Cr.
Catfish Cr.
MARSH
INSANE ASYLUM
Catfish Bay
SHALLOW FLAT
White House
FARWELL'S BLUFF
9
Asylum Bay
70 FT
3
66 FT.
Rocky Reef
Mc Bride's Pt.
FOX BLUFF
LIVSEY'S SPRINGS
Pheasant Branch
LANDING
79 FT.
7
75 FT.
LAKE MENDOTA
60 FT.
8
18 FT.
66 FT.
Sandy Reef
54 FT.
20 FT.
2
Rocky Reef
Second Pt.
Picnic Pt.
12 FT
12 FT.
1
5
7 FT.
5 FT.
HAMILTON ST LANDG
EAGLE BLUFF
MERRILL'S SPRINGS
MARSH
10 FT
6
12 FT.
UNIVERSITY LANDING
UNIVERSITY GROUNDS
CITY OF MADISON
Lake Menona
LINES OF DREDGING INDICATED THUS
SEINE HAULS " "

year; but a haul in only 20 feet of water on the rocky reef above mentioned gave the common deep-water forms, *Pisidium adamsi* and the red *Chironomus*,* with an occasional *Corethra* larva also.

The shallow-water dredgings of 1885 were much more fruitful than those of 1884, giving many times the number of individuals, and especially a greater number of case-worms and small crustaceans (*Allorchestes*).

A cursory examination of a haul of the dredge made on the sandy shallow, likewise dredged in 1884, showed an abundance of *Allorchestes dentata* and small white *Chironomus* larvæ, a multitude of case-worms of various genera (including the curious *Heliopsyche* in its spiral tube of sand grains), *Amnicola*, *Valvata tricarinata* and *V. sincera*, *Sphærium*, leeches, planarians, etc., and a few Entomostraca. A fine *Plumatella* occasionally occurred encrusting the stems of weeds in shallow water.

The ordinary Unionidæ of these waters were *Unio luteolus* and *Anodonta footiana*, both of which were very abundant.

In the surface net occurred immense quantities of a helmeted *Daphnia* with head of truly monstrous size, sometimes larger than the body, apparently the *Daphnia kerusses* of Cox, rather imperfectly described and figured† from Fox River, the general outlet of this chain of lakes. With this were also many Daphnias of a species apparently new. Associated with these were frequently found large numbers of *Leptodora hyalina*, a few *Cyclops*, *Diaptomus*, and *Epischura*, occasional larvæ of *Chironomus* and *Corethra*,‡ examples of *Daphnella* and of water-mites (Hydrachnidæ), and immense and astonishing quantities of a shelled flagellate infusorian, *Ceratium longicorne*, with now and then the curiously similar rotifer, *Anurea longispina*. These minute forms fairly lined the net, and clouded the alcohol in which the specimens were preserved.

If any useful comparison of the biological conditions prevailing in Lake Mendota during these two years may be made on the rather slender basis of my collections, it would lead to an inference that invertebrate life was very much more abundant in 1885 than in 1884, and would suggest an over-population of the lake in the latter year which had greatly reduced the usual food of fishes of indiscriminate carnivorous habit. The vast abundance of the perch especially, in this lake, is shown by the fact that they formed nearly the whole product of three hauls made with the seine in 1885, notwithstanding that approximately 300 tons of this species had died here during the epidemic of the year before.

* This blood-red larva, so often mentioned, is uniformly segmented, and about 30 millimeters long. It bears on the back of the penultimate segment four clavate anal appendages about as long as the segment itself, and on the antepenultimate segment two pairs of similar appendages, one at the anterior third and the other at the posterior margin. At the posterior margin of the dorsal surface of the penultimate segment are two prominent chitinous tubercles, each bearing three long recurved hairs. The labrum bears fifteen teeth, the middle one large and blunt with a very small coherent tooth each side. The remaining six on each side diminish in size outwards, the inner one of the series being larger than the median tooth. This tooth and the second are very closely united, the others free. The antennæ are five-jointed; the first joint cylindrical, stout, and very long, more than twice as long as the other four taken together. It bears articulated to its inner distal margin a long spine, lobed at the base, and as long as the remainder of the antenna. The next joint is also cylindrical, and about one-fifth as long as the first; the third joint is thick and short; the fourth longer but more slender; and the last minute.

† Amer. Monthly Micros. Jour., Vol. IV (1883), p. 88.

‡ Our collections were all made by day.

THE FISH EPIDEMIC IN LAKE MENDOTA IN 1884.

Early in July, 1884, public attention was attracted, at Madison, Wisconsin, to the extraordinary numbers of fishes dying and floating ashore in Fourth Lake or Lake Mendota. By the middle of the month the accumulation of their rotting bodies along shore had become a public nuisance, and the street commissioner began to cart them away from the city front and bury them. By the 19th not less than 15 tons had been thus removed, and by August 4 from 75 to 100 tons. As the city borders only a small part of the lake, it was estimated that fully 300 tons had died up to that time. On August 7, the Madison Transcript reported that 200 tons had been hauled away by the city authorities during the four weeks preceding, and that the fishes were still dying. August 15, when the writer arrived at the lake, this remarkable epidemic had practically ceased, and during the week following (about six or seven weeks after its beginning) it disappeared completely, not to return that season or the following summer.

By far the greater part (perhaps 90 per cent.) of the fishes which perished were the common perch (*Perca flavescens*), much the most abundant species in the lake. Next came the lake herring (*Coregonus artedi*),* locally called the "white fish;" while pike-perch, white bass, and sunfish (*Lepomis*) were much less numerously represented.

My own first visit to the lake was made in consequence of a request from Professor Baird, then U. S. Fish Commissioner, conveyed in the following letter received by me at Normal, Illinois, August 13:

WOOD'S HOLL, MASSACHUSETTS, *August* 10, 1884.

DEAR SIR: Would it be convenient for you to visit the districts in Wisconsin where the mortality among the fish has developed itself to a very great degree? If you can, I will be glad to have you make a thorough investigation of the circumstances of the case. * * * I consider it a matter of very great importance, and one that should occupy the careful attention of specialists. I requested specimens to be sent to Mr. Ryder for his examination, but an investigation in the field on the sick and dying fish will be of much more importance.

Yours truly,

SPENCER F. BAIRD.

I arrived at Madison August 15 at 2.30 p. m., with seine, dredge, microscope, and a suitable apparatus for studying the fresh fluids and tissues of the diseased fishes, and for the permanent preservation of material of all kinds likely to throw any light on the subject under investigation. Through the kind assistance of Hon. Philo Dunning, of Madison, president of the Wisconsin State Fish Commission, a work-room was obtained at once in the boat-house of the steamer company, at the principal landing, and I spent two hours on the lake the same afternoon in search of dead and dying fish. I remained here until August 22, making collections as opportunity offered, carefully examining the freshest obtainable specimens for evidence of fungous parasitism, making numerous autopsies of fishes recently dead, preparing and staining slides of the blood and other fluids of those not yet dead when taken, for bacteriological study, and preserving the tissues of such fishes for later histological work. I also dredged the lake along shore and in deep water, as described in a foregoing part of this paper, but lack of time prevented my making as extensive general collections as was to be desired.

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* This fish was introduced from Lake Michigan some years before, according to information given me by Mr. Philo Dunning and others.

During the first two or three days it was not difficult to find floating on the lake, among hundreds of putrescent bodies, now and then one which presented a fairly fresh appearance, the gills unaltered, the eyes not sunken, and the color bright. During many hours rowing, however, I saw but two perch in the act of dying and succeeded in capturing but one. The actions of these perch were precisely those described by previous observers as characteristic of the death struggle of the diseased fish. They were at the surface, fluttering their fins, spinning irregularly about or scarcely moving at all, often gasping as if for breath, rolling over on their sides or backs between convulsions, and occasionally, for a few moments, disappearing from sight or swimming feebly and irregularly along. The single sick fish captured, I took while it was still struggling, but it scarcely moved after it was landed in the boat. Slides of the blood of this fish, taken with a pipette from the auricle of the heart and from the venous sinus, were at once prepared, and its viscera were placed in 94 per cent. alcohol within a half hour of its death. I made similar preparations of the fluids and organs of other perch that had died of the disease—the freshest I could obtain—and dissected twenty-four of them for a study of the contents of their alimentary canals. In preparing the blood, I used the common method of making slides for bacteriological study, drying rapidly upon a cover glass a thin film of the blood, flaming it in the blaze of an alcohol lamp, staining with a glycerine solution of methyl violet or of Bismark brown, and mounting in Canada balsam.

The general appearance of recently-dead specimens was that of a healthy fish. They were, almost without exception, in good average condition, often fat and plump; a fact noticed with astonishment by all who gave the matter any close attention. The color was always bright, and the surface everywhere clean, and without a trace of fungous attack. The gills were very commonly congested, but not appreciably more so than those of a fish dying in the air. Their mucous membrane was seemingly always quite uninjured, and was certainly so in several specimens of which I examined the filaments microscopically; and there was no trace of parasitism, fungous or animal, in the gills of any fish I took. The heart was always distended with blood and sometimes so gorged that the bulging of the venous sinus was visible from without. The liver was likewise congested, but seemingly by mechanical causes, as its tissues gave no evidence of infiltration. The blood itself was normal, the corpuscles in perfect condition, and both they and the plasma free of bacteria. The alimentary canal presented no unusual appearance, and was commonly fairly well filled with food, much of which had evidently been eaten rather recently. Many of the large Chironomus larvæ, which composed the greater part of it in every case but one, were entire and still retained their dark red color.

Concerning the histological condition of the principal tissues of the diseased perch I have unfortunately very little to report. My removal during the autumn of 1884 from Normal to the University of Illinois at Champaign, and the consequent transfer of the laboratory equipment and collections under my charge, made it impossible for me then to prepare and mount the material obtained for histological study, and this was kindly undertaken for me by a microscopist in Chicago. From him I received later a good series of sections of liver, spleen, heart, brain, kidney, stomach, and intestine of the lake herring, but all the material from the single perch taken alive was destroyed by an unfortunate accident while in his possession, and I had left for study only some slides of the brain, heart, liver, and spleen, hurriedly prepared in the field from two perch which had been dead an unknown length of time when taken.

Apart from the gorging of the heart and congestion of the liver already mentioned and a noticeable amount of cellular degeneration in the liver and especially in the spleen, these slides gave no definite hint of the nature of the disease. This degeneration, very much more abundant in the herring, consisted of a conversion of the contents of the cells into a yellow, dark brown, or black mass of minute spherical granules which had the appearance of micrococci; but as they did not stain with aniline they were very probably pigment granules instead; a supposition rendered more plausible by the equal or greater pigmentation of the viscera which I have since noticed in many seemingly healthy fishes. These altered cells were more abundant near the larger blood vessels, and where considerable numbers of them had undergone degeneration their walls were often broken down, and the cells were thus replaced by a collection of their dark yellow or black contents.

From a general study of my fish collections and of the conditions prevailing in Lake Mendota a number of additional facts of some significance may be selected.

(1) The herring, or so-called whitefish, of the lake were perishing in extraordinary numbers during the entire period of this outbreak, with symptoms precisely like those of the perch, and taking into account the relative numbers of these species in the lake, perhaps in as large or even larger proportion. These herring, like the perch, are, as is well known, bottom feeders, and in midsummer remain in the deeper waters. Furthermore, they die every summer, according to the uniform testimony of those with whom I talked, in precisely the same way as in 1884, but in very much smaller numbers. The condition of the bodies of the fresh herring examined, two of which were taken before death, was precisely that of the diseased perch, except that there was a greater amount of cellular degeneration of the viscera, particularly of spleen and kidney. Substantially all the substance of the former organ except the gorged blood vessels was replaced by masses of the spherical granules already described, or by cells filled with them, and the kidneys of the specimens examined were so loaded with them as to be black to the naked eye.

There follows from the above a considerable probability that the perch were affected by the same cause as the herring, or else that the disease was a contagious one and taken from the herring directly. It is further likely that this cause is present every year, as is shown by the regular death of a small number of the latter fish, but that its action was greatly intensified in 1884.

(2) The majority of the perch dying were full grown, and absolutely no young were seen either by myself or by any one with whom I talked. The captain of the passenger steamer, who spends most of his time on this lake, had seen none dead less than 5 or 6 inches in length and of an estimated age of three or four years. The smallest specimens which I saw were at least half grown; but according to Professor Birge, of the University of Wisconsin, a few specimens were seen not over 3 or 4 inches long.

(3) There was a marked contrast in food between the dead and diseased fishes and the healthy ones taken by the use of the seine in the shallow waters along shore. The former had eaten, almost without exception, little or nothing but a large red Chironomus larva living, as shown by the notes on collections given in the preceding part of this paper, in the mud of the deeper water, while the healthy fishes taken in the seine had not fed at all upon these large red larvæ, but only upon smaller white

larvæ of another species of Chironomus and upon a variety of the smaller animal forms occurring among the weeds in the shallow water. The following are the details of the food of fourteen diseased perch and of nine healthy ones taken by hook or seine at the same time, the numbers being those from my laboratory catalogue of accessions.

FOOD OF DISEASED PERCH.

4929. The intestine of this specimen was empty, but the stomach was well filled with larvæ and pupæ of the large red Chironomus.

4947. Full of large red Chironomus larvæ * 20 to 25 millimeters in length, and pupæ of the same species 16 millimeters long.

4948. A great quantity of food, consisting of the usual large red larvæ and pupæ of Chironomus, 15 millimeters long, with some very fine dirt.

4949. A moderate amount of the large Chironomus larvæ and pupæ.

4950. A rather small quantity of larvæ and pupæ of red Chironomus, with some very fine dirt.

4951. A moderate amount of the same material.

4952. Red Chironomus larvæ and pupæ, as usual, in very large quantity. A single crushed entomostracan of the order Cladocera.

4953. The usual larvæ and pupæ of Chironomus only.

4954. As above, the larvæ 20 millimeters in length.

4955. A great quantity of food of the usual character and nothing else, the pupæ predominating.

4956 and 4957. Larvæ and pupæ of the red Chironomus only.

4958. This specimen furnished the only exception to the usual food of the dead perch taken. The stomach contained a moderate number of nymphs of Ephemera and a few small white larvæ and pupæ of Chironomus, the larvæ 10 millimeters long. Although dead when taken, it is possible that this fish had not perished by disease. The objects which it had eaten are those found in relatively shallow water.

4961. A rather small amount of food, not recently taken, the pupæ and larvæ of the red Chironomus being chiefly in fragments.

The contents of the alimentary canal of ten other specimens, not examined microscopically, was evidently of the same character.

FOOD OF HEALTHY PERCH.

4945. Chiefly larvæ and pupæ of Chironomus, the former white, 10 millimeters long; also two or three specimens of *Allorchestes dentata*, and a long and slender caseworm with tube of sand.

4946. A considerable number of small larvæ and pupæ of Chironomus, white in color, several *Allorchestes dentata*, a single caseworm with sand tube, one specimen of *Eurycercus lamellatus*, and a single Cyclops.

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* The food of these larvæ, determined by dissection, consisted of very fine mud, with a great quantity of minute vegetable débris, composed of various kinds of cellular structures. These were evidently in a state of decomposition, as shown by the vast numbers of bacilli and other bacteria everywhere among the contents. There was also occasionally a filamentous alga resembling Oscillaria, and a few unicellular algæ were noted.

4959. Chiefly the small white Chironomus larvæ, and pupæ of the same, several examples of *Allorchestes*, a few nymphs of the genus Ephemera, a single *Eurycercus lamellatus*, and fragments of filamentous Algæ, with some other vegetable particles.

4960. A considerable quantity of the larvæ and pupæ of Chironomus already mentioned,—the former 9 to 10 millimeters long,—together with immature Ephemeræ and fragments of filamentous Algæ.

4962. This specimen added to the usual Chironomus larvæ and pupæ which formed the greater part of the food, a few *Allorchestes*, a young larva of Ephemera, a Corixa larva, a small leech, and a single young Sphærium.

4963. Many specimens of *Allorchestes dentata*, a few caseworms with their sand-tubes, several nymphs of Ephemera, a considerable number of small chironomid larvæ, and two specimens of Cyclops.

4964. Chiefly larvæ and pupæ of the small Chironomus. Besides these a few caseworms and specimens of *Allorchestes*.

4965. (From Third Lake.) Several of the usual small Chironomus larvæ, a larva of Corethra, and the mollusk Physa.

4988. The stomach of this example contained only larvæ and pupæ of the small Chironomus. In the intestine, besides the above, there were two caseworms in their cases.

(4) All the facts just cited tend to show that the perch perishing were ranging in the deeper water, and that they had almost invariably made their last meal of insect larvæ found only in the mud of the deeper parts of the lake; that they had been, in short, in company with the herring likewise notably diseased. I was informed by a fisherman familiar with the lake and its inhabitants that it was an extraordinary thing to find the perch ranging into deep water in midsummer, although they were frequently found in numbers in the depths of the lake in winter, when fished for through the ice. In these winter specimens red "worms" (Chironomus larvæ ?) were often noticed.

(5) The mud from the deeper part of the lake, as has been already mentioned, had a peculiar rank and almost stinking odor, and contained a considerable quantity of organic matter undergoing more or less rapid decay.

(6) A comparison of my collections from Lake Mendota with those from Lake Geneva, reported in this article, and especially with my much more abundant collections made from the lakes in northern Illinois, shows an unusually small proportion of cray-fishes, Aselli, Allorchestes, and other crustaceans ordinarily common in our lakes among the weeds and shallower waters generally, and a correspondingly large percentage of Chironomus larvæ in the food of all the perch examined,—a fact which hints at the probable deficiency in this lake of the kinds of insect larvæ and crustaceans usually selected by the perch.

(7) The weather of the summer had been warm and rather showery, but not in any way especially remarkable. There was, however, one heavy flooding rain not long before the outbreak of the fish disease, which may well have washed into the lake unusual quantities of organic matter from the swamp beyond Catfish Bay and from the surrounding country. Any organic accumulations due to such an occurrence would necessarily have been more evident in Lake Mendota, the uppermost of the chain, and that with the largest drainage basin, than in any of the lakes below.

(8) What seem, from the best information I can obtain, quite similar cases of destruction of our native fishes, are of rather common occurrence in the rivers of Illi-

nois in the hottest weather of the year. They usually, if not always, follow upon flooding rains, and thus occur when the streams are full or overflowing with turbid water loaded with the products of decay. They are sometimes succeeded by great deposits of rotting fish along the river front of towns, requiring burial to protect the general health.

We have in the facts reported here abundant material for surmise and the construction of hypotheses; but no means of precise verification. Arriving at Lake Mendota after the practical cessation of the epidemic argued a disappearance or a great reduction of its cause, and unable to obtain good material enough from which to generalize, I have withheld this report in the hope that a similar occurrence within my reach might enable me to complete the investigation. Several of the kind have, in fact, been noticed in Illinois within recent years, knowledge of which has reached me through our State Fish Commission, but always much too late to permit successful study. It therefore now seems to me best merely to put on record the facts already ascertained, and to postpone discussion until more evidence has been collected.

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