

Report of Biological Marine
Work and Investigations in
Utah during the summer of
1938.

by

Reed W. Fautin

REPORT OF THE BIOLOGICAL MARINE WORK DONE AT THE
HOPKINS MARINE STATION, PACIFIC GROVE, CALIFORNIA
AND OF ECOLOGICAL INVESTIGATIONS IN UTAH DURING
THE SUMMER OF 1938.

Six weeks were devoted to a study of the fauna, chiefly of the intertidal zone, around the coast line of the Monterey Peninsula. This work was done during the period from June 25 to August 5, 1938. I was registered at the Hopkins Marine Station and investigated the fauna of the region from that base. See special report for details of the work done while at this station.

The work done in Utah covered a period of two weeks in which a number of areas in the state were investigated in an attempt to find a suitable sagebrush area on which to begin an ecological study for my doctorate problem. A number of sagebrush (Artemesia tridentata) areas were anticipated before investigations were made, but when these areas were investigated it was found that the sage may not be the climatic climax vegetation, but may be subclimax and at the present time is the predominant plant in many places because the bunch grasses, which are thought to be climax, have been killed due to over-grazing and the sage, being less palatable, has become much more abundant than it originally was under undisturbed conditions. This hypothesis was arrived at after finding various protected places in the state in which bunch grasses were the predominant plants, while just outside these protected areas the sage was the most abundant plant.

Three days were also spent in Idaho investigating areas in which bunch grass is known to be the climatic climax in order to make comparisons between it and the protected sage brush areas of Utah.

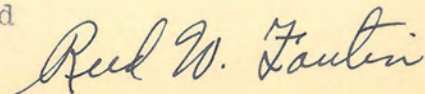
Due to the uncertain ecological status of the sagebrush in Utah, the anticipated ecological study of this type of vegetation was abandoned. After investigating the west-central part of Utah, in company with Dr. Shelford, where the shadescale (Atriplex confertifolia) is the predominant plant, it was decided that my research problem would be an ecological study of this desert area.

In the midst of this desert area is a Desert Range Experiment Station which covers an area of fifty-five thousand acres and at which place I have obtained permission to carry on a good share of my research.

Contacts were also made with Mr. Zimmerman and Mr. Rasmussen of the United States Biological Survey and information obtained from them concerning the trapping and poisoning activities of the survey in the desert region concerned.

Although no ecological studies of this area have as yet been made, the area desired for study purposes has been definitely decided upon and outlined and plans are being made to begin this study this next June.

Signed



Reed W. Fautin

REPORT OF THE MARINE WORK AT HOPKINS MARINE
STATION, PACIFIC GROVE, CALIFORNIA DURING THE SIX-WEEK
PERIOD FROM JUNE 25 TO AUGUST 5, 1938.



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MONTEREY BAY



Fishing boats in dock at the Monterey Municipal harbor.



Jaques Loeb building at the Hopkins Marine Station, Pacific Grove, California.



The rocky shore at Mussel Point with the sandy beach in the background looking eastward across Monterey Bay.

PESCADERO POINT



Algae-covered rocks near the water's edge.



Tide pools at low tide among the large rocks with Point Lobos in the background across Carmel Bay.



Students collecting among the algae in the higher tide pools.

Report of Marine Work at Hopkins Marine Station, Pacific Grove, California during a six-week Period from June 25 to August 5, 1938.

Introduction

The primary objective in doing this work was to become acquainted with as many forms as possible of the marine fauna of the intertidal zone and if possible to determine some of the environmental relationships which exist in as many different types of habitats as possible.

Due to limited amount of time spent in this study no very intensive work could be done and only a general survey was made of the more conspicuous forms of life which were to be encountered.

Most of the work consisted of collecting and observing animals in the tide pools during periods of low tides. The animals collected were then taken to the laboratory and observed and determined as to species. Notes were taken as to the place, time, and situation under which the animals were found.

As many different types of habitats as possible were visited which included rocky intertidal areas of Mussel Point, Point Pinos, Lighthouse Point, Pescadero Point and Carmel Point just east of Carmel Beach. Sandy beaches were visited at Monterey Beach, Carmel Beach and Asilomar Beach. A marine estuary habitat was visited at Elkhorn Slough.

More than two hundred species were identified and observed during this six-weeks period.

A rather hasty population study was made of the eelgrass, Phyllospadix, of the intertidal zone at Mussel Point and of an algae Gigartina caniculata which grows at a level just above the eelgrass. See the separate discussion of these studies.

I wish to thank Dr. Rolf Bolin for many helpful suggestions and information that he gave me; for the determination of the fish that I collected;

and for the use of keys and literature which he placed at my disposal. Thanks are also due Professor Tage Skogsberg for extending me the privilege of auditing his invertebrate class lectures.

Physical factors affecting the fauna of the rocky coast of Monterey and Carmel Bays.

- Topography -

The substratum of the rocky portions of the shore line is primarily granite porphyry which forms the core of the Monterey Peninsula. This granite border has been cut and weathered by the action of wind and water until the shore line has become very rugged and characterized by many large granite boulders and by rocky islands which project up above the water level near the shore.

The ruggedness of the rocky coast offers a very large surface for the attachment of sessile organisms and also makes for varied animal habitats depending on the exposure to the surf action, protection from surf action, presence of regulation, lack of vegetation and etc..

- Temperature -

The average range of the temperature of the open water during the year is only 7.6°C varying from 9.7°C to 17.3°C. The average monthly variation is only 4.7°C. In the tide pools the temperature may vary from 3.0°C to 29°C depending on the time of year and the location of the pool. This bay is located in the cold temperate zone and the Northern fauna is the most typical. With such a narrow range of temperatures breeding occurs all the year round in Monterey Bay.

- Temperature (Air) -

The air temperatures have a much greater range than the water fluctuating from 2.2°C to 30.5°C. Of course the submerged organism would not be affected by the temperature of the air and the exposed ones are usually not subjected to such extremes. Those from the Pelvetia - Fucus Zone down would probably not be affected at all by the air temperatures.

- Salinity -

Salinity of the water is slightly lower than that of the open ocean due to the fresh water that comes from the surrounding land. The salinity of the open water of the bay is 32.12 to 33.82 parts per thousand, being very constant in the degree of salinity.

In certain tide pools the range of salinity may become very great. In winter after a rainstorm it may become practically fresh while in summer evaporation may increase the salinity to the point where salt crystals will form on the bottom of the pool. The mean annual rainfall is 16 inches per year with 90% of it coming from December to February.

- Oxygen -

The waters of the shore regions are usually always rich in oxygen due to a great amount of exposed surface, to the surf action, and to the plants growing along the shore. The average amount of oxygen in the water is 6.2 c.c. per liter.

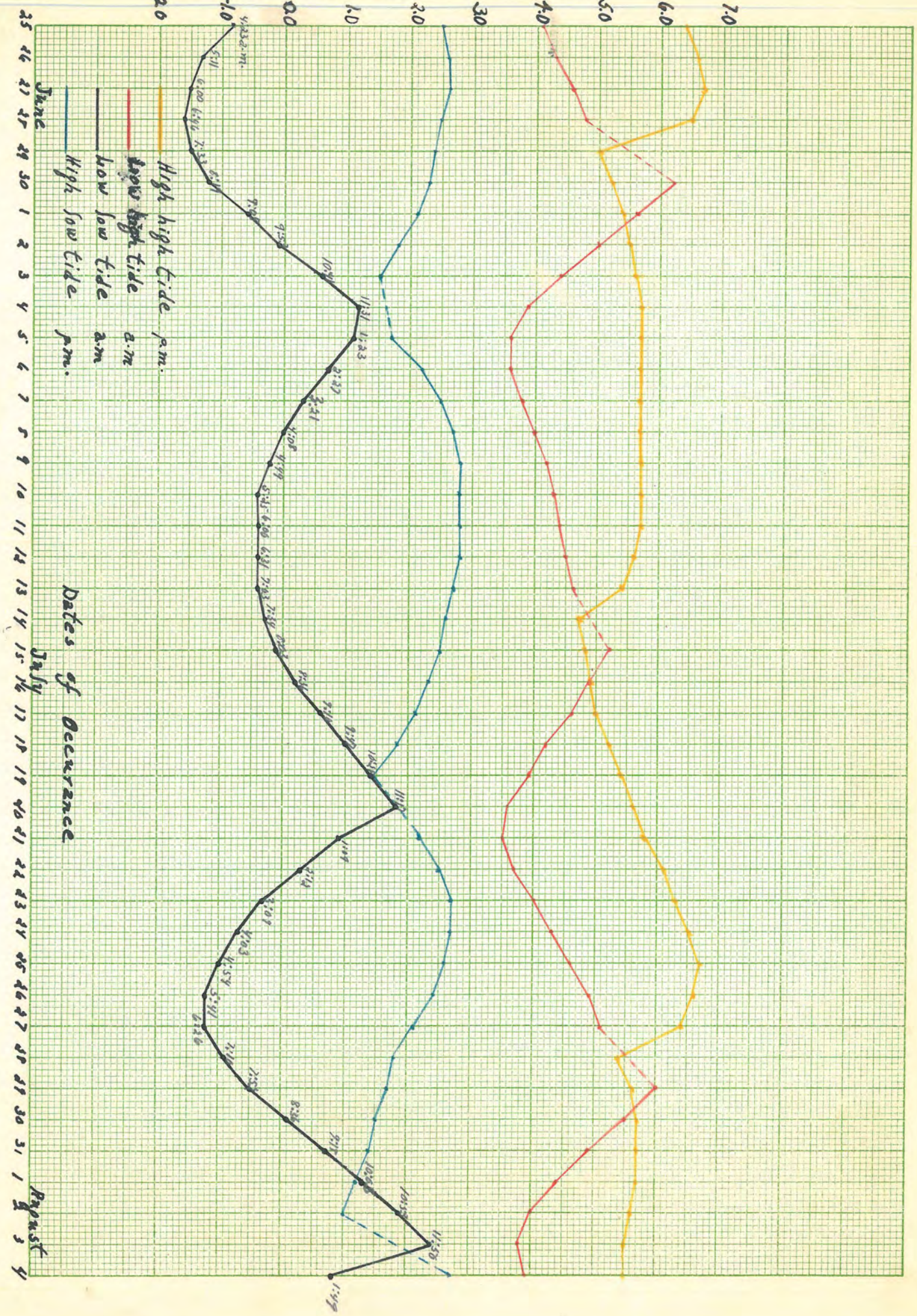
- Fog -

Fog probably has a direct affect on the temperature and light. It is usually absent in the winter so that the surface of the land and water gets the full benefit of the sun but in the summer it is present so that the temperature is reduced making for a cool summer climate and a mild winter climate.

- Tides -

In Monterey Bay there are two high tides and two low tides in every lunar day of approximately 24 hours and 50 minutes, consequently on each succeeding solar day the corresponding tides occur 50 minutes later than on the previous day. The extreme range of the tides in the Bay is about 8.6 feet with a mean of 3.5 feet. See graph of the low and high tides occurring during the time this study was made.

Tide Levels in Feet



These tides have a very profound influence on the distribution of the intertidal animals of this region. Although there are undoubtedly many factors which enter into the distribution of the animals in relation to the various tidal levels, their distribution seems to be greatly influenced and correlated with the relative lengths of the periods of exposure due to the tides.

- Surf Action -

The surf action is relatively great most every place around the peninsula, consequently the animals found here are largely adapted to withstand the severe action of the surf. In certain places the action of the surf is somewhat reduced by the presence of rocky points or projections which are found out from the coast line and which tend to impede or reduce the force of the waves before they reach the coast. The heavy growth of Kelp also helps to reduce the force of the waves and swells before they reach the coast line.

Resistance to Desiccation

When the tide goes out it leaves certain areas exposed to the air. The length of time these areas are exposed of course depends on their location and the magnitude of the tide. The lower areas may be exposed for only a few minutes while the higher areas of the intertidal region may be exposed for 48 hours or more. The animals which are found in these places, that are periodically exposed, must have special adaptations or means which make possible their survival.

One way in which they meet this situation is to migrate with the water -- going to lower levels when the tide goes out. Most of the fish, some crabs and some starfishes follow this procedure but the majority of invertebrates are unable to migrate and are consequently adapted in various other ways to resist desiccation.

Another way of resisting desiccation is to seek permanently moist habitats. When the tide goes out there are certain low places in and among the rocks into which the water drains forming small pools. Many of the animals such as shrimps, certain fish (Cottids), nudibranchs and etc. are found congregated in these small pools until the tide comes in again. On sandy beaches, the animals such as the sand crab (Emerita) and the gastropod (Olivella) burrow down into the moist sand when the water recedes.

Crevice and the under-surfaces of rocks usually remain moist for some time after the water recedes and consequently such animals as isopods (Cirolana), flatworms (Leptoplana), sponges and spinunculid worms are found abiding in such places.

Many of the crevices are filled with sand in which such animals as Lentosynapta, Nereis, Orenicola, and many others are found.

The roots of eelgrass and the hold-fasts of many of the algae also afford places that remain moist and in which many forms of life are found, especially many of the annelid worms.

The leaves of the eel grass and the fronds of the algae also provide suitably moist retreats for such animals as limpets (several species of Acmaea), isopoda, amphipods, gastropods (principally Tegula funebris), and some fish such as blennies. This vegetation retains enough moisture to insure the survival of the animals that abide there.

Another means of resisting desiccation is for the animals to group closely together in large aggregations. Thus on the exposed surfaces of some rocks will be found huge masses of mussels (Mytilus) and gooseneck barnacles (Mitella sp.). Such animals are usually not exposed very long but by being grouped together the total exposed surface is much less than if each individual was isolated. Other animals that tend to form in groups are a small sea anemone, (Evactis) and a tunicate (Clavellina). Many smaller forms including

such animals as isopods, amphipods, annelids, and even small crabs resist desiccation by remaining in these aggregations of larger animals.

Some animals resist desiccation by having sealed chambers into which they can retire. Plecypods and gastropods, especially operculate snails, can withstand desiccation by virtue of their calcareous coverings but there is a great deal of variation as to the amount of desiccation that even structurally similar gastropods can withstand and still survive. In confirmation of this statement I took two species of gastropods of the same genus, Littorina planaxis and Littorina scutalata, and placed them on a shelf in my lab. in order to determine the survival value of the two species when subjected to desiccation, because I had observed that the two species occupied entirely different levels along the coast with respect to the tide levels. Littorina planaxis occurs at a much higher level than does Littorina scutalata and is exposed to the air several hours at a time and sometimes for a period of several days. Littorina scutalata on the other hand occurs at a much lower level and is never exposed for more than a few hours. Twenty specimens of Littorina planaxis were collected and placed on a dry shelf in the laboratory July 7. August 5 they were placed in a finger bowl and covered with water and 18 of the 20 specimen were still alive. Twenty specimens Littorina scutalata were collected July 11 and treated in the same manner as the Littorina planaxis and on August 5 when they were placed in water they were all dead. Thus the difference in their resistance to desiccation seems to be directly correlated with the distribution of these two species with respect to the tide levels along the coast.

Besides occurring in closely associated groups which helps to them to resist desiccation, the tunicate Clavellina and the sea anemone Evactis have gelatinous coverings into which they can contract when the water recedes and which aids them in resisting desiccation for relatively long periods of time.

Suspended activity also aids many of the animals in resisting desiccation. When the water recedes the animal forms withdraw into their natural covering, such as the gastropods, the sea anemones, the limpets, or the barnacles and ~~these~~ they remain in an inactive state until covered with water again. Some barnacles of the species Balanus glandula are situated in places where they may be out of the water 95% of the time during certain periods of the year. They are able to survive largely because they remain inactive during the time they are exposed to the air and become very active just as soon as they are covered with water, actively extending their cirri in search of food.

The motile forms such as many of the crabs, the fish, isopods, and others seek moist places such as beneath rocks or beneath the algae, or retreat into pools when the water recedes and remain in a more or less inactive state in these places until the water returns. Limpets feed only when covered with water but remain inactive and stationary during times of exposure adhering as closely to the substratum as possible.

Resisting Wave Impact

When one watches the breakers rolling in and pounding the shore line of the coast he is immediately confronted with the problem as to how the animals, which live along the coast in the intertidal zone, are able to resist the impact of the waves. Upon further observation one soon finds that there are certain sheltered places where the animals may seek refuge from the force of the waves. Some of the snails such as Acanthina lanilloides will be found adhering to the sheltered sides of rock walls. The crabs, and especially those of the genus Petrolisthes find refuge beneath rocks and in cracks and crevices. The algae or sea weeds offer much protection to many forms of which the black turbin snail, Tegula funebris, is a very characteristic species which resists the wave's impact by remaining among the algae. Some animals such as the mussel Mytilus californicus and the barnacle Mitella polymerus grow very close

together and thus offer some protection to each other and also provide shelter for other forms such as small crabs, isopods, annelids and many other forms.

In many places along the shore there are large beds of kelp growing out beyond the shore line which help very much in reducing the impact of the waves before they reach the shore.

One very characteristic thing about the animals of the intertidal zone is that they all seem to have special powers of adhesion which help them to resist the impact of the waves. In many forms these organs of adhesion serve merely as temporary means of attachment, such as the hook-like claws of many of the crabs. The tube feet of the star fishes and sea urchins are also very effective means of attachment. The sucking disk on the ventral surface of the fish, Caularchus, enables it to adhere tightly to the surfaces of rocks. The pedal surface of the gastropods especially the abolinies and limpets enable these animals to adhere very closely to exposed surfaces and offer a very great resistance to the wave impact.

Other forms such as the mussel Mytilus californicus and the sea anemones have semi-permanent attachments. These forms are capable of moving somewhat but their movements are usually very restricted. Although the mussels are attached by slender thread-like structures called bysses, they are very strong and it is only during severe winter storms that the mussels may be dislodged from their places of attachment.

Many forms such as the sponges, hydroids, bryozoa, tunicats, rock oysters, and barnacles are permanently attached to the substratum and consequently are able to withstand the action of the waves unless torn apart.

Some forms such as the fishes are streamlined and by facing into the oncoming waves are able to cope very well with them. Limpets, besides having an effective pedal attachments are streamlined dorsally which also helps them resist wave action.

Some forms such as ~~n~~dibranchs offer no particular resistance to the wave impact but merely flatten out and passively ride the waves, often adhering to the surface film.

ELKHORN SLOUGH



Looking west across the slough showing the exposed mud flats at low tide and the sand dunes in the background which lie between the slough and the ocean.



Looking south along the slough showing exposed mud flats in the foreground and numerous shore birds, most of which were Western Willets, and the old Salinas River channel in the background.



Students at work on the edge of the old river channel at low tide.

Elkhorn Slough

Elkhorn Slough is located on the east side of Monterey Bay, midway between Pacific Grove and Santa Cruz. It is 23 miles north, by road, from the Hopkins Marine Station at Pacific Grove. It is at the head of a submerged river gorge, which was perhaps, before subsidence, the Salinas River. A Coast and Geodetic Survey Map of 1878 shows the Slough as a part of the Salinas River, and ~~it~~ at that time it was the outlet of the river. It continued to serve as the outlet of this river until 1908.

At the present time the connection between the Salinas River and the Slough is disestablished and only during the winters does any water enter the Slough from the Salinas River, consequently, Elkhorn Slough is at the present time a strictly salt water estuary.

The Slough has several branches, but none of them add greatly to its storage powers. The main body of the Slough extends east and north for about eight miles, and for most of its length is in from one hundred to three hundred yards wide. There is no appreciable fall throughout its length.

The mouth of the Slough is about 2.5 feet above mean low water or 0.0 feet, and consequently the tides must be greater than that before the water will be forced back into the Slough. When the tide is out there are many of the higher parts of the Slough which are exposed and due to the height of the mouth of the Slough some of the lower tides do not come in and consequently these higher places may remain exposed for as much as 18 hours or more. The water in the burrows of certain animals may thus remain unchanged, except for seepage, for many hours.

The soil of the Slough bottom varies from ocean beach sand to a very stiff clay. The part I visited being a black sandy mud.

Plant life is quite abundant, and the uniform conditions at certain places allow patches of Zostera to become established and continue from year

to year. Most of the algae are animals, and they grow in large areas where Zostera does not grow and where the bottom is not exposed at low tide.

The temperature is fairly constant as the daily tides prevent water from standing long enough to warm more than one or two degrees. Even the surface of the mud flats which are exposed to the direct rays of the sun do not show any great rise in temperature because of evaporation.

The oxygen supply is kept relatively high by the incoming tides which bring in well aerated water from the surf; and by the fact that the water of the Slough is for the most part shallow allowing a large surface to be in contact with the air per volume of water.

The salinity is about the same as the open ocean but there is probable a little greater variation than in the ocean due to fresh water entering the Slough in winter and spring, and because it is not very deep allowing considerable evaporation which would tend to increase the salinity during certain times of the year.

Since the Slough is shallow everywhere except in deep channels that are cut through it, the light is quite intense. However, most of the animals are mud dwellers and live in the dark.

The animal population of this Slough is relatively high, but from external appearances there appears to be but little life because most of it lives in the mud. Mac Ginnitie (1925) ^{lists} 207 species of which 22 were new having never been described before and the ranges of 23 others were extended to this area.

I made ~~two~~ trips to the Slough for a short period of two or three hours and consequently was able to observe only a small part of the Slough and that part very superficially. These trips to the Slough were made during the morning of July 20-21. The following are the animals collected at this time which are probably the most conspicuous and typical animals of the Slough.

Urechis caupo Fisher and Mac Ginnitie

The Urechis lives in muddy sand in burrows shaped like a widely expanded U, the two openings of which are from 16 to 38 inches apart, the average being about 27 inches. The diameter of the tunnel varies with the size of the animal, and the apertures are about one third the diameter of the burrow. These burrows are permanent, the only changes being enlargement and elongation to compensate for the growth of the animal which is very slow, or repair or renewal of a damaged entrance.

The rapidity and manner of locomotion of Urechis suggests that of an earthworm. It can move backward and forward with about equal rapidity. It elongates the anterior portion of the body, then, by contracting the circular muscles of the posterior portion of the body, most of the viscera and weight of the animal are forced into the anterior end. Then the posterior part of the body is drawn forward, the walls of the burrow serving to anchor the anterior portion during this process. It never leaves the burrow of its own volition and after an Urechis is once established in a permanent burrow its daily activities consist of respiratory movements, feeding, cleaning the burrow and resting.

Respiration of Urechis is anal. The posterior portion of the hind gut is a thin-walled muscular cloacal chamber. Water is inhaled through the anus by a series of from one to thirty intakes and usually exhaled by a single discharge.

Urechis employs a very unique method of feeding. A short distance posterior to the oral setae in a zone of mucous glands, which encircle the body. When Urechis is ready to feed it expands this region until it presses against the sides of the burrow, usually near the mouth. The animal then begins to secrete mucus, and as it backs down the burrow it leaves a mucous tube, one end of which is attached to the burrow, and the other to its own body. As the tube is being formed the normal respiratory peristalsis takes place, but the portion of the body anterior to the attachment of the tube is constricted and undergoes a

peculiar spiral peristalsis. The slime tubes may be from 2 to 8 inches in length. When the tube is completed the spiral peristalsis ceases, and normal pumping or ventilating peristalsis continues until, apparently, the water current is blocked by the clogging of the mucous with detritus. The animal slips the tube forward, catches it with the proboscis, and proceeds towards the entrance of the burrow, swallowing the tube with its intercepted detritus as it goes.

Urechis has three permanent commensals living with it, Hesperonoe adventor, a polyclad which subsists on the particles of food rejected by Urechis when swallowing the slime tube; Scleroplax granulata, a small crab, which lives on food washed into the burrow of Urechis; and Pinnixa franciscana another small crab which screens detritus, by means of its second maxilliped, from the current of water which passes through the burrow of its host. The structural adaptations of the polyclad Hesperonoe adventor indicated that it has been associated with Urechis for a long period of time. Only one Hesperonoe occurs within each burrow, and if another enters the two will fight until one is killed or driven out. Other annelid worms which may find their way into the burrow are speedily dispatched and devoured. Hesperonoe stays with its dorsal surface in contact with the body of Urechis, moving along the burrow with the latter by making short runs as the peristaltic movement of the body of Urechis passes by. It always faces the same direction as does Urechis, and when the latter turns in its burrow the polynoid quickly does likewise.

Phoronopsis viridis Hilton

This species occurs in such members in certain regions of the Slough that when they are covered with water and their tentacles are expanded the bottom of the Slough takes on almost a solid green color. They seem to have a tendency to form colonies which may be an acre in extent. They seem to prefer the open Slough bottom and never occur in the beds of Zostera. When they are exposed by the low tide they retract leaving tiny holes in the surface of the sand. Mac

Ginnittie counted 281 of these holes in 100 sq. cm. The tubes in which they live extend down deep into the sand and mud and probably help to keep it from washing away.

Callianassa californiensis Dana

This "Ghost shrimp" is one of the most characteristic animals of the Slough. Its abundance and activity make it a very important animal of the Slough as it no doubt plays a role for the bottom soil of the estuaries comparable to the earthworm in the fields. It makes possible the existence of certain other animals in that its burrows, which often extend downward as far as any other life exists, supply the deeper soil with fresh water. It is a detritus feeder, securing its food by sifting out the sand. When feeding the shrimp takes sand from the face of the burrow and sifts it by means of the hairs on the dactyls of the second and third legs. The hairs take out the desired material and allow most of the sand to slip through. The fine material which has been retained by the hairs is scraped off the hairs of the third maxillipeds and passed into the mouth by a series of movements of the mouth parts. The discarded sand is picked up, carried to the entrance and pushed outside.

Although the burrows often extend downward to a depth of 30 inches the main activity is within the upper 18 inches of soil, for this is the richest part. The surface of the bottoms of the sloughs, with its layer of detritus is thus continually being covered and worked deeper by the feeding and burrowing activities of these animals as they bring the excavated sand to the surface.

The following commensals are said by Mac Ginnittie (1935) to be found with the ghost shrimp: Scleroplax granulata, Pinnixa franciscana, Hesperonoe complanata, Crystomya californica, and two species of Hemicyclops (one from the egg masses, the other from the gills.)

Cancer productus Randall

This crab is said to be found at the Slough throughout the year and is usually found among the vegetation.

Cancer antennarius Stimpson

This is one of the most common crabs of the Slough and may be found throughout the Slough but is more common the more protected places. It is a scavenger like the above species.

Pachygrapsus crassipes Randall

This crab is very numerous in burrows along the clay bank of the east side of the Slough. While along the rocky coast it finds crevices to retreat into, here it has burrows in the clay bank into which it quickly vanishes when approached.

Pachygrapsus crassipes is a scavenger as an adult, but the juveniles pick algal growth by means of their chelae and eat it.

Hemigrapsus nudus Dana

This species is found only where there are rocks along the Slough. Unlike other shore crabs it does not inhabit burrows along the bank.

Hemigrapsus oregonensis (Dana)

This shore crab is the most plentiful of all the crabs at the Slough and is found most everywhere. It seems to prefer beds of Zostera or algae, such as Enteromorpha or Polysiphonia, for places of refuge, but many individuals were seen on the bottom in the open water where their carapaces become covered with algae making very inconspicuous.

- Mollusca -

Pelecypoda

Family -- Ostreidae

Ostrea lurida Carpenter

This is the west coast oyster and it is rather plentiful in all parts of the Slough where there are rocks or pilings to serve as places of attachment. It attaches itself to most anything solid and must be kept from mud or it will become smothered.

Family -- Cardiidae

Cardium corbis (Martyn)

This cockle is fairly abundant throughout the Slough. Since the siphon of this clam projects just beyond the edge of the shell, the clam lies either partly exposed or buried just beneath the surface so that the siphons are just at the surface. It is rather active and can move quite considerable distances. It usually remains where the bottom is not exposed at low tide, but if on exceptionally low tide occurs it will often be found out on the exposed flats, where it has migrated during high water.

Family -- Venevidae

Saxidomus nuttallii Conrad

This is a large edible clam with extremely rough valves. Because of its food value it is being rapidly depleted in numbers almost to the point of extinction. It is one of the few larger clams which Mac Ginnitie says has no parasites or commensals.

Family -- Tellinidae

Macoma nasuta (Conrad)

This is the most common clam in the Slough and is called the 'bent-nosed clam' because the valves are bent to the right on the siphon end. A simple shovelful of mud may contain 10-20 ^{individuals} of this clam in certain places. Macoma lies in the mud on its left side, with the bent portion of the shell directed upward, and may be found anywhere in the first part of soil. This clam feeds by extending its excurrent siphon out on the sand for a distance of one or two centimeters. The tip is then rotated or waved back and forth over the surface of the sand sucking up the detritus that is deposited there. After two or three minutes the siphon is retracted even with the surface of the sand, and then the clam blows out through this same siphon the sand and other inedible materials taken in. After one place has been sucked clean the clam moves away 3 or 4 inches to another one. The excurrent siphon is small and does not

usually reach the surface.

Family -- Mactridae

Schizothaerus nuttallii (Conrad)

This is probably the most abundant of the large clams. This species is easily located by the large size of the hold through which the siphon comes to the surface, and if the siphon is extended it may be readily identified by the hard chitinous plates on the end of the siphon which are unique for the genus. It is an edible clam but its gaping valves make it unsuitable for shipping. These clams can often be seen spouting water from their siphons for a foot or two above the surface of the sand or more below the surface from which position they extend their leathery siphon to the surface.

Family -- Myacidae

Cryptomya californica (Conrad)

This is a small (22 to 30 mm.) inequivalved clams that is usually most abundant in the vicinity of Callianassa, Urechis, and Upogebia. It has short siphons yet it is often found 20 inches below the surface. It is thought that it is able to live at these depths by the fact that it lives with its siphons projecting into the burrows of Upogebia, Urechis and Callianassa (Mac Ginnitie, 1934.) In this way it is able to obtain its food from the water that circulates through the burrows of these animals.

Family -- Pholadidae

Zirfaea gabbi Tryon

This is a boring clam which is found only in the hard clay. The upper layer through which the siphon is extending may be muddy or sandy but the clam itself will always be found in the hard clay substratum. Zirfaea has a very thin shell which is easily broken, and is not the kind of equipment one would expect in a borer. The shell seems to lack a nacreous layer and for this reason lacks the pearly appearance of most bivalves, but instead has the dull limy appearance of pure calcium carbonate. On the outside near the ~~an~~ anterior end, are many rather

sharp spines with which the animal scrapes material loose from the sides and ends of the burrow. The siphon is double and very extensible and the openings are usually held about even with the surface. The lower end of the burrow is from 12 to 14 inches below the surface.

Class -- Gastropoda
 Order -- Opisthobranchiata
 Sub-Order -- Nudibranchiata
 Tribe -- Cladohepatica
 Family -- Aeolididae

Hermisenda crassicornis (Eschscholtz)

This nudibranch was very numerous at the Slough, and very large, some of them about 60 mm. in length. They were in the water and on the Zostera. Their eggs were attached everywhere to Zostera and Enteromorphi. The eggs are arranged in groups of loosely coiled masses in a regular order. In appearance they resemble a tangled string of tiny white beads embedded in a gelatinous mass.

Order -- Streptoneura

Olivella biplicata Sowerby

This snail is found on the bare sandy bottom of the Slough where it ploughs along through the soil, either with its foot just below and the shell partly above the surface or with its entire body just below the surface, leaving a small furrow behind as it plows along. Olivella is a scavenger and seems to prefer partly decayed flesh.

Vertebrata
 Class -- Pices
 Family -- Syngnathidae

Syngnathus californiensis Storer

This is a relative of the sea horse and is quite common among the Zostera. It is very difficult to see in the water because it stands upright. This habit makes it look almost like a blade of Zostera, for it, too, is greenish in color. The male pipefish have a brood pouch in which they carry eggs until hatched.

Family -- Perchidae

Cymatogaster aggregatus Gibbons

This is a small perch which gives birth to living young. Two young were removed from the coelomic cavity of a specimen that was collected. The body is encircled by yellow bands.

Class -- Aves

Tide flats such as Elkhorn Slough seem to be a favorite feeding ground for shore and sea birds. The daily feeding of large numbers of birds cannot help but have a considerable affect on the animal life of the Slough. The gulls seem to be the most numerous of which the Western Gull, Ring-billed, and Herrmann's Gull are the most common. Within the Slough these gulls feed on anything they can find, living and dead. They scour the tide flats at low tide, picking up any form of stranded life and taking considerable toll of the young clams which have the habit of coming to the surface when exposed by the tide.

Probably the next important bird, from the point of view of its effect on the animal life of the Slough, is the Brown Pelican. These birds obtain fish from the water by diving and many of them were found engaged in fishing activities at the mouth of the Slough.

The Great Blue Heron also feeds on the animal life of the Slough. These birds are said to nest in the Eucalyptus grove on the south side of the Slough just above the highway bridge and can be seen feeding at most any time of the day on the Slough.

Although the Least Tern is a rather small bird yet they are tireless fishers and are constantly swinging up and down the Slough in search of fish.

The Scoters, Loons, and Cormorants fish to some extent in the Slough. The Scoters are probably most important because they feed on small crabs as well as fish. Mac Ginnitie (1935) lists the following birds as occurring on the Slough. The ones marked with an asterisk are abundant the entire year: Herrmann's Gull, Herring Gull, Ring-billed Gull, *Western Gull, Forster's ^{Tern,} Pacific Loon, Pied-billed Grebe, Western Grebe, Eared Grebe, *California Brown Pelican, White Pel-

ican, *American Coot, Red-breasted Merganser, Surf Scoter, *California Great Blue Heron, Black-crowned Night Heron, Dowitcher, Marbled Godwit, Knot (not common); Western Willet, Least Sandpiper, Wilson's Phalarope, Greater Yellow Legs, and Kingfisher.

A Quantitative Study of the Gigartina caniculata and
Phylospadix sp. of the Intertidal zone at Mussel Point.

Much of the rocky and gravelly surface which is covered with water the greater part of the time at Mussel Point is covered with a dense growth of vegetation. This growth of vegetation begins at about the zero tide level and extends on down. Between the zero and two foot level the growth consists principally of the algae Pelvetia and Fucus with the first one being the most abundant. At a level just below the Pelvetia - Fucus Zone a number of other algae come in. One of the most conspicuous of these is Gigartina caniculata. This algae was found growing principally on a solid rock substratum forming a dense vegetative growth over the surface of the rock. At the time this study was made, July 25 and 26, this algal growth was only about 2 to 4 inches high.

One-tenth square meter samples were taken and the number of animals per area of ten square meters computed from these samples.

Amphipods and isopods proved to be the most numerous species of animal life found in this algae. Most of the amphipods were colored brown very much the same as the algae on which they occurred. The genus Amphithoe sp. was the most abundant amphipods and Cirrolana harfordi was the most abundant isopod, see Chart No. 1.

Eighteen species were found in the samples taken - see Chart No. 1. All of these forms were small, and even though some of them, such as Strongylocentrolin purpuratus and Pagettia productus, were representatives of larger species. Only very young specimen of these larger species were found. Spirorbis were very numerous on old pieces of shells and rocks lying among the algae.

The eel grass (Phylospadix) occurred at a level just below the Gigartina and was seldom exposed for more than an hour or two at a time. It was from a foot to eighteen inches high and its roots formed a regular sod of the gravelly substratum on which it grew. Thus it provided a place of refuge for animal life both above the surface and in the substratum among its roots.

23.

Amphithoe sp.

Exosphaeroma amplicauda

Psecypod (small white)

Cirolana harfordi

Annelids (undetermined sp.)

Orchestoidea californica

Strongylocentrotus purpuratus

Tegusa funebris

Nereis sp.

Crepidula adunca

Small Chiton (undetermined sp.)

Thais lima

Pugettia productus (small)

Limpet (small undetermined sp.)

Small undetermined Brittle star

Psanocera californica

Acmacea simulata

Spirotbis sp.

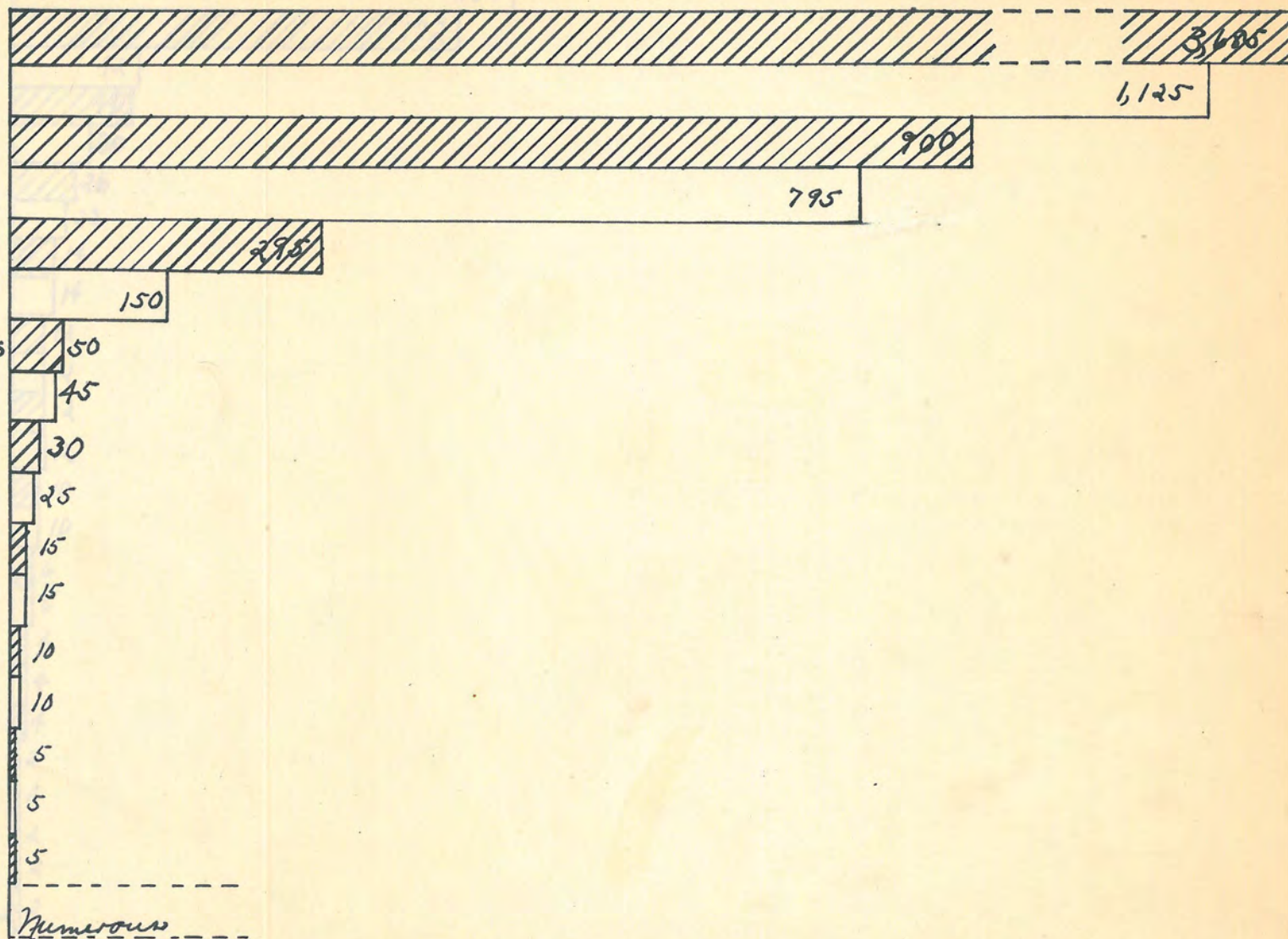


Chart No. 1. showing the kinds and numbers of animals found per square meter of *Gigartina caniculata*.

24.

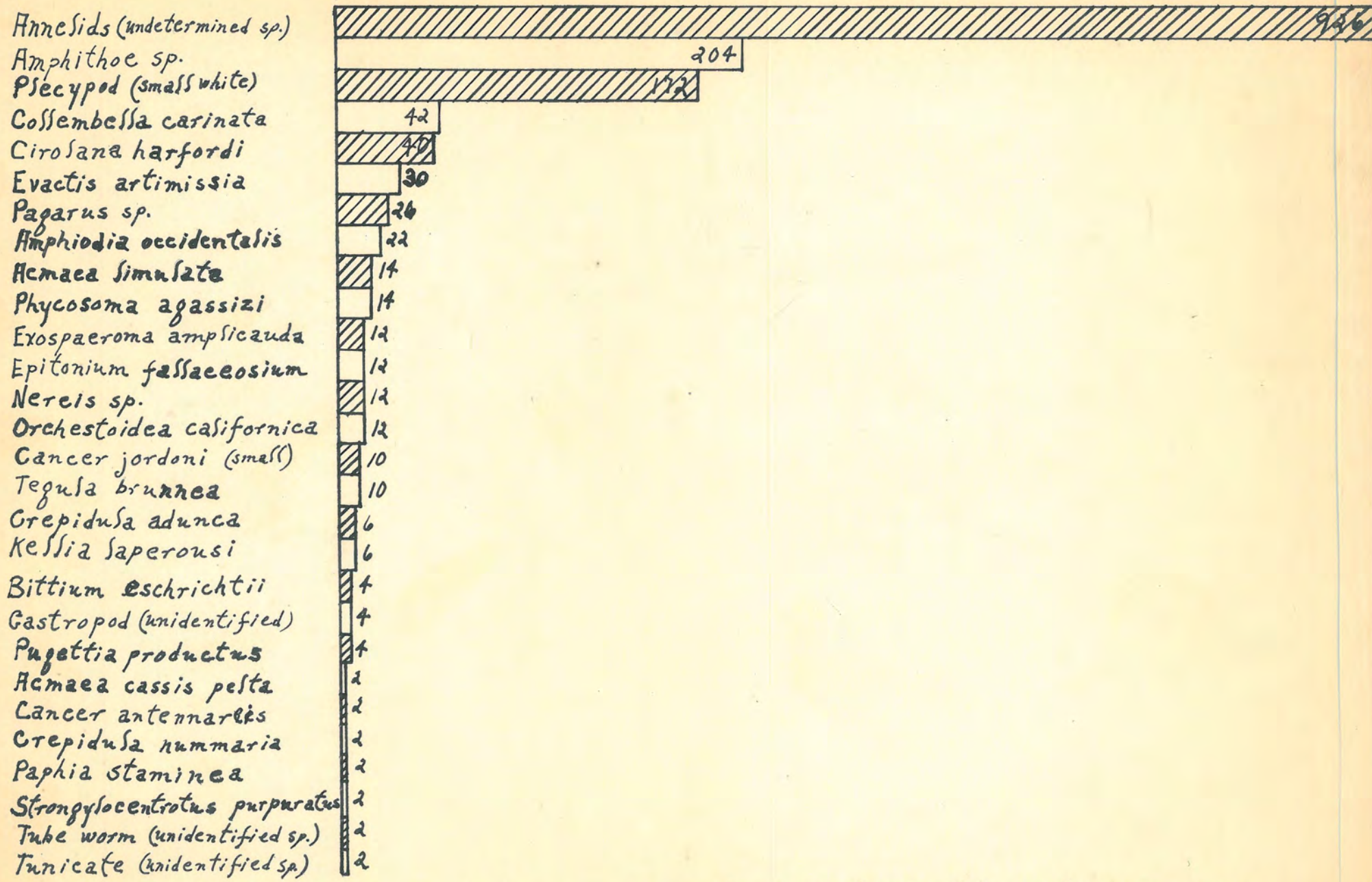


Chart No. 2. showing the animal population of one square meter of eel grass, Phyllospadix sp.

The sod which it formed was simply filled annelids, they being the most abundant form of animal life found, see Chart No. 2. In certain places there were many sea anemones, Evactis artimissia, practically all of the ones found were taken from one tenth square meter sample

Gastropods and crabs of various species were quite abundant and the number of species found, 28 in number, was much greater than the number (18) found in the algae.

Animal life of the Sandy Beaches

Although most of the coast around the Monterey Peninsula is rocky, there are some places where there are sandy beaches. Some of the beaches visited were Monterey Beach, Asilomar Beach and Carmel Beach.

The animal life at these beaches was found to be very limited. Sand is not a very desirable habitat for most animals because it is so unstable and is always shifting due to the action of the wind and waves. Because of the sand that is carried in suspension in the water, due to the whipping of the waves, most animals meet with difficulty in breathing such water. Along such beaches there is also little or no growth of vegetation which might afford protection to animals and consequently only those forms which are able to burrow in the sand and cope with such a changing habitat are able to survive.

The following are some of the most conspicuous animals found at these beaches:

(Orthopoda)

Class - Crustacea

Subclass - Malacostraca

Order - Amphipoda

Suborder - Gammaridea

Family - Talitridae

Orchestoidea californica (Brandt)

This is a very large amphipod that is common along the sandy California beaches. This species is said to be usually seen feeding on the kelp that is left on the beach by the receding tides, but, the ones that I observed at the Monterey Beach between the Municipal Wharf and Pop Ernest's were out on the sand beyond where the high tide reached. There were hundreds of them on the surface of the dry sand and some were burrowing down into the sand.

The body of this amphipod is white to pinkish and the peduncle of the second flagellum is red. The flagellum is longer than the peduncle, and the antennae as a whole is longer than the body of the animal

Order - Isopoda

Superfamily - Cymothoidea (Flabellifera)

Cyrolana harfordi (Tockington)

Although this isopod is not restricted to the sandy beaches it is found here as well as every other place I visited around the Peninsula. It is a scavenger and will be found most everywhere where there is any dead animal matter. Because of its scavengeristic tendencies, this species is often used in cleaning the skeletons of animals. By placing an animal along the shore where the isopod is numerous the skeleton can be cleaned within a very short time.

The color of this species is not constant but in general the ground color is light with a pattern formed of black dots. The uropoda have two branches and the abdomen, which is composed of six segments, bears a number of spines upon its posterior border. Epimera are present upon the last six ~~thoracic~~ segments.

Order - Decapoda
 Suborder - Natantia
 Tribe - Cardides
 Family - Crangonidae

Crago nigricauda (Stimpson)

The "black-tailed shrimp" is very characteristic of sandy beaches and is protectively colored by black specks which give the animal a dark gray color that closely resembles the sand.

The distinguishing characteristics of this shrimp are one median spine on the rostrum and a small spine just back of it; the dorsal profile of the carapace is nearly straight; the hand is a little more than twice as long as wide and reaches the tip of the antennal scale; and the fifth abdominal segment has a keel on its dorsal surface

Suborder - Reptantia
 Tribe - Anomsera
 Family - Hippidae

Emerita analoga (Stimpson)

The "sand crab" is found along sandy beaches usually at the lower tide levels but is also often found at higher levels. If stranded on the sand by receding waves it immediately burrows down backwards and buries itself.

The adults are steel gray above, with transverse flecks of lighter color, the general effect tending to harmonize with the sand. The ventral surface and legs are white with a pinkish tinge. There is a great difference in the size of the two sexes, the females averaging 29 mm. in length and the males 12 mm.

They live principally on plankton because they lack hard mandibles which would facilitate chewing. While feeding they lie buried just beneath the surface of the sand with their antennae extended up above the surface and arranged in the shape of a funnel so that the plankton that is caught is moved downward to the mouth.

Tribe - Brachyura
 Subtribe - Brachygnatha
 Superfamily - Brachyrhyncha
 Family - Cancridae

Caner magister (Dana)

This cancer crab is practically restricted to sandy or gravelly bottoms and is never found in rocky situations.

Its carapace is widest at the tenth anterolateral tooth; the posterolateral margin is entire, with teeth; the anterolateral teeth have more or less prominent serrations anteriorly; the carapaces of the chelipeds have a single spine above at the distal end.

It is reddish brown in color, being darkest anteriorly and often light orange below. The inner sides of the anterior feet and hands are crimson.

(Mollusca)
 Class - Gastropoda
 Order - Ctenobranchiata
 Suborder - Orthodonta
 Family - Olividae

Olivella biplicata (Sowerby)

This gastropod which is called the "purple olive" has a strong, solid shell which is rather pearl-gray in color shaded with purple or pure white except for a narrow purple band winding on to the collélla. It has a wide, white callus on the collumella and two small folds at its base.

The living mollusks may be found when the tide is low on sandy beaches. If

the water recedes and leaves them stranded on the sand they almost immediately bury themselves and crawl along just beneath the surface of the sand.

Suborder - Streptodonta
Family - Naticidae

Polinices lewisii (Gould)

The "Lewis moon-snail" is a very large predaceous mollusk that is said to usually occupy mud flats where it plows along just beneath the surface of the mud but I found them at low tide levels at the Monterey Beach where it was very sandy.

The shell is strong, brownish white; the interior chocolate color; and the umbellicus narrow and deep with a callus extending partly over it from above. A medium sized specimen measures 105 mm. in length.

It has an enormous foot which when extended looks as if it would be impossible to get it back in its shell. It is said to be very fond of oysters and clams as food.

The specimens collected were on the surface of the sand in water about eighteen inches deep.

INTERTIDAL ANIMALS



A typical growth habit of the mussel, Mytilus californicus, and the goose-neck barnacle, Mitella polymerus, on the surface where they are exposed to heavy surf action.



Polinices lewsi, the moon-snail which is found on sandy or mud bottoms.



Pisaster brevispinus, one of the starfishes which are not so common in the intertidal zone but occur at lower depths just beyond the intertidal region.

Intertidal Animals of the Rocky Coast Line.

The following list of animals includes only those forms that I collected or observed along the rocky coast at Mussel Point, Point Pinos, Lighthouse Point, Carmel Point, and Pescadero Point. Notes as to the description of each of the animals, the situations and places where they were found, were made at the time the animals were observed.

(PORIFERA)

Leucosolenia eleanor Urban

This is a loosely connected sponge being made up of a mass of tubes grown together to form a rather thick mass. It is greyish white in color and is found on the under surfaces of over-hanging rocks.

Ophlitospongia pennata (Lambe)

This is brilliant red sponge that forms an encrusting coat which may get to be an inch thick or more on the upper surfaces of rocks that are back in places that are protected by over-hanging ones.

Rhabdodermella nuttingi

This a Grantia-like sponge which grows in the general shape of a vase. It is greyish-white in color and grows to a length of an inch or inch and a half in clusters on the under-surfaces of over-hanging rocks at low tide levels in rather well protected places.

(COELENTERATA)

Class--Hydrozoa (Hydromedusae)

Order--Gymnoblastera

Family--Bimeriidae

Garveia annulata Nutting

This is a very beautiful and somewhat conspicuous hydroid because of its orange color. It has hydranths that have a conical or dome-shaped proboscis surrounded by a single whorl of about 16 thread-like tentacles. The reproducing polyps are fixed sporosacs on branch-like pedicels and are not permanently surrounded by a perisarc. The stalk is made up of a number of stems tightly held together. The whole colony may be 50 mm. in height. The annulation of the stems may or may not be pronounced. The color is orange

With the main stem and sporosacs a deeper color than the rest of the colony. They are found at low tide levels growing on a rocky substratum in well-protected places.

Family--Eudendriidae

Eudendrium californicum Torrey

This hydrozoan may easily be mistaken for one of the brown algae. The stem is made up of a single tube which has a stiff brown outer covering. The flower-like hydranths are borne at the tips of the secondary branches. This species is characterized by numerous rings or annulations throughout its length. The reproductive zooids are borne on the hydranths just below the tentacles. It was found growing to a rocky substratum at low tide levels either on bare rock surfaces or among the eel grass or algae.

Family---Tubularidae

Tubularia marina Torrey

This is a rather long slender hydroid which grows on rocks that are exposed to the breakers. The stems arise in clusters from a creeping "stalk" which adheres firmly to the substratum. The stems are more or less annulated, unbranched, and from 30 to 50 mm. long. There are 20 to 26 tentacles in the outer circle and 26 in the inner. The female medusoids have four stout tentacles that are as long as the medusoids themselves.

Order--Calyptoblastea (Leptomedusae)

Family--Campanulariidae

Orthopyxis caliculata (Hincks)

This a very small hydroid which is usually found growing on sea weed. The stems which bear the hydrothecae are only about a quarter of an inch long and unbranched, springing from a creeping rootstalk. The pedicels are usually regularly annulated throughout their length. The hydrothecae are variable in shape and in the thickness of their walls, but the walls are always thickened toward the bottom forming a shelf upon which the polyp rests. The medusae is one sixteenth of an inch high with no tentacles but with four minute pigmented bulbs and eight lithocysts.

Family---Sertulariidae

Abietinaria filicula (Ellis and Solander)

The slender stems of this hydroid have alternating branches pinnately arranged and the branches may themselves be branched more than once. The flask-shaped hydrothecae are nearly opposite each other on the stem and have small round openings. The only specimens observed were found attached to tunicates at a low tide level at Mussel Point.

Sertularia pulchella (d'Orbigny)

This hydrozoan was found growing in an abundance among the eel grass. The colonies have few or not branches and grow out from a creeping stolon. The hydrothecae are in pairs and opposite each other. There are two marginal teeth and the hydrotheca has a large opening.

Family---Plumulariidae

Aglaophenia struthionides (Murry)

This is one of the most common hydroids that I encountered. Each colony has regular, alternating branches from each side of the the central stem, the whole colony often growing to a length of about six inches. The hydrothecae are in one series on one side of the branch and each has eleven prominent teeth and three nematophores. They are usually attached to algae.

Free medusae are not formed but the egg cells develop into ciliated larvae with the gonangia.

Family---Thaumantiidae

Polysorchis penicillata (Eschscholtz)

This is beautiful little medusae which was taken in the open water by means of a plankton net near the station at Mussel Point. It is bell-shaped, about 50-60 mm. high and 30-40 mm. broad. It has four short lips. The ring canal is unbranched but the radial canals each have 15-25 pairs of short branches which end blindly. It has 40-150 tentacles arranged in 2-4 rows. The tentacles can contract until they are only short thick stubs or they can become extended to twice the length of the bell. There is an eye

spot at the base of each tentacle. The gonads, 4-8 in number, arise from each of the radial canals between the sides of the stomach and the branched parts of the canals. The stomach, gonads, tentacle-bulbs, and radial canals are reddish brown to purple in color.

Class--Anthozoa or Actinozoa
 Subclass--Zoantharia
 Order--Actiniaria
 Tribe--Hexactiniae
 Family---Bunodactidae

Bunodactis xanthogrammica (Brandt)

This is probably the most common large sea anemone encountered along the coast. The disk may reach 6 inches in diameter and the color is highly variable ranging from a dull gray to a purplish green. The green color is exhibited only by those individuals that are exposed to the sun. This color is said to be due to the presence of unicellular alga that are embedded in the endoderm of the column wall, mesenteries, and the tentacles. Specimens growing in the light are usually green marked with purple, while those in the shade are frequently almost white or delicately tinged with pink or lavender.

Evactis artemessia (Dana)

This is a rather small sea anemone and is probably the most common species around the bay. When the water recedes it contracts and small pieces of shells and small pebbles adhere to its outer surface so that it looks much like the substratum to which it is attached. In certain places it forms a complete mat over the surface of the substratum. It is usually found at a higher level than Bunodactis xanthogrammica and is much smaller although both species are very similar in color and structure.

Epiactis prolifera Verrill

This is a small sea anemone that is characterized by having egg pits on the outside of its body. It is thought that the eggs remain within the body until they reach an advanced stage of development when they migrate to the pits on the outside where they complete their development and the young remain attached to the base of the parent for some time after they are hatched.

The color is usually red or reddish brown but some may be greenish. The column is marked by vertical lines of lighter and the pedal disk often spreads out at the base giving the animal a fluted appearance.

Family---Sagartidae

Metridium dianthus Ellis

This sea anemone may be readily recognized by its short, numerous tentacles which extend over nearly the whole of the greatly expanded and frilled oral disk. The color is said to vary from brown, salmon, and orange to white, but the only ones I observed were pure white. This species is found on the Pacific Coast from Monterey to Alaska and on the Atlantic Coast from New Jersey to Labrador.

The only place I observed this species in the Bay was on the pilings of the municipal wharf where they occurred in definite strata just below the Evactis artemesia and above the Bunodactis xanthogrammica.

Corynactis sp.

This is a beautiful little sea anemone that is usually found in the crevices between rocks or on the under surfaces of over-hanging rocks at relatively low tide levels. It is blood-red in color with white tentacles that are rounded and enlarged at the tips.

Order--Madreporaria imperforata

Family---Eupsammidae

Balanophyllia elegans Verrill

This is a very beautiful orange-red or flame-red hydrocoral which is fairly abundant at low tide levels. It is usually found attached to the under side of large rocks but is sometimes also found on smaller ones. Specimens were also taken by a dredge at a depth of seven fathoms.

Allopora porphyra Fisher

This hydrocoral is lavender in color and is an encrusting form which grows on the surface of a large rock back in a sort of a cave at Pescadero Point where it is rather well protected and exposed only at low tide. The specimen observed was the type colony from which Dr. Fisher named this species.

(PLATYHELMINTHES)

Class--Turbellaria
 Tribe--Acotylea
 Family---Planoceridae

Planocera californica Heath and McGregor

This is the only species of this class that I encountered . It is characterized by the eyes being arranged in clusters near the tentacles in some what elongated areas, diverging anteriorly instead of being in two parallel rows. It is found in crevices and on the under surfaces of rocks at low tide levels.

Class--Nemertinea
 Order--Hoploneurtea

Parameretes peregrina Coe

This is a long slender nemertean with a somewhat flattened head and bordered with a lighter color on the ventral surface. The color is variable, ranging from dark brown to orange brown or purplish-brown while the under side is white or yellowish.

Specimens have been reported to 400 mm. in length but 150 mm. is the more usual size. The stylet of the proboscis is about the same length as the base and has a remarkable braided appearance. The reserve stylets, grouped in 2-4 pouches, are similiarly braided.

Amphiporus bimaculatus Coe

This species is rather short, flat, and broad for a nemertean. The whole dorsal surface back of the head is deep-red or brownish in color. There are two long triangular marks on the head and a light line on the dorsal side of the body for about a sixth the length of the animal. It was found among the rocks and the wharf pilings at low tide levels.

Order--Heteronemertea

Lineus pictifrons Coe

This species is dark brown in color with a fine yellowish dorsal strip extending the full length of the body and with circular bands of orange bordered with yellow. The head and posterior ends of the body are narrower.

than the middle portion.

This nemertean is found at low tide levels in rock crevices , under stones, and among tunicates on wharf piles.

(MOLLUSCOIDEA)

Class--Bryozoa or Polyzoa
Subclass--Ectoprocta
Order--Cyclostomata
Family---Crisiidae

Crisia occidentalis

This bryozoan has an erect habit of growth, forming delicate little tufts on other bryozoans and on sea weed at low tide levels. The zooecia are stiff and calcareous but is moveable due to numerous flexible joints. The zooecia are straight or very slightly curved and divided into two parts at the joint with appears brown in the younger specimens and black in the older ones.

Crisia denticulata

In this bryozoan the zoarium is erect, branched and biserial. The margin around the orifice has a sharp lateral point or tooth. Like the above species it grows in erect tufts that are white in color, often occurring on tunicates.

Crisidia franciscana

The orifice is round and without an operculum. The zoarium is erect, branched and uniserial. A number of specimens were found growing on red rock weed at low tide at Mussel Point.

Order--Chilostomata
Family---Cellulariidae

Menipea occidentalis Trask

This bryozoan forms bushy tufts on kelp or on rocks, with the branches bending outward in such a manner as to bring all the polypides on the lower surface. The zooecia are elongated, tapering somewhat below. The aperature which is closed by a membraneous sheath, occupies nearly half the front and is surrounded by about six spines. Specimens were collected at low tide growing on a red aglae.

Scrupocellaria californica Trask

In this bryozoan an operculum is present; the zoarium is erect and branched; and the zooecia are provided with vibracula. This species is calcareous and is well provided with spines and vibracula so that clumps of it are rough to touch. The species californica has fewer vibracula than some of the other species of this genus.

Family---Bicellariidae

Bugula californica

This is a christmas tree-like bryozoan with the branches large and arranged in a spiral manner. It is orange in color and grows on the surfaces of rocks that are usually protected from other over-hanging rocks. The avicularia are shaped like vultures heads and the zooecia are numerous, branching, tree-like, and without vibracula.

Bugula neritina (Linnaeus)

This bryozoan occurs in tufts that may reach a length of nearly four inches. It varies in color from brown to purplish. The zooecia are elongated and somewhat rectangular. The aperture occupies nearly all of the front. The operculum is part of the membrane which forms the front wall and is not conspicuous.

Family---Membraniporidae

Membranipora membranacea (Linnaeus)

This bryozoan forms thin, flat colonies on the floats and fronds of kelp. The zooecia radiate outward from the older part of the colony forming a more or less regular patch.

Membranipora tuberculata

The zoarium of this bryozoan was found encrusting red rock weeds at low tide levels. The margins of the zooecia are raised, and the front wall at least partly membranous.

(ANNELIDA)

Class--Chaetopoda
 Order--Polychaeta
 Family---Nereidae

The nereids are worms which are characterized by having two small tentacles, two palps, four eyes, and four pairs of cirri--long tentacle-like structures on the head. The proboscis has one large pair of jaws. The "feet" are well developed and bear numerous tufts of bristles.

Nereis vexillosa Grube

This nereid is found in a variety of places from among the barnacles and mussels on wharf piles to gravelly beaches and under rocks. The color varies from dark brown to blue green, and is often beautifully iridescent. The segments number about 118, the prostomium or anterior part of the head is longer than broad, the tentacles are shorter than the prostomium and well separated at their bases, the palps are large and reach beyond the tentacles. Only the longest of the cirri of the head reach beyond the palps.

Numerous specimens were observed in the Mytilus beds at Mussel Point and others were seen at most every place visited around the Bay.

Family---Sabellidae

Eudistylia polymorpha (Johnson)

This species lives in a translucent tube which adheres to rocks or piling and is usually encrusted with sand or small pieces of shells. The color of the feathery gills is variable, being purple or wine color, whitish or tawny. One color only may be present or it may be banded with two colors. The thoracic segments are distinct from the tapering abdomen. The gills number about 30 on each side and are in spirals of 2-3 turns each. Each gill has 2-10 conspicuous black eyespots.

In a quite tide pool the expanded gills look like gaily colored flowers but disappear as one reaches for them. The tubes usually extend far down into the crevices between the rocks so that whole specimens are difficult to procure.

Family---Serpulidae

Serpula columbiana Johnson

This polycheate is found under stones in tide pools at low tide levels. It forms a white calcareous tube more or less coiled. A funnel-shaped operculum closes the opening when the worm withdraws into its tube. The collar, gills, and operculum are variously colored with red and white. Sometimes they are mostly red while in others the white predominates. The operculum is on the right side and has a notched border made up of one hundred or more ribs, its mate on the left side is short and rudimentary. The branchiae number 54 and the abdominal segments 250 or more.

Spirorbis sp.

There are many species of Spirorbis and most of them are small and difficult to distinguish. They form small coiled porcelain-like calcareous tubes on the surfaces of shells, rocks, sea weeds and the carapaces of crabs.

Most of them have an operculum which closes the opening of the tube when they retract, and feathery branchiae which they extend out through the opening.

In some species the embryos are developed within the white tube and the operculum is used only to protect the animal by closing the tube. In others the operculum becomes a thin-walled pouch or cavity in which the embryos develop.

Family---Hermellidae

Sabellaria sp.

This particular species of Sabellaria was found at low tide underneath over-hanging rocks. It forms a heavy mucus-like tube to which the part not adhering to the surface of the rock was covered with small pebbles, pieces of shells and etc.

Sabellaria californica Fewkes

This tube worm forms enormous masses of tubes on the rocks along the shore left exposed at low tide. The appearance of these masses is much like that of a huge sponge. The tubes are made of a mucus-like substance, impregnated with mud, sand, and pieces of shells. Great masses of these animals were

observed at low tide underneath and just west of the Fishermen's Wharf at Monterey.

Class--Gephyrea
Order--Inermia

Phycosoma agassizi Keferstein

This spinunculid is found in the ~~cr~~ crevices of granit rock, in the gravelly sod of eel grass (Zostera), and underneath rocks in gravelly situations most every where around the Bay.

It is grayish-yellow in color with brown spots over the surface of the trunk and with a few larger brown blotches on the skin. The introvert is a little lighter with black circular bands around it with are not regularly spaced and are not the same widths.

(ECHINODERMATA)

Class--Asteroidea
Order--Forcipulata
Family---Asteriidae

Pisaster ochraceus (Brandt)

This is the most common species of starfish along the coast. It is found most every shere on the surfaces of rocks and especially in crevices and in somewhat protected places at low tide levels. It also frequently occurs at intermediate tide levels.

The color of this species varies from yellow through orange and brown to purple, the spines being somewhat lighter that the body color. This disk is thick and broad and there are five, occasionally six, stout, tapering rays. The short dorsal spines are arranged in close-set rows forming a distinct network.

Pisaster giganteus (Stimpson)

This species is much less numerous than P. ochraceus and is characterized by the dorsal spines being less numerous than in the above species and in being much larger. Each dorsal spine is white and encircled at the base by a blue ring. One specimen was observed at Pescadero Point whose rays were 8 to 10 inches long and it was feeding on an abolonie that was about five inches

in length.

Pisaster brevispinus (Stimpson)

This species is characterized by its dorsal spines which are arranged in a few distinct rows upon the rays, and upon the disk they form a pentagon which usually includes a single spine or a cluster of spines. This species ordinarily occurs at greater depths than do the above species but it is occasionally seen in the intertidal zone where the bottom is somewhat sandy. One specimen was taken while dredging at about seven fathoms on a shale bottom and others were observed on the piles of the municipal wharf at Monterey at low tide.

Leptasterias hexactis (Stimpson)

This is a small six-rayed starfish which is not very common. Its rays are only about an inch and a half long and rather slender and tapering. It is usually found in gravelly situations underneath rocks or algae.

Leptasterias aequalis (Stimpson)

This species seemed to be the most common of the six-rayed starfishes. It resembles L. hexactis somewhat but its rays are shorter, blunter and the granules are more numerous and set closer together. It varies greatly in color and is often marked with black spots or blotches.

Pycnopodia helianthoides (Brandt)

This is a very beautiful starfish which is called the "twenty-rayed" starfish because it may have from 18 to 24 rays. It is less ridged than most starfish, its rays being very pliable and rather soft. It is beautifully colored with red and green hues which blend in very well with the color of the algae and rocks where it occurs. It is rather uncommon and often grows to be about two feet in diameter. It occurs in the tide pools at low tide levels.

Order--Spinulosa

Family---Echinasteridae

Henricia leviuscula (Stimpson)

This is a small red starfish which is characterized by the absence of pedicellariae. It never gets larger than six inches in diameter. The

dorsal surface is covered with numerous groups of short spinlets (or pseudo-paxillae) arranged in a fine-mesh network with little spaces intervening. It has a small disk and the slender, strongly arched rays taper gradually. It is usually found at low tide levels from California to Alaska.

Family---Asterinidae

Asterina miniata (Brandt)

This starfish has a thick, inflated disk and short triangular rays, which are usually five in number. It is very common, especially at Lighthouse and Pinos Points at low tide levels. It is usually found in crevices and underneath rocks but was also observed among the algae. It varies in color from yellowish brown to red.

Order--Phanerozonia

Family---Goniasteridae

Mediaster aequalis Stimpson

This is a very brilliant rather small starfish. The upper part is vermillion or deep red in color, the under parts scarlet, salmon, or orange, and the tube feet frequently red. The largest specimens measure only six inches across. The disk is broad and flat and the rays moderately long in proportion to the disk and tapering. The marginal plates are granulated and conspicuously well developed. The dorsal surface is covered with well-spaced paxilliform plates.

This species seldom occurs in water less than twenty fathoms deep and is more often taken at depths of about forty fathoms. I collected one at low tide at Pescadero Point 2/28/38 which according to Dr. Fisher is the first record of its occurrence in intertidal waters of that locality.

Family---Asteropidae

Dermasterias imbricata (Grube)

This starfish, called the "leather star", is quite different from the rest of the Spinulosa because the entire animal is covered with a thick, soft membrane concealing the spines except along the grooves. This membrane

contains hidden spicules of lime in the shape of rods and perforated plates and may be covered with mucus. Sessile pedicellariae are usually present dorsally, but are lacking in many individuals. The usual number of rays is five. It is red, orange, or lead-blue mottled with dull red. It is found in tide pools at low tide levels from Monterey to Alaska.

Class--Ophiuroidea
Order--Ophiurae
Family---Ophiolepidae

Ophiura lutkeni (Lyman)

Ophioplocus esmarki Lyman

This is an orange colored brittle star with short arms which are hardly more than three times as long as the diameter of the disk. This species is usually found in the sand or gravel underneath rocks at low tide levels.

Family---Amphiuridae

Amphiodia occidentalis (Lyman)

This species is called the "long-armed" brittle star. Its small disk is covered with almost microscopic over-lapping scales. There is a notch in the margin of the disk between the radial shields and the base of the arm. The arms are very long being 8 to 10 times the diameter of the disk. It is rather grayish in color with transverse black marking on the arms.

Numerous individuals were found in the gravel sod of the eel grass at Point Pinos.

Ophiopholis aculeata (Linnaeus) Gray

This is a rather small species which is rather reddish in color and usually curiously streaked and mottled with other colors, very often with green. In light colored specimens the rays are usually banded with red.

The disk is small with five conspicuous lobes between the rays, and, in large specimens, appearing somewhat inflated on the lower surface. It is covered with small conical spines which appear longer on the outermost parts of the lobes, and a series of three or more rounded plates in a row from the central part of the disk to the base of each ray. There are five spines on

the lateral plates of the rays, the middle one the longest. Like most other brittle stars they occur on sandy or gravelly bottoms usually beneath racks.

Amphiopholus squamata

This very small brittle star was found to be very abundant in the gravel at low tide levels beneath rocks at Lighthouse Point.

This very tiny brittle star carries its eggs in a hollow formed above the mouth by the arching of the disk. In this hollow the young hatch and develop until they assume the adult shape. Six young, fully formed, were taken from the body cavity of one specimen.

Family---Ophiocomidae

Ophiopteris papillosa (Lyman)

This is a large conspicuous brittle star whose disk reaches about 11mm. in diameter and who has a soft skin covered with granules. The radial plates are entirely concealed. The arms are comparatively short and support a fringe of long flat spines standing at right angles to them. Those on the upper row have small accessory spines overlapping them at the base. Altogether there are 5 longitudinal rows. Tooth papillae are present and are arranged in four or five vertical rows. The color is brown with narrower, darker bands around the arms. Specimens were taken at low tide levels at Pescadero Point and also while dredging at a depth of seven fathoms just north of the Municipal Wharf at Monterey.

Ophiothrix spiculata Le Conte

This is a very beautiful brittle star with the disk covered with small spines and with rather long rounded spines on the arms in seven rows. Specimens were taken at low tide levels from beneath rocks and also from among the algae in gravelly situations.

Class--Echinoidea

Order--Centrochinoida

Family---Strongylocentrotidae

Strongylocentrotus purpuratus (Stimpson)

This is the most abundant species of sea urchin on the Pacific

Coast, ranging from Mexican to Alaskan waters. In places where the surf is very heavy it is said to excavate holes in the rock in order to protect itself from the surf action and from the large fishes. The only places that I observed this species about Monterey Bay was in crevices and rather well protected tide pools. At Pescadero Point this species was especially abundant, actually forming a complete carpet over the surface of the rocks in some of the tide pools. Very few were observed at Mussel Point. Their general color is purple but very young specimens are apt to be green.

Strongylocentrotus franciscanus (A. Agassiz)

This is a very large species of sea urchin, the test alone often exceeds five inches in diameter. It is usually found in deeper water than the purple sea urchin. It can readily ^{be} distinguished from the purple sea urchin by its longer spines and because the test is higher in relation to its diameter than the test of S. purpuratus. There are two principal color phases of this species, which are a deep reddish brown and a very dark purple, but I saw one which was a vivid pink.

Class--Holothurioidea

Family---Synaptidae

Leptosynapta albicans

This is an elongate, brownish, worm-like echinoderm which lives buried in the sand or mud at about the tide line. It is sometimes almost transparent and has 10 or 12 tentacles surrounding the mouth. Individuals were taken at Lighthouse Point, buried in the sand.

Family---Cucumariidae

Cucumaria curata Cowles

This is small, black holothurian found only at Pescadero Point in Carmel Bay. The specimens observed were in a rather high, shallow tide pool on the top of a flat rock. They were very numerous at this particular place but were rather inconspicuous because of their color and size.

Cucumaria chronhjelmi Theel

This sea cucumber has numerous , long tube feet forming a double row along each side of the radii. There are ten short, much branched, tuft-like, yellow, or orange-tipped tentacles, and ~~two~~ smaller ventral ones. The calcareous plates are many and varied in form, being like cups or baskets in the body wall, plate-like in the tube feet, and rod-like in the tentacles. The color is white or yellowish..

Thyone rubra Clark

This is a small species of sea cucumber which is reddish pink above and white below. The body is almost cylindrical and uniformly covered with numerous tube feet which are seldom arranged in rows at any point. The tentacles number ten with the two ventral ones smaller than the others.

This species is viviparous, the embryos developing in the body cavity. It occurs at low tide levels in the gravel beneath rocks.

(ARTHROPODA)

Class--Crustacea

Order--Cirripedia

Suborder--Lepadomorpha

Family---Scalpellidae

Mitella polymerus (Sowerby)

This "goose-neck barnacle" has 18 or more plates on the capitulum, with numerous irregularly arranged scales at the base, and the peduncle covered with fine scales. The general color is red or reddish brown to yellowish brown, except for the plates, which are white. Usually it is found occurring with Mytilus californicum on surf-swept rocks where the spray comes over them even though the tide is very low. They grow in very closely associated patches completely covering the surface of the substratum.

Suborder--Balanomorpha

Family---Balanidae

This family includes those acorn barnacles in which the rostrum is provided with radii or wings which overlap the next lateral plate or compartment.

Balanus glandula Darwin

This is one of the smaller acorn barnacles which is found chiefly between the low and high-tide levels along the rocky shores all the way from the Aleutian Islands to southern California. It also occurs at rather high tide levels in some places and is usually found growing on horizontal surfaces.

Balanus tintinnabulum californicus Pilsbry.

This species of acorn barnacle is very distinctive with its reddish or pink coloration. It is found at greater depths than B. glandula and is only encountered during very low tides. It attaches itself to rocks, mussel shells and etc. at these low-tide levels.

Balanus aquila Pilsbry

This is large acorn barnacle that was taken while dredging at a depth of about seven fathoms just north of the Monterey Municipal wharf. It is yellow in color, about an inch and half at the base and more than an inch high.

Tetraclita squamosa rubescens Darwin

The "thatched barnacle" is found on the rocks that are exposed only during low tide. It is roughly conical with only four compartments which are not distinctly marked. The color is usually a dull red and the surface is often much eroded and roughened. The margin of the mantle is dull red and bordered in places with yellowish white.

Subclass--Malacostraca
Order--Amphipoda
Suborder--Gammaridea
Family--Amphithoidae

Amphithoe sp.

The antennae of this amphipod is more than half the length of the body. The flagellum of the first antenna is two to two and one-half times the length of the peduncle. The second antennae are stout. The third abdominal appendage does not reach beyond the second and its outer branch has two hooks.

This amphipod was especially abundant among the algae at low-tide levels.

Suborder--Caprellidea

Caprella scaura Templeton

Numerous specimens of this caprellid were found on hydroids that were growing at low-tide levels. They varied in color from a greenish brown to red but in all cases tended to be the same color as the object upon which they were found.

Order--Isopoda

Superfamily---Cymothoidea (Flabellifera)

Cirolana harfordi (Lockington)

See discussion under animals of the sandy beaches.

Exosphaeroma amplicauda Stimpson

This isopod is characterized by the large size of the uropoda, both branches of which extend to the tip of the abdomen. They are very wide and as the body gradually increases in width toward the abdomen the specimens exhibit a peculiar triangular appearance when seen from above. The inner branch of the uropoda is fastened rigidly to the abdomen, but the outer one is moveable. There are small tubercles on the dorsal surface of some of the thoracic segments. This isopod is grayish white in color with some brown specks on the thoracic segments. The body covering is rough and hard as if impregnated with lime salts. It is usually found on the substratum among a dense growth of algae.

Exosphaeroma octoncum (Richardson)

The head of this isopod is very small. The first pair of antennae reach almost to the posterior margin of the first thoracic segment. The uropoda do not reach the extremity of the abdomen by some little distance. The outer branch is shorter and broadly rounded posteriorly. The inner branch is more pointed at the extremity. This isopod was found in very similar situations to the one above.

Superfamily---Oniscoidea

Ligyda occidentalis (Dana)

This is probably the most conspicuous isopod along the California coast. It will be seen scurrying about upon the rocks at about the high-tide level or hiding itself among them. It often escapes notice by remaining motionless in depressions or crevices in the rocks and is aided by its dull gray or brown colors which are highly variable, some individuals being much darker than others. The legs are tipped with orange. The uropoda are very conspicuous and divided into two stiff projections, the inner one of which is tipped with a spine.

Individuals were observed in all rocky situations along the bay at about the high-tide level. They were also quite numerous among the shells that were washed up on the shore.

The eggs were observed being carried underneath the abdomen of the parent until they had hatched and even until the young were able to run about.

Order--Decapoda

Suborder--Natantia

Tribe--Cardides

Family---Hippolytidae

Spirontocaris paludicola (Holmes)

This species is very much like the following one but the rostrum always reaches only about to the middle of the thicker flagellum of the antennules or beyond, while in S. picta the rostrum only slightly exceeds the antennular peduncle, if at all. This species is uniform green in color and occurs in tide pools at low tide levels.

Spirontocaris picta (Stimpson)

This is rather small shrimp which is almost transparent to slightly greenish, especially the abdomen with oblique red lines that are particularly noticeable on the carapace. The legs are banded with dark or reddish bands. The rostrum is shorter than the rest of the carapace but reaches beyond the

middle of the antennal scale. The rostrum is armed with seven teeth above and three below. This shrimp is found in the tide pools at low-tide levels.

Family---Crangonidae

Crangon dentipes (Guerin)

The "pistol shrimp" gets its name from the fact that its right cheliped is enlarged and modified in such a way that it makes a snapping or popping sound when it is disturbed.

Numerous specimens were found among the roots of the eelgrass and holes in the granite rock at low-tide levels.

Crangon bellimanus (Lockington)

This species is much like the one above but has no spine on the lower side of the merus of the walking legs. The fingers of the large hand are not horizontal, the dactyl is short, curved, and works horizontally. It is found in practically the same type of situations as C. dentipes but seemed to be much less abundant.

Suborder--Reptantia

Tribe--Anomura

Family---Paguridae

Pagurus samuelis (Stimpson)

This hermit crab seemed to be the most common species found. It was usually found occupying black turbin shells but was by no means confined to them as it was found in most every type of gastropod shell available but most commonly in the turbin shells.

Pagurus hemphilli (Benedict)

This hermit crab is characterized by the carpus of the cheliped being deeper than wide. It was less numerous than the above species but also chiefly occupied black turbin shells.

Pagurus granosimanus (Stimpson)

This species is characterized by the front of the rostrum or carapace

being rounded and low as opposed to acute and triangular as in the above two species. This species was usually found at about the intermediate tide levels.

Pagurus hirsutiusculus (Dana)

This hermit crab has distinct white or pinkish bands on the walking legs and the joints of the second and third pairs of legs are banded at the outer ends. The dactyls have longitudinal strips of red on a light blue ground color. The sides of the walking legs often have a longitudinal median strip of blue or whitish. The antennae are the color of the body with white bands. One specimen was taken while dredging at a depth of seven fathoms.

Family---Lithodidae

Haplogaster cavicauda Stimpson

This is a small hairy crab whose abdomens is soft and not segmented except for two plates at the anterior end. Its legs are incised and flattened and very hairy. It is found underneath rocks adhering very closely to the surface of the rock and often being very difficult to detect because it is usually the same or very near the same color as the substratum to which it adheres.

Family---Porcellanidae

Pachycheles rudis Stimpson

The "porcelain crabs" are not true crabs but the abdomen is rather well developed and folded up under the thorax. In this species the pleurae are divided into two plates. The chelae are granular and have a median distal tubercle. Many of the females observed were carrying eggs attached to the ventral surfaces of their abdomens. The chelipeds are unequal, with a rugose, irregularly tuberculated and granulated upper surface, provided with a few scattered hairs. The telson is composed of five joined plates. The second maxilliped is modified into a plankton strainer with long curved cirri or hair-like structures. All specimens observed were usually beneath rocks at rather low tide levels.

Petrolisthes cinctipes (Randall)

This genus has the pleurae in one plate. This species is distinguished from the following one by the cirrus being wider in proportion to its length and having a rounded enlarged inner angle at its proximal end. They were usually found at intermediate to low tide levels beneath rocks.

Petrolisthes eriomerus Stimpson

This species is distinguished from the one above by the cirrus of the cheliped being twice as long as wide and the sides being parallel. The second maxilliped is modified into a bailer for scraping up plankton. The last four joints of the maxilliped are a brilliant blue in color. Like the above species, this one was also found beneath rocks at rather low tide levels.

Tribe--Brachyura
Subtribe--Brachygnatha
Superfamily--Oxyrhyncha
Family--Inachidae

Pugettia productus (Randall)

This is a very long-legged crab which is spoken of as the "kelp crab" because it is usually found in the kelp beds. It is practically the same color as the kelp, usually being a dark brown, and is often difficult to see among the kelp fronds unless it happens to move. Some specimens were also observed in small tide pools at low tide levels among the rocks.

Pugettia richii Dana

This species is characterized by the carapace being ovate, tuberculated, and with the median region tumid and furnished with four tubercles, the anterior three of which are nearly abreast. The cardiac and intestinal regions each have one tubercle and two tubercles on the branchial region, one before the other. The preocular tooth is acute and directed forward, outward, and upward. The post-ocular tooth is acute and triangular. This species did not seem to be as abundant as the above one and was usually found in the tide pools among the rocks at low-tide levels.

Mimulus foliatus Stimpson

This is a small purplish-red crab with light-colored markings on the legs. The carapace is flattened, smooth or nearly so, more or less pentagonal; and the lateral portions laminate, much produced, wing-like. The anterolateral margin is cut by a narrow fissure into two closely approximate equal lobes. The rostrum is bifid, short, and horizontal. The basal antennal joint is enlarged at the base, narrowing distally. The orbits are incomplete below but furnished above with a pre and post-ocular spines. The first pair of ambulatory legs are the longest. Specimens were found beneath rocks at low tide levels.

Herbstia parvifrons Randall

This is small hairy crab which is similiar to the one above. It is tan in color and has a triangular-shaped body. Its body was usually decorated with sponges and sand with made it very inconspicuous in the sand beneath the rocks at low-tide levels.

Scyra actifrons Dana

The "sharp-nosed" crab has a flattened rostrum which is produced into two diverging horns. The carapace is pear-shaped with a very rough surface and marked with several elevations and depressions. Its length considerably exceeds its breadth. It is usually well covered with sponges, bryozoans and hydroids. Individuals were observed beneath rocks at low-tide levels.

Superfamily--Brachyrhyncha
Family---Canceridae

There are four species of cancer crabs at Monterey Bay. One of these, Cancer magister Dana, is restricted to sandy or gravelly situations, and is discussed under the part of this report that deals with the fauna of the sandy beaches. The other three species, Cancer productus Randall, C. antennarius Stimpson, and C. jordoni Rathbun, are all restricted to rocky or estuary situations and were found around the rocky coast line at low-tide levels and

also at Elkhorn Slough. C. jordoni can be distinguished from the other two species by the fact that it has two spines on the merus of the chelipeds and has no eleventh lateral spine on the carapace. It also has no red blotches on the ventral side as does C. antennarius.

Family---Xanthidae

Lophopanopeus heathii Rathbun

This is a small species of crab that is usually mottled with various colors and is found at intermediate tide levels underneath rocks. Its carpus is smooth and the claws black.

Lophopanopeus bellus (Stimpson)

This species is called the "black-clawed" crab because of the presence of a black band across the thumb and finger of the chela. It inhabits rocky shores usually being found beneath rocks in practically the same situations as the above species. Both the hand and the carpus are smooth. The color is subject to considerable variation ranging from reddish brown or purplish through shades of gray to almost white with the color usually occurring in irregular spots.

Xanthias taylori (Stimpson)

This is a purplish-red crab covered with warty tubercles on the front part of the carapace and chelipeds. The fingers of the chela are black and the ambulatory legs are covered with hairs or setae. Specimens were observed underneath rocks at low-tide levels.

Family---Pinnotheridae

Fabia subquadrata (Dana)

This crab inhabits the gill chambers of mussels and clams. The male is unknown but the females have been taken from Alaska to Laguna Beach.

The carapace is smooth, rather membranaceous, squarish with the edges rounded off and the front turned downward. The abdomen is larger than the carapace. The distinguishing feature of this genus is the presence of two

longitudinal grooves which extend from the orbits nearly halfway back on the carapace. The palm of the chela has two rows of fine hairs on the lower margin, the outer one extending to the base of the immoveable finger and the inner one reaching to the tip. The color is whitish marked with orange. One specimen was taken from the gill chamber of a Mytilus californicus at Mussel Point, 7/12/38.

Family---Grapsidae

Hemigrapsus nudus (Dana)

This is one of the most numerous crabs along the rocky shore , actually occurring by the hundreds. It is strictly a littoral species being found at most of littoral zones but it seemed to be most abundant at about the intermediate tide levels in especially rocky places where it could retreat into the crevices of the cliffs and underneath the rocks.

The carapace is not markedly striated and has two teeth behind the orbital angle. The outer maxillipeds are without a wide rhomboidal gape and only moderately gaping. The merus is large and not produced at the antero-external angle. The palp is joined in a notch at about the middle of the distal margin. The abdomen of the male does not cover the sternum at its base. The ambulatory legs are smooth. The hands of the chelipeds are conspicuously spotted with red. The color is quite variable and may range from a purplish tone to dark red or be marked with white.

Hemigrapsus oregonensis (Dana)

This species differs from the one above in that its ambulatory legs are hairy and the front has a deep sinus in the middle. Its carapace is more strongly undulated in front than in H. nudus but is not so much flattened behind. This and the above species were usually found in the same type of habitat along the coast.

Pachygrapsus crassipes Randall

The carapace of this "shore crab" is marked with transverse striae. The merus of the last pair of ambulatory legs has a posterodistal angle which may be either denticulate or entire. The frontal (interorbital) margin is practically straight in frontal aspect, but the lateral margin is strongly arcuate. The general color in life is a very dark red with a variable amount of whitish, which is sometimes almost entirely absent and in other cases may give the whole carapace a light shade. Each striae on the carapace has a light color in front of it. The ambulatory legs are similar in color to the carapace but the chelipeds are generally tan and vined with red. The thin cuticle at the joints is a livid green.

This crab is a typical littoral animal and seemed to prefer to be out of the water among the rocks rather than in the tide pools although it was also frequently found in the tide pools as well.

Class--Arachinoidea
Order--Pycnogonida
Family---Ammonotheidae

Ammothella bi-ungulata Dohrn

This is a straw-colored pycnogonid that is found under rocks at low-tide levels. Palpi and ten-jointed ovigerous legs are present in both sexes. The legs are stout and have few hairs except those which are in a double row on the sole of the last segment. The animal is so transparent that the branches of the stomach are easily traced out into the legs under the microscope.

Tanystylum intermedium Cole

This is one of the smallest of the pycnogonids. Its body is disciform with the lateral processes close together and the body segments not very well marked. Specimens were found on Aglophenia and Abietenaria, which they resembled in color so closely that it was difficult to detect the pycnogonids.

Family---Pycnogonidae

Pycnogonum stearnsi Ives

The chelifond and palpi of the members of this family are both absent and the ovigera are present only in the males. This particular species seems to vary greatly in color from yellow to brownish, some being almost orange depending on the substratum on which they are found. This species is readily recognized by its thick, broad trunk and stout legs that are armed with powerful claws. Specimens were taken from low-tide levels from the underneath surfaces of rocks in sandy or gravelly situations.

(MOLLUSCA)

Class--Pelecypoda (Lamellibranchiata)

Order--Prionodesmacea

Family---Ostreidae

Ostrea lurida Carpenter

Although this pelecypod is found attached to rocky substratum, I failed to find it except on some rocks at Elkhorn Slough. None were found along the coast of Monterey Bay. See discussion of Elkhorn Slough for notes on this species.

Family---Pectinidae

Hinnites giganteus Gray

This purple-hinged or rock scallop is free swimming when it is young and has a shell that is nearly symmetrical, but when it reaches a length of about 20-30 mm. it attaches itself to a fixed object such as a rock or another shell. The shell grows to conform to the surface to which it is attached and thus often becomes very irregular. The left valve is less convex than the right. On the inner side of the valves the hinge area is tinged with purple. Specimens were found at low-tide levels at Pescadero Point.

Family---Anomiidae

Pododesmus macrochisma (Deshayes)

This mollusc is called the "rock oyster or jungle". It has a very irregular surface and shape and is attached to rocks or shells by a byssus which passes through a deep notch in the flat lower valve. The upper valve has only two muscle scar impressions and the larger scar is radiately striated.

Family---Mytilidae

Mytilus californicus Conrad

This mussel forms enormous beds on the surf-beaten rocks at many places along the coast. The glossy black covering is sometimes worn away on the older parts of the shell. They seem to be restricted to places where the water is heavily oxygenated and occur chiefly on the face of the rocks where the surf beats against them and the spray is continually covering them. I observed none of them occurring at a level above where the spray did not reach, even at low tide. They are able to withstand the constant hammering of the surf *by* the fact that they securely fasten themselves to the rocks by a byssus which they secrete from a gland within the shell.

Family---Carditidae

Cardita subquadrata Carpenter

This is a small somewhat heart-shaped plecypod which has a very strong shell that is characterized by about fourteen prominent radiating ribs. Specimens were taken from the under surfaces of rocks at low tide levels where they were attached by a byssus.

Family---Veneridae

Paphia staminea (Conrad)

The "rock cockle" is rather a small cockle and is characterized by the fact that the radiating ribs are very fine and are crossed by concentric ridges which are about equally as prominent as the ribs. Small spines may be present where the ribs and ridges intersect. The inner margin of the valves

is rough and the shell is very thick.

Venerupis lamellifera (Conrad)

The "rock Venus" has a very irregular white shell with prominent concentric ridges which are like thin folds of the shell. Radiating ribs are absent or show but a mere trace. This plecypod is found among the rocks at low tide levels from Monterey to San Diego.

Class--Gastropoda
Order--~~Opisthobranchiata~~ (Sea Slugs)
Suborder--Nudibranchiata
Tribe--Holohepatica
Family---Tritoniidae

Tritonia festiva (Stearns)

This is a translucent white nudibranch with chalky white longitudinal dorsal markings. It has prominent dorso-lateral branchiae and two yellowish oval dots on its back toward the anterior end which are bordered with chalky white. The tentacles are surrounded with fringed tube-like structures. Specimens were collected in the intertidal zone and also while dredging at a depth of about seven fathoms.

Family---Dorididae (Cryptobranchiatae)

Anisodoris nobilis (Mac Farland)

This is a light yellow nudibranch mottled with patches of dark brown or black between the tubercles. It has large, white, spreading branchial plumes. Some specimens seen were two inches in length. They were usually observed during low tide on the under surfaces of over-hanging rocks.

Cadlina flavomaculata Mac Farland

This nudibranch has a white mantle with low rounded tubercles. Down each side from the rhinophores to the branchial plumes is a row of lemon-yellow spots on low tubercles. The rhinophores may be brown or black. The branchial plumes are white. Specimens collected were beneath rocks at low tide.

Cadlina marginata Mac Farland

This is a translucent yellowish white nudibranch with low tubercles, each of which is tipped with a spot of lemon yellow surrounded by a ring of white. The margins of the mantle and foot have a narrow band of lemon yellow. The tips of the branchiae and rhinophores are also yellow. Specimens were collected from floating kelp at low tide.

Diaulula sandiegensis (Cooper)

This is a pale yellow nudibranch with a distinctive row of dark brown rings down each side of the dorsal surface. The head is entirely covered by the mantle but the tip of the foot shows beyond the posterior edge of the mantle when the animal is crawling. There are six branchiae which can be retracted. One specimen was taken from the surface of a rock about a foot below the surface of the water at low tide.

Rostanga pulchra Mac Farland

This species of nudibranch closely resembles the substratum on which it is found, varying in color from almost white to brown. The body is elliptical in shape and the ends are about equally rounded. It is covered with minute papillae. The branchial plumes are contractile and are about eight in number. The tentacles or rhinophores are white and slender with a small knob at the end. They are contractile and are surrounded at their bases by a horse shoe-shaped group of reddish tentacle-like structures which open anteriorly. Specimens were collected from among the algae at low tide.

Family---Dorididae (Phanerobranchiatae)

Hopkinsia rosacea Mac Farland

This is a beautiful rose-pink nudibranch that is covered with numerous long papillae. The rhinophores are long, slender and non-retractile. This one of the most common species in the tide pools and was found both on rocks and among the algae.

Laila cockerelli Mac Farland

The body of this nudibranch is white with the tail, rhinophores, and numerous club-shaped papillae of the body tipped with bright orange-red. It has five non-retractile branchial plumes which are often tipped with orange. Was quite a common species in the tide pools of the intertidal zone.

Triopha carpenteri (Stearns)

This is a rather large nudibranch which often has white spots on very small tubercles. The frontal margin is wide in the region of the rhinophores and is continued behind into a dorso-lateral ridge. This frontal margin bears along its whole length a number of papillae which are tuberculated and irregularly lobed. The papillae, the tips of the branchiae, the rhinophores and the scattered tubercles of the back are bright orange in color. There are also irregularly arranged spots of orange along the sides of the animal. It lives on the brown kelp and is found in the tide pools at low tide.

Triopha maculata Mac Farland

The body of this nudibranch is colored orange-yellow with bluish-white spots or dots scattered over the surface. In young specimens these spots are often inconspicuous. A number of specimens were found in rocky tide pools at Point Pinos.

Family---Doridopsidae

Doriopsis fulva Mac Farland

This is a rich yellow nudibranch with yellowish-white branchial plumes and dark rhinophores. The surface of the mantle bears papilla-like elevations which are tipped with white. The foot and under side of the mantle are light yellow, the mantle having a mesh work of fine light lines. It has five wide-spreading, retractile branchial plumes. Specimens were taken from over-hanging rocks in tide pools at low-tide levels.

Order--Ctenobranchiata
 Suborder--Orthodonta
 Family---Conidae

Conus californicus Hinds

This gastropod had a heavy, porcelaneous shell with a short spire and a long narrow aperture. It was found at low tide levels on the rocks among the algae.

Family---Alectrionidae

Alectrion fossata (Gould)

This is one of the largest of the "basket shells". The shell has prominent spiral grooves which show plainly within the aperture and longitudinal elevations across these grooves. There is a callus on the columella and above the reflexed canal is a deep fossa or furrow. The color is brown or ashy and the callus often had an orange tinge. One specimen was found on the mud flats of Elkhorn Slough.

Family---Columbellidae

Columbella carinata Hinds

This is a narrow, brown, high-spired mollusc which is characterized by a keel just below the suture of the first whorl. Specimens were collected at Lighthouse Point at low tide levels.

Amphissa versicolor Dall

Specimens of this gastropod vary in color from brownish through orange to yellowish. They are rather abundant in some places along the coast at low tide levels beneath the algae usually on a gravelly bottom.

Family---Muricidae

Purpura foliata (Martyn)

The "leafy hornmouth" is very conspicuously marked with its three broad, wing-like varices which seem to be made up of over-lapping scales. The canal is long and curves backward and as growth takes place the old

canals are left at the base of each varix when the animal builds on to the shell. Spiral ridges encircle the whorls and spread out fan-like upon the varices. The outer lip is crenulate with a sharp horn near the lower end.

Tritonalia interfossa (Carpenter)

This is a spindle-shaped shell with well marked spiral grooves, deep sutures, and sharp transverse ridges which give it a rough appearance. The outer lip is thickened and bears a row of teeth. It was observed at low tide at Lighthouse Point.

Tritonalia circumtexta (Stearns)

This mollusc has a heavy shell with deep, distinct and regular spiral grooves encircling it with the whorls crossed by low but prominent ridges. It is characterized by a ring of brownish spots on the body whorl. The rest of the shell being grayish in color.

Tritonalia lurida (Middendorff)

Being much like the above two species, this animal has a spindle-shaped shell with numerous rounded raised spiral lines and a distinct suture. The outer lip is thickened and bears a row of teeth within its inner edge.

Thais emarginata (Deshayes)

This snail has a shell with a rather short spire. The shell is rough with coarse spirals that are roughened with nodules which in some cases almost become spines. It varied from white through grayish to brown in color.

Acanthina lapilloides Conrad

This is a predaceous mollusc whose shell is rather grayish in color with a brownish or purpleish lining of the aperture. Inside the outer lip is a row of teeth and near the base of the aperture on the outer lip is a prominent projection or tooth which it is said to use in capturing other snails on which it feeds. This species was observed on the rocks among the Pelvetia just below the bare rock or barnacle zone at Mussel Point.

Acanthina spirata (Blainville)

This mollusk has a higher spire than the preceding one but like the other one it has a prominent tooth near the base of the outer lip. It also has a prominent row of teeth within the aperture. The whorls are marked with dark more or less broken spiral bands which give it a pebbled appearance.

Suborder--Streptodonta
Family---Epitoniidae

Epitonium fallaciosum Dall

The "white whtle trap" has a thin shell with eight rounded whorls and eleven to fourteen varicos which are sharp and thin, sometimes reflexed and with a prominent keel near the suture. Six specimens were taken down among the roots of the eel grass at Mussel Point.

Epitonium wroblewshii (Morch)

This species has seven or eight whorls on its shell which are only slightly convex and bear eight blunt, transverse ribs which form radiating ridges from the apex of the shell. The color is white and the length is about 28 mm..

Suborder--Pectinibranchiata
Family---Cerithiidae

Bittium eschrichtii (Middendorff)

The shell of this molluck has a high spire with the spirals separated by strong spiral grooves. There are 9 or 10 whorls and the color is white to brownish being often mottled with the brownish color. Specimens were taken in the gravel at low tide levels at Lighthouse Point.

Family---Littorinidae

Littorina planaxis Philippi

The gray littorine has a broad and conical shell with three whorls. The outer lip is thin and the inner lip and columella is flattened as though a portion of the shell had been dissolved away. This animal is found very

abundantly among the barnacles and on the bare rocks, usually at levels where only the spray reaches.

Littorina scutulata Gould

The checkered littorine has a shell with four whorls. The surface of the shell is smooth except for faint lines of growth. The color varies from practically black to yellowish with various bands of white giving it a checkered effect. It is found at a lower level than the above species and unlike it lacks the flattened area in the region of the columella. It is especially abundant among the barnacles at the lower barnacle levels.

Family---Lacunidae

Lacuna porrecta Carpenter

This species is called the "wide chink shell" because it has a large umbilical chink, a depressed spine and a wide spreading aperture with the outer lip extended. It was usually found living on kelp at low tide levels.

Family---Hipponicidae

Hipponix antiquatus Linnaeus

The "ancient hoof-shell" has an oblique cone with a flattened apex and with the surface roughened by prominent leaf-like lines of growth. One specimen was found solidly attached to a granite rock at a low tide level.

Family---Turbinidae

Leptothyra carpenteri Pilsbry

This small red "turbin" has its shell encircled by about fifteen fine spiral ridges. The operculum is solid and calcareous. The color may be red, ashen, or purple. They were found beneath rocks at low tide levels.

Family---Trochidae

Tegula funebris (A. Adams)

The black turbin is one of the most common molluscs at relatively high tide levels although it also extends down into lower intertidal zones.

It usually has two teeth on the columella. It is solid black or somewhat brownish in color.

Tegula brunnea (Philippi)

The brown turbin may vary in color from russet-yellow through brown and orange to crimson. The sutures of the shell are deep and the umbilicus is somewhat excavated. There may be one or two teeth on the columella. This species occur at lower levels than does the black turbin, being found principally in the tide pools below the Pelvetia-Fucus zone.

Family---Crepidulidae

Crepidula adunca Sowerby

This crepidula is is very distinctive mollusk with a very pointed apex situated anteriorly and projecting forward and curved downward, sometimes even beyond the anterior margin of the shell. The color is brown. It is found principally on the shells of Tegula. The eggs are brooded underneath the shell because several individuals were found covering egg masses. Oftentimes small crepidulas are found on the shells of the larger ones.

Crepidula nummaria Gould

The "white slipper shell" may be found occupying rock surfaces at low tide levels but it is also frequently found within the aperture of Tegula shells which are usually inhabited by hermit crabs. The shell is white in color and very thin and delicate.

Family---Acmaeidae

Acmaea asmi (Middendorff)

This is a plain black limpet with a rather high pointed shell whose apex is located somewhat anteriorly. It is colored a plain lusterless black. This limpet seemed to be restricted to the strap-like frons of the brown algae Agregia and is found wherever this plant was found growing.

Acmaea cassis pelta Eschscholtz

This is a rather flat limpet with a rather pointed apex situated well toward the anterior end. On the outside of the shell there were about 25 radiating lines. It was gray or striped in color and had a brown line around the inside border.

Acmaea insessa (Hinds)

This is called the "seaweed limpet" because it is found on the flat ribbon-like portions of the brown seaweeds which are abundant along the rocky coasts. The shell is brown and the sides are flattened. The apex is relatively high.

Acmaea limulata Carpenter

The "file limpet", so called because of the scally or rough radiating ribs or ridges which radiate from the anteriorly located apex. The shell is yellowish brown in color and the foot is pigmented with black. It was quite common on the surfaces of rocks at low tide levels.

Acmaea mitra Eschscholtz

The "white cap limpet" has a rather heavy white conical shell with a nearly central, high, pointed apex. Most generally specimens of this species were completely covered with a coat of pink coralline algae.

Acmaea paleacea Gould

The "chaffy limpet" has a very narrow shell which never exceeds the width of the eel grass, Zostera, on which it is found. The apex of the shell is white but the rest of the shell is brown without any stripes. It is only about a fourth of an inch in length and only found on eel grass.

Acmaea scabra Gould

The "ribbed limpet" lives high up on the rocks. The margin of the shell is very irregular and is of the shape of the surface of the rock where

it adheres during the time that it is at rest. Heavy ridges radiate out from the apex and the specimens found varied in color from yellow to gray with the apex of the gray ones much higher than that of the yellowish ones and the margins of the shells of the yellowish ones tending to to more irregular and ragged than the gray ones.

Acmaea digitalis Eschscholtz

This is a brownish gray limpet whose apex is situated anteriorly and elevated forward so that in some cases it may actually form a hook. Heavy ridges radiate from the apex but the posterior ones are the heaviest and most prominent. It is similiar to Acmaea scabra but can be distinguished by the foot not being speckled with black and the apex being more anterior. It occurs at intermediate tide levels just above the Pelvetia-Fucus zone.

Lottia gigantea Gray

This a rather large limpet with the apex of its shell near the anterior end and the shell rather flat. The side of the foot is pigmented with black. It was observed most commonly in the crevices of rocks which were subjected to a considerable amount of surf action.

Family---Haliotidae

Haliotis cracherodii Leach

The black abalone is greenish black in color and practically smooth except for the lines of growth. The shell is markedly convex and the perforations usually number 5-8. The inside nacre is silvery with red and green reflections. This animal is found on the underside of rocks and in crevices at intermediate and low tide levels. The smaller ones seemed to be at higher levels and closer to the shore line than did the larger and older ones which were usually restricted to the low tide levels.

Haliotis rufescens Swainson

The red abalone has a heavy shell which is less convex than the black abalone and the outside is sculptured with low irregular radiating waves. The red outside layer projects out at the edge of the lip making a narrow coral-red edge. The perforations are tubular, large, and number three to four. The species is less numerous than the black abalone and seemed to be restricted to deeper water.

Family---Fissurellidae

Fissurella volcano Reeve

This is a beautiful pink key-hole limpet which is oblong in shape; rather highly arched, and with an oblong orifice at the top and a little in front of the center of the shell. It is found at low tide levels on the under side of rocks.

Diadora asner (Eschscholtz)

The "rough-shelled" keyhole limpet has a high arched shell with a small, oval or nearly circular hole in the apex. The margin is crenulate and the color is gray with darker radiating rays. The inside is glossy white.

Megatebennus bimaculatus (Dall)

The yellowish colored mantle of this keyhole limpet nearly covers the shell in the living animals and the yellow foot seems to be larger than the shell. It is oblong-oval in shape with a comparatively large "keyhole" of the same shape as the shell. There are numerous radiating ridges from the apex which tend to widen slightly toward the margin of the shell. The ends of the shell do not project down as far as the sides so that when the shell is laid on a flat surface the end margins do not touch it. The color varies from white to brown or slate.

Class--Amphineura
Family---Lepidochitonidae

Lepidochitona hartwegii (Carpenter)

This chiton is rather wide in comparison with its length. It is rather a faded green in color and sometimes marked with black. The valves are rather flat and narrow and the girdle is narrow and smooth.

Lepidochitona lineata (Wood)

The "lined chiton" has a smooth surface and is moderately arched. The light ground color is tinged with lavender, brown, red or yellow and is marked with wavy lines of dark brown bordered above with light blue. This was a rather common species at low tide levels..

Nuttallina californica (Reeve)

The "California chiton" is a common species living rather high up on the rocks left bare by the tides or in crevices ordinarily covered with Fucus and Pelvetia. The coarse, rough valves are often much eroded, but where the surface is presented, it is blackish and sculptured with fine granules. The girdle is covered with coarse, stiff spinelets of a brownish color. The foot is reddish and the inside of the valves is bluish green. This species was found most every where along the rocky coast among the algae.

Family---Ischnochitonidae

Ischnochiton conspicuus (Carpenter)

This chiton gets to be as much as three inches long. The girdle is thickly covered with bristles which give it a velvety appearance. The ridges of the valves are pink, and the front or anterior valve is concave. One specimen was encountered at a low tide level underneath an over-hanging rock.

Ischnochiton magdalenensis (Hinds)

This chiton is rather long and narrow with the sides and ends of the shell having fine radiating ribs. It is light in color most often being pink.

Ischnochiton mertensii (Middendorff)

The "red chiton" is oval in shape with angular dorsal ridges and straight sides. The color varies from orange to dark brown and is sometimes marked with white blotches. The valves are sculptured and the mantle is covered with fine rounded scales. It is found most everywhere around the Bay in rocky situations at low tide levels usually on a reddish background.

Ischnochiton regularis (Carpenter)

This is a very beautiful greenish blue, elongate chiton whose plates are somewhat keeled or highly arched. It is not very numerous and only occurs at low tide levels.

Callistochiton Grassicostatus Pilsbury

This is called the "thick-ribbed chiton". It has a narrow, elevated, oval, oblong shell. The color varies from green to brown. The front and posterior valves each have seven heavy ribs. One specimen was taken at low tide at Pescadero Point from the under surface of a rock.

Callistochiton palmulatus Carpenter

The "palm chiton" has small highly arched valves which are marked with raised sculpturing. There are eleven ribs on the anterior valve and seven bifurcated ones on the posterior one. The color is brownish. The last valve is somewhat thickened and oval in shape.

Family---Mopaliidae

Mopalia ciliata (Sowerby)

The "hairy chiton" has a rather oblong shell whose surface is lusterless and finely sculptured. The most usual coloring is green spotted with black or brown or chestnut spots on the ridge or some of the valves may be scarlet mixed with olive or white or entirely white with a yellow girdle. The central areas are sculptured with longitudinal, curving riblets, some what granulated. The girdle is generally notched behind and sparsely covered with curling, strap-like brown hairs which bear near their bases a band of minute

white, acute spines.

Mopalia muscosa (Gould)

The "mossy chiton" is a rather large chiton with the girdle densely covered with round, curved or curled hairs. This is one, if not the most common chiton of the intertidal zone.

Placiphorella velata Carpenter

This is a very flat chiton which is somewhat circular in shape with the girdle wider at the anterior end than it is at the posterior end. One specimen was collect from the under surface of a rock at low tide.

Family---Acanthochitonidae

Katharina tunicata (Wood)

This is a large black, leathery chiton which is readily recognized by the fact that the girdle extends up over the plates leaving only about a third of them exposed on the dorsal surface.

Family---Cryptochitonidae

Cryptochiton stelleri (Middendorff)

This is the largest chiton of the coast and can be easily recognized by its size, color and the fact that the girdle completely covers the valves. The girdle is thick, red, and leathery and is covered by minute clusters of vermillion spinelets. Some of them get to be six or eight inches in length.

(CHORDATA)

Subphylum--Tunicata

Order--Ascidiacea

Suborder---Ascideae Compositae

Amaroucium californicum Ritter and Forsyth

This tunicate is a rather prostrate, encrusting form which is irregular and variable in thickness, ~~often~~ lobed and sometimes pedunculated. It often reaches 20 cm. in extent and is never encrusted with sand, though sand is sometimes found in its deeper parts. Its color varies from a rather

opaque white to reddish brown. The zooids are often clearly visible and their distinct grouping more or less distinct. Numerous specimens were observed on the under surfaces of over-hanging rocks and over the surface of rocks in protected places.

Clavellina sp.

This is a sort of a pedunculated tunicate which is almost transparent. Masses of these peduncles were found growing together among the eelgrass and on the undersurfaces of over-hanging rocks. The peduncle is narrow and slender at the base and gradually widens out until the distal end is ovate in shape. The internal organs can be seen through the tunic as orange-colored structures.

Glossophorum planum Ritter and Forsyth

This tunicate forms large regular colonies, spherical or flattened, with thick cylindrical peduncles. The surface is smooth and free from sand or foreign substances. The system of zooids can be plainly seen in distinct and regular groups. Specimens were usually found attached to rocks in rather well protected places such as beneath over-hanging rocks, however, at Mussel Point specimens were found attached to a rock substratum covered with eelgrass and gravel.

Perophora annectens Ritter

The test of this tunicate is practically transparent and one can see the heart pulsating and the course of the water moving in at the branchial siphon and out the atrial siphon. This species forms irregular masses sometimes 2 inches or more long on sticks, rocks, and seaweeds. The color is pale greenish yellow. The individual zooids are about 1mm. wide and $1\frac{1}{4}$ mm. long, short, oblong and laterally compressed, usually crowded together and wholly embedded in the test, but sometimes farther apart with only the basal part embedded.

Subphylum---Vertebrata
Class ---Pices

The following fishes were taken in the tide pools and from among the algae of the intertidal zone:

Cymatogaster aggregatus Gibbons

Poichthys notatus Girard

Caularchus meandrus (Girard)

Greeleya rubellio (Greeley)

Dialarchus snyderi Greeley

Cebidichthys violaceus (Girard)

Gibbonsia metzi Hubbs

Anoplarchus purpurescens Gill

Xiphister mucosus (Girard)

Epigeichthys atro-purpureus (Kittlitz)

Syngnathus griseolineatus

Hopkins Marine Station
Pacific Grove, Calif.
(Courtesy of R.W.Fautin)



Fig. 1. The side of a channel leading into a bay. Note the dense beds of mussels and barnacles on the rock.



Fig. 2. A close-up of a mussel-barnacle bed such as the one seen on the point of rock projecting toward the right in the picture above. The mussels are Mytilus californicus and the barnacles are Mitella polymerus, both very common all along the Pacific Coast (Also note the limpets on the mussel shells - Acmassa spp.)

Hopkins Marine Station
Pacific Grove, Calif.
(Courtesy of R.W.Fautin)

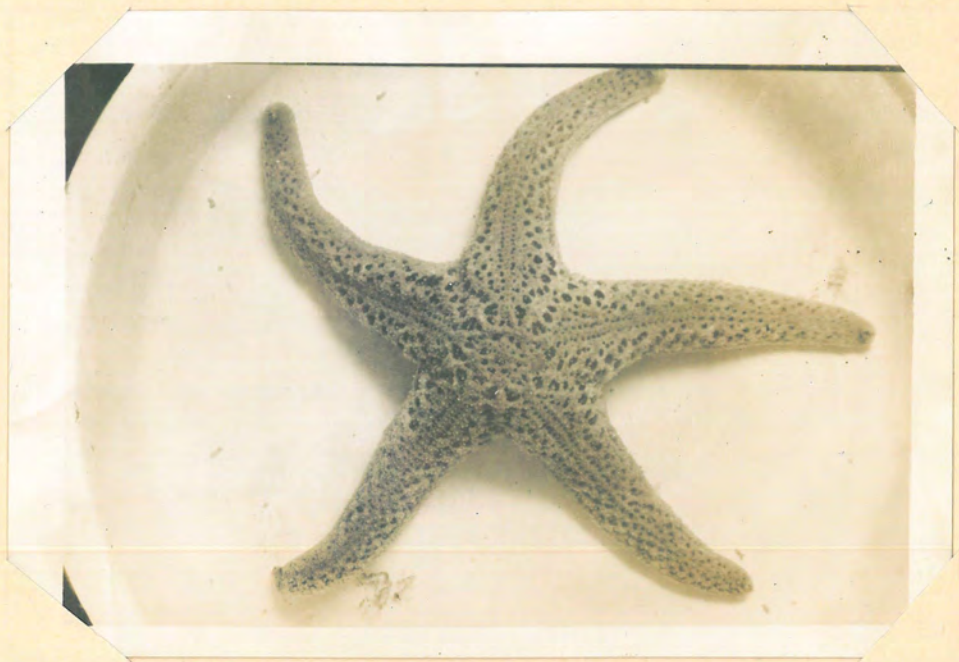


Fig. 1. The star-fish, Pisaster brevispinus.

(Found all along Pacific Coast, Washington, Oregon, California.)

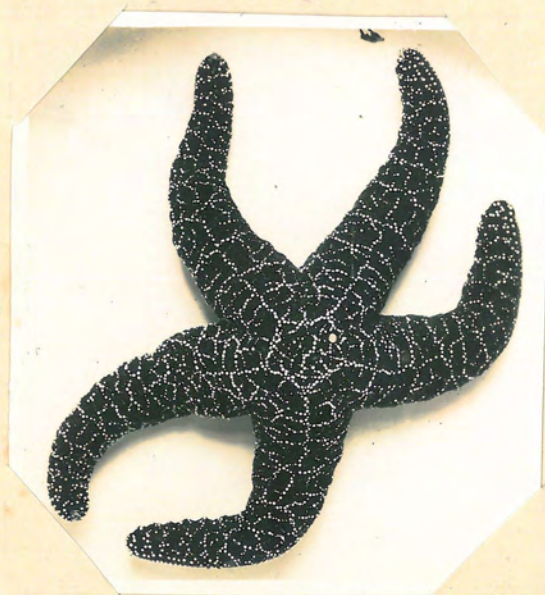


Fig. 2. Pisaster ochraceus,
a very common star-fish.
(Found all along Pacific
Coast, Washington, Oregon,
California.)

Hopkins Marine Station
Pacific Grove, Calif.
(Courtesy of
R.W. Fautin)



Fig. 1. The Moon-snail, Polinices lewisi, a destroyer of clams and disturber of oyster beds.



Fig. 2. The habitat of the Moon-snail. The one pictured above was taken from this area, just below the water's edge.

Hopkins Marine Station
Pacific Grove, Calif.
(Courtesy of R.W.Fautin)



Fig. 1. A typical rocky shore, covered with sea weeds and many marine animals.



Fig. 2. A close-up of part of the area in the picture above, showing the detail of two of the principal algae of the region.



Fig. 1. Upper left: Cancer productus, the red crab. It is fairly common and is edible, but is not the most common edible crab of the West Coast. Upper right: Pachygrapsis sp., a shore crab. A common species. Lower left and right: Dermasterias imbricata, the leather-star--a smooth-skinned starfish. All these animals are common along the coast--Washington to California, inclusive.



Fig. 2. Bynodactis xanthogrammica, a sea anemone. This is the larger species of sea anemones which are a bright green color and are common all along the coast. This specimen measured 6 or 8 inches in diameter. The green color is due to the presence of a unicellular alga in the endoderm.