

Letters and Recollections of Alexander Agassiz: The 1891 *Albatross* Expedition

G. R. AGASSIZ

Alexander Agassiz (Fig. 1) had always been most anxious to supplement his work on the *Blake* (Fig. 2) in the Caribbean, by an expedition in the Panamic region of the Pacific, for it was well known that the littoral fauna of these two localities bore a striking resemblance. This led him to believe that a comparison of the deep-sea forms on the Pacific side of the Isthmus of Panama with his old friends in the Caribbean would furnish reliable data for some most interesting conclusions. If he could establish geologically the approximate period at which the Caribbean ceased to be a bay of the Pacific, he hoped to be able to determine the amount of change that had taken place between the deep-sea fauna on each side of the Isthmus, since the passage connecting them had ceased to exist.

Already he had been twice disappointed in his hope of undertaking such an expedition. In 1879, he was invited by Admiral George Belknap to join his flagship, the *Tuscarora*, off Panama and undertake a deep-sea cruise; un-

fortunately the breaking-out of the war between Peru and Chile made this expedition impossible. Again in 1888, business matters prevented his accepting an invitation to join the *Albatross* (Fig. 3) at Panama, on her way from New York to San Francisco.

Then in 1890, he was asked by Colonel Marshall MacDonald (Fig. 4), the U.S. Fish Commissioner, to take charge of a deep-sea expedition off Panama the following year in the *Albatross* (Fig. 5). The conditions under which Agassiz was offered the ship included his supplying the coal, assisting in thoroughly reequipping the boat, and paying part of the running expenses. In return he was to get a first set of the collections which especially interested him. The result of the arrangement was, that this and his subsequent expeditions in the *Albatross* were little if any less expensive to him than the expeditions he undertook later without government aid.

The *Albatross* was built in 1882 especially for the use of the U.S. Fish Commission (USFC). She was 234 feet over all, 200 feet on the water-line, with

a beam (moulded) of 27 feet 6 inches. At 12 feet draught, she displaced a trifle under 1,100 tons. Her engines had an indicated horsepower of a shade over 450, and she was fitted with twin screws.

She was furnished with a very complete marine laboratory; and when re-equipped for this expedition possessed all the most approved devices of the day for the investigation of the ocean. Her officers were detailed from the U.S. Navy, and her captain, Lieutenant Commander Zera Luther Tanner (Fig. 6), had been in charge ever since her first cruise. From 1883 to 1886, she worked for the USFC along the Atlantic coast. In 1887, she left for the Pacific, sounding and dredging along her route; and in 1890, she was sent to Bering Sea to investigate the fur seal, *Callorhinus ursinus*, fisheries.

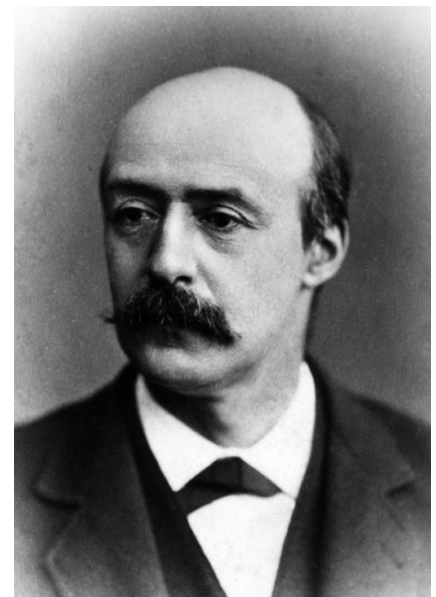


Figure 1.—Alexander Agassiz (courtesy of Harvard University Archives).

EDITOR'S NOTE—Presented here is another in the list of historic accounts of iconic research cruises of the USFC Steamer *Albatross*, this a reminiscence of the renowned scientist Alexander Agassiz edited by his son G. R. Agassiz, a chapter from the volume "Letters and Recollections of Alexander Agassiz," published in 1913. Agassiz made three major cruises in the *Albatross* in 1891, 1899–1900, and 1904–05, adding greatly to the world's store of specimens and knowledge of thalassography, his favored term for oceanography, and specifically of the Pacific Ocean. Having made important cruises and studies with the *Blake* in the Caribbean, he sought to do comparable research in the Pacific. His opportunity came in 1890,

and with the consent of President Benjamin Harrison, he took charge of this *Albatross* research cruise, paying much of the expense himself. In contrast with the other ships he had been on, he found the laboratories, equipment, and furnishings to be comparatively luxurious and extremely well appointed for his work. Further, the *Albatross* was then captained by Lieutenant Commander Zera Luther Tanner who seemed to take as much interest in the oceanographic research as did the scientists, and Agassiz appreciated working with him, too. Little of the original text has been altered, and readers are cautioned that some of the views expressed may reflect unfortunate prejudices of that era toward individuals, nationalities, etc.

In January, 1891, with the consent of the President, the *Albatross* was ordered to Panama. Agassiz left New York on February 10, taking with him Magnus Westergren (Fig. 7), who was to act as artist of the expedition. On reaching Panama, after crossing the Isthmus, where the French were at work on the canal¹, Agassiz writes:

“It seems quite natural for me to be here again in the same old hotel where I have so often stopped and with the same landlord who was here in 1859, when I first passed through on my way to California, and who has been here ever since. He seemed quite pleased to see me again and has made me as comfortable as one can be in a combination of a French–Spanish mansion.

“The canal can be fairly seen from the line of the railroad, and it is really frightful to see the waste; the whole length of the line is one long village, houses for the men, and all along you find dredges by the half dozen laid up and going to pieces, and in a few localities every ten miles or so there is an entrepôt with miles of machinery, much of which has never been used, and no less than six large steamers have returned to Europe filled with the wrecks which could be still used elsewhere. There has been

¹The French made a failed attempt to construct the Panama Canal.

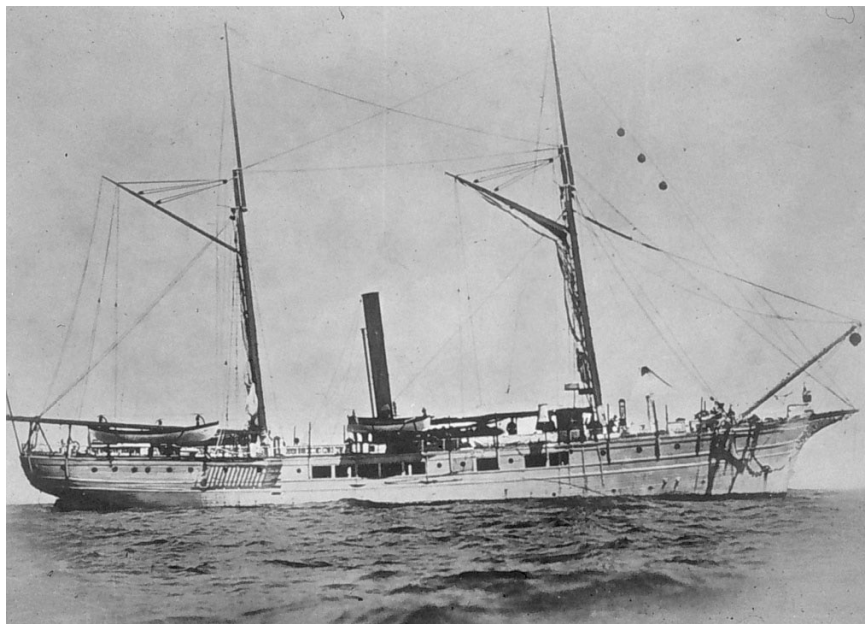


Figure 2. —U.S. Coast and Geodetic Survey Steamer *Blake* (source: NOAA Central Library).

much less work done than I imagined, judging from the money spent; it was generally supposed that nearly one-third was done, but I hardly think there is one-tenth of the work finished. They have, it is true, some twenty-five miles of canal in the plains at the two ends well advanced, but the real work of cutting consists only of a few scratches, nowhere more than twenty feet below the railroad!

“I go on board the *Albatross* this P.M., and we start tomorrow. The working accommodations are fine, an upper room twenty by twenty for rough work and general laboratory, and a second floor below for storing the collection in racks—we ought to do well. My cabin is nine by eight; I have a closet to hang things, about twelve good-sized drawers under my bunk and in a bureau, and I

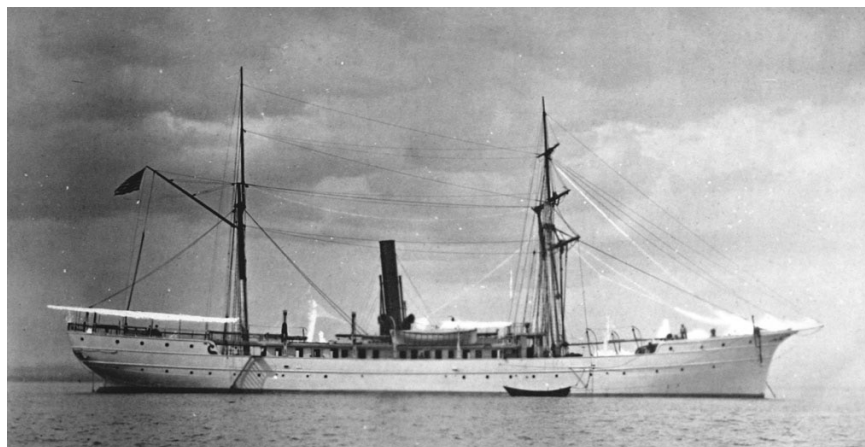


Figure 3. —U.S. Fish Commission Steamer *Albatross* in Panama (source: NOAA Central Library).

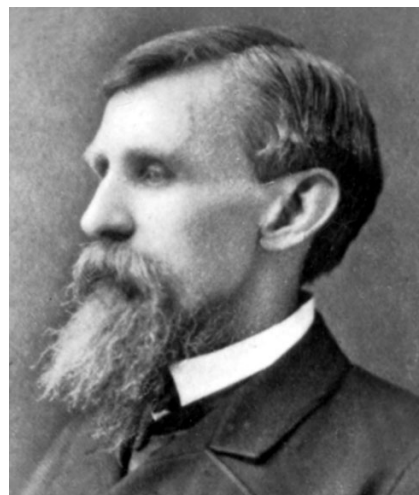


Figure 4.—Marshall McDonald, U.S. Fish Commissioner 1888–1895 (source: NOAA Central Library).

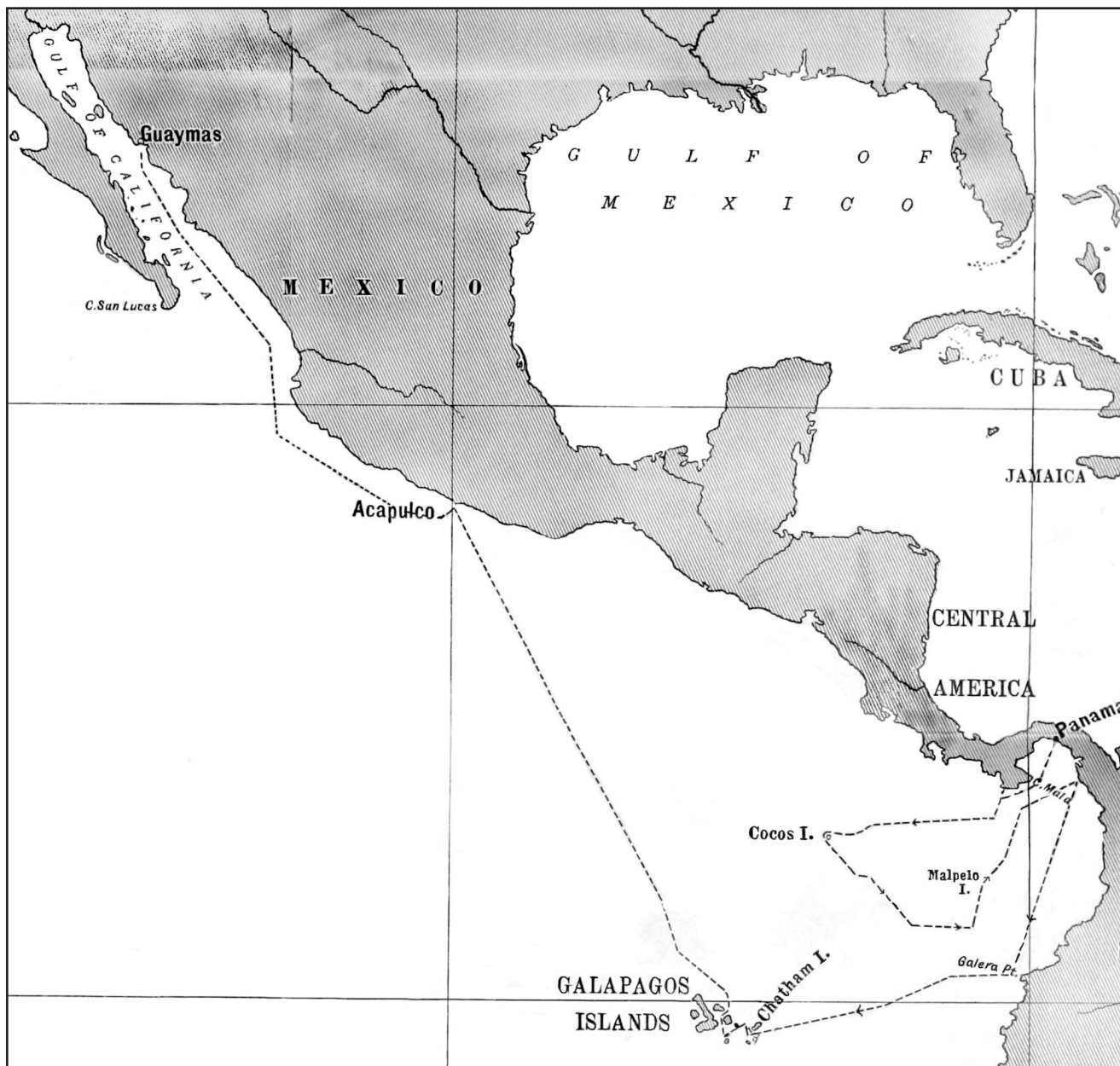


Figure 5.—*Albatross* 1891 cruise map (adapted from “Letters and Recollections of Alexander Agassiz” edited by G. R. Agassiz).

keep one of my trunks to stowaway stuff, a couple of shelves and hooks, and you have my equipments. My cabin opens out into a good-sized dining-room and sitting-room of about twelve feet by the width of the ship, where Tanner and I sit and take our meals. It has large portholes, a fine skylight, and is very airy and comfortable. Strange to say, it has the desk and sideboard

which were on the *Hassler* [Fig. 8] when Father [Louis Agassiz] made his trip from New York to San Francisco in 1871–72!”

The first trip was a sort of preliminary trial to test the apparatus; the ship left Panama on February 22, and returned after an absence of 20 days. On leaving Cape Mala, which

marks the western entrance to the Bay of Panama, she proceeded to Cocos Island, over 400 miles to the westward, and from there made a broad sweep to Malpelo Island, about 300 miles to the eastward, and back to Panama. Some idea of what was done on the initial cruise can be gathered from Agassiz’s letter to the U.S. Fish Commissioner, written after reaching Panama.

To Marshall MacDonald
On Board the *Albatross*,
March 14, 1891.

“I have found, in the first place, a great many of my old West Indian friends. In nearly all the groups of marine forms among the Fishes, Crustacea, Worms, Mollusks, Echinoderms, and Polyps, we have found familiar West Indian types or East Coast forms, and have also found quite a number of forms whose wide geographical distribution was already known, and is now extended to the Eastern Pacific. This was naturally to be expected from the fact that the district we are exploring is practically a new field, nothing having been done except what the *Albatross* herself has accomplished along the west coast of North and South America. The *Challenger* [Fig. 9], as you will remember, came from Japan to the Sandwich Islands [Hawaii], and from there south across to Juan Fernandez [Islands], leaving, as it were, a huge field of which we are attacking the middle wedge. As far as we have gone, it seems very evident that, even in deep water, there is on this west coast of Central America a considerable fauna which finds its parallel in the West Indies, and recalls the pre-Cretaceous times when the Caribbean Sea was practically a bay of the Pacific. There are, indeed, a number of genera in the deep water, and to some extent also in the shallower depths, which show far greater affinity with the Pacific than with the Atlantic fauna. Of course, further exploration may show that some of these genera are simply genera of a wider geographical distribution; but I think a sufficiently large portion of the deep-sea fauna will still attest the former connection of the Pacific and the Atlantic.

“I am thus far somewhat disappointed in the richness of the deep-sea fauna in the Panamic district. It certainly does not compare with that of the West Indian or Eastern United States side. I have little doubt that this comparative poverty is due to the absence of a great oceanic current like the Gulf Stream, bringing with it on its surface a large amount of food which serves to supply the deep-sea fauna along its course. In



Figure 6.—Lieutenant Commander Zera Luther Tanner (source: NOAA Central Library)



Figure 7.—Andreas Magnus Westergren (1844–1936).

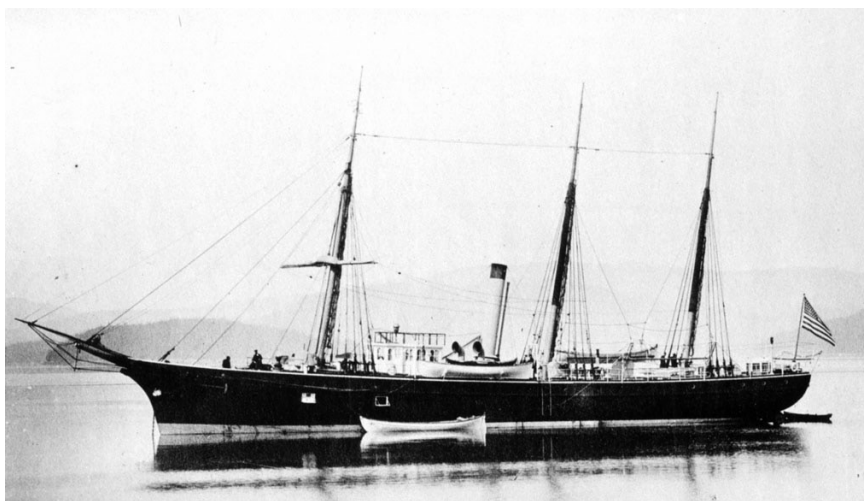


Figure 8.—Coast and Geodetic Survey Ship *Hassler* (source: NOAA Central Library).

the regions we have explored up to this time, currents from the north and from the south meet, and then are diverted to a westerly direction, forming a sort of current doldrums, turning west or east or south or north according to the direction of the prevailing wind. The amount of food which these currents carry is small compared with that drifting along the course of the Gulf Stream. I was also greatly surprised at the poverty of the surface fauna. Except on one occasion, when during a calm we passed through

a large field of floating surface material, we usually encountered very little. It is composed mainly of *Salpael*, *Doliolum*, *Sagittas*, and a few Siphonophores—a striking contrast to the wealth of the surface fauna to be met with in a calm day in the Gulf of Mexico near the Tortugas, or in the main current of the Gulf Stream as it sweeps by the Florida Reef or the Cuban coast near Havana. We also found great difficulty in trawling, owing to the considerable irregularities of the bottom. When trawling from north to south, we

seemed to cut across submarine ridges, and it was only while trawling from east to west that we generally maintained a fairly uniform depth. During the first cruise we made nearly fifty hauls of the trawl, and in addition several stations were occupied in trawling at intermediate depths. In my dredgings in the Gulf of Mexico, off the West Indies, and in the Caribbean, my attention had already been called to the immense amount of vegetable matter dredged up from a depth of over fifteen hundred fathoms, on the lee side of the West India Islands. But in none of the dredgings we made on the Atlantic side of the Isthmus did we come upon such masses of decomposed vegetable matter as we found on this expedition.

“Cocos Island is only about two hundred and seventy-five miles from the mainland, and its flora, so similar to that of the adjacent coast, tells its own story. Malpelo, on the contrary, which is an inaccessible rock with vertical sides, and destitute of any soil formed from the disintegration of the rocks, has remained comparatively barren, in spite of its closer proximity to the mainland.

“The most interesting things we have found up to this time are representatives of the Ceratias group of Fishes, which the naturalists of the *Albatross* tell me they have not met before on the west coast of North America. The Crustacea have supplied us with a most remarkable type of the *Willemaesia* group. The paucity of Mollusks and also of Echini is most striking, although we brought up in one of the hauls numerous fragments of what must have been a gigantic species of *Cystechinus*, which I hope I may reconstruct. We were also fortunate enough to find a single specimen of *Calamocrinus* off Morro Puercos, in seven hundred fathoms, a part of the stem with the base, showing its mode of attachment to be similar to that of the fossil *Apiocrinidae*. The number of Ophiurans was remarkably small as compared with the fauna of deep waters on the Atlantic side, where it often seems as if Ophiurans had been the first and only objects created. The absence of deep-sea corals is also quite striking. They play so important a part

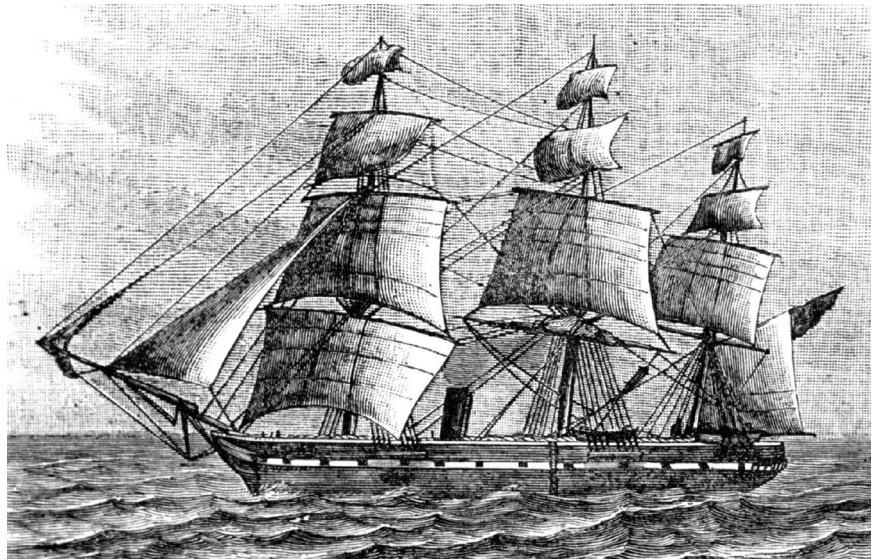


Figure 9.—H.M.S *Challenger*, 1872 (source: NOAA Central Library).

in the fauna of the deeper waters of the West Indies, that the contrast is most marked. Gorgoniae and other Halcyonoids are likewise uncommon. We have found but few Siliceous Sponges, and all of well-known types. Starfishes are abundant, and are as well represented in the variety of genera and species as on the Atlantic side of the Isthmus. I may also mention the large number of deep-sea Holothurians (Elasipoda) which we obtained, as well as a most remarkable deep-sea Actinian, closely allied to *Cerianthus*, but evidently belonging to a new family of that group. We found the usual types of deep-sea West Indian Annelids, occasionally sweeping over large tracts of mud tubes in the region of green mud. Although we dredged frequently in most characteristic Globigerina ooze, I was much struck with the absence of living Globigerinae on the surface. Only on two occasions during a calm did we come across any number of surface Globigerinae and Orbulinae. On one occasion the trawl came up literally filled with masses of a species of *Rhabdammina* closely allied to *R. lineata*. Thus far no pelagic Algae have been met with.

“I can hardly express my satisfaction at having the opportunity to carry on this deep-sea work on the *Albatross*. While of course I knew in a general way the

great facilities the ship afforded, I did not fully realize the capacity of the equipment until I came to make use of it myself. I could not but contrast the luxurious and thoroughly convenient appointments of the *Albatross* with my previous experiences. The laboratory, with its ingenious arrangements and its excellent accommodations for work by day and night, was to me a revelation. Mr. Westergren has found his time fully occupied, and we have in this trip brought together a considerable number of colored drawings, giving an excellent general idea of the appearance of the inhabitants of the deep waters as they first come up. These drawings can be used to great advantage with the specimens in making the final illustrations to accompany the reports of the specialists who may have charge of working up the different departments.”

While coaling and making some slight repairs he writes:

“The *Albatross* is an excellent sea boat and she rides the sea wonderfully well, and really much better than many a large ocean steamer I have been on. We have done about as much work these eighteen days as I did on the *Blake* on my first cruise. You can have no idea how comfortable the trip has been. The

quarters I share with the Captain are very spacious and in this hot weather it makes a great difference not to feel cramped. The accommodations for work and for taking care of the collections are excellent. There are two men to help to put them aside, a Mr. Townsend², who is called the naturalist of the ship and who is the most obliging and hard-working man imaginable, and a Mr. Miller³, the chemist, who gets all the needed preparations ready and also helps to put up the things, so that I have a chance to spend what time there is between the dredgings and, while the things are being sorted, to examine them and make notes and superintend Westergren. We shall hardly get away from here before the 20th, as there are two ships ahead of us for coal and our repairs may take the greater part of the time till our turn comes. While coaling ship I shall live on shore and go on line of the railroad with the doctor of the old Canal Company. I have also an invitation to spend the day at the plantation of a Mr. Erman, who is the principal banker here. This plantation is about fifteen miles from Panama near one of the most interesting parts where the work was done on the Canal. He seems to have seen a good deal of Father and of the *Hassler* people while they spent three weeks at Panama, and says I shall find on the plantation a good many people who are old acquaintances of the *Hassler*. Captain Tanner has been perfectly indefatigable; he is indeed a model Captain for such a trip. We begin at 5 A.M. and keep it up till 10 P.M. My patent intermediate net was a failure, but Captain Tanner and I rigged up a new machine which has worked to perfection and shows plainly that there is no intermediate fauna as I have always stuck to. But using the net deep down just above the bottom, say one hundred fathoms, I have brought up some interesting things, and have also found some good things by towing at two hundred fathoms only in deep water and have caught as surface things, which go down in the day or

²Charles Haskins Townsend (1859–1944) served aboard the *Albatross* from 1886 to 1896.

³N. B. Miller, an assistant fishery expert on the *Albatross*.

when it blows, many of the so-called deep-sea things.”

On leaving Panama for the second time, the *Albatross* proceeded to Galera Point, about 400 miles from Panama Bay, on the coast of Ecuador; from here she ran a line across the Humboldt Current as far as the south face of the Galapagos (Fig. 10), something over 500 miles to the westward of Galera Point. After visiting the islands the ship worked her way to Acapulco.

When once well out at sea the work of the expedition settled down to its regular routine. The day’s program began with a sounding, often before six, but sometimes, after a hard day, it was not taken till the change of the watch at eight o’clock. Then the whir of the machine on the poop deck overhead could be heard buzzing away merrily while Agassiz and the Captain were at breakfast. As soon as the bottom sample, a tube full of abyssal ooze, reached the surface, it was taken to the laboratory amidships. While Agassiz was examining this, the great dredging boom was swung out to starboard, the big Blake trawl was lowered away, and the ship lay to while the three or more miles of wire rope sometimes necessary to drag it along the bottom was slowly payed out; then the vessel steamed ahead slowly, while Agassiz occasionally left his work in the laboratory to note the strain on the tackle recorded on a dial.

After a time the vessel was again stopped, and the long tedious process begun of reeling in what appeared to be an endless line of cable. The incessant monotony of the clank, clank, of the reeling engine was punctuated by an occasional sharp vibrating jar, as a sudden roll of the ship brought an extra strain on the gear. Meanwhile in the laboratory, Agassiz and his assistants were busy sorting what remained of the hauls of the previous day, preserving the specimens and preparing them for storage in the racks in the lower laboratory.

As soon as the catch arrived on board (Fig. 11), all was bustle, activity, and excitement. The contents of the bag, a mass of ice-cold ooze, was turned into sieves and washed down under spray,

while Agassiz, eager as a boy, inspected each fresh revelation from the silent depths of the sea. Again the work of sorting and preserving the specimens continued under Agassiz’s supervision in the laboratory, some of the more delicate being turned over to Westergren to sketch (Fig. 12). There were usually three or four dredgings a day. Often the last haul did not come on board till after dark, sometimes as late as ten or eleven o’clock, when they were handled by the help of the deck lights.

While the trawl was dragging slowly over the bottom, a surface tow net was sent overboard on one of the lower booms. If this haul proved interesting, the ordinary routine would be interrupted, and the huge intermediate tow net, substituted for the trawl, would be sent down, often three or four times, if the surface towings showed abundance of life.

On very still nights the surface net was in use till late into the night, while Agassiz examined, in glass bowls held directly over an electric light, the catch of minute pelagic forms. At every anchorage electric lights were put into the water at night to attract the surface fauna. This furnished sport for the sailors, who fished up the prey with long-handled gauze dip nets (Fig. 13). Agassiz’s attentive consideration of all the specimens brought to him by the men served to keep up their interest, and the amount of pelagic material thus collected was considerable.

After reaching the Galapagos, writing to Colonel MacDonald of the line across the Humboldt Current he says:

“With the exception of three good casts the trawling on that part of the sea bottom proved comparatively poor.”

He must, however, have been thinking at the time of some of the wonderfully rich ground he had dredged in the *Blake*, for the letter continues:

“In the deeper parts of the channel between Galera Point and the southern face of Chatham Island we found a great number of *Elasipoda*, among them several genera like *Peniagone*, *Bentho-*

dytes, and Euphronides, represented by numerous species. The Starfishes of this our second cruise did not differ materially from those collected during our first trip, but we added some fine species of Freyella, Hymenaster, Astrogonium, Asterina, and Archasteridae to our collection. Among the Sea-urchins on two

occasions we brought up fine hauls of a species of Cystechinus with a hard test, many specimens of which were in admirable state of preservation.”

And so on through a list of the Ophiurans, Gorgonians, crustaceans, worms, mollusks, fishes, etc.

“Arriving as we did at the Galapagos at the beginning of a remarkably early rainy season, I could not help contrasting the green appearance of the slopes of the islands, covered as they were by a comparatively thick growth of bushes, shrubs, and trees, with the description given of them by [Charles] Darwin, who represents them in the height of the dry season as the supreme expression of desolation and barrenness. Of course here and there were extensive tracts on the seashore where there was nothing to be seen but blocks of volcanic ashes, with an occasional cactus standing in bold relief (Fig. 14), or a series of mud volcanoes, or a huge black field of volcanic rocks (Fig. 15), an ancient flow from some crater to the sea; but as a rule the larger islands presented wide areas of rich fertile soil, suitable for cultivation.

“The course of the currents along the Mexican and the Central and South American coasts clearly indicates to us the sources from which the fauna and flora of the volcanic group of the Galapagos has derived its origin. The distance from the coast of Ecuador (Galera Point and Cape San Francisco) is in a direct line not much over five hundred miles, and that from the Costa Rica coast but a little over six hundred miles, and the bottom must be for its whole distance strewn thickly with vegetable matter. The force of the currents is very great, sometimes as much as seventy-five miles a day, so that seeds, fruits, masses of vegetation harboring small reptiles, or even large ones, as well as other terrestrial animals, need not be afloat long before they might safely be landed on the shores of the Galapagos. Its flora, as is well known, is eminently American, while its fauna at every point discloses its affinity to the Mexican, Central, or South American and even West Indian types, from which it has probably originated; the last indicating, as well as so many of the marine types collected during this expedition, the close connection that once existed between the Panamic region and the Caribbean and Gulf of Mexico.”

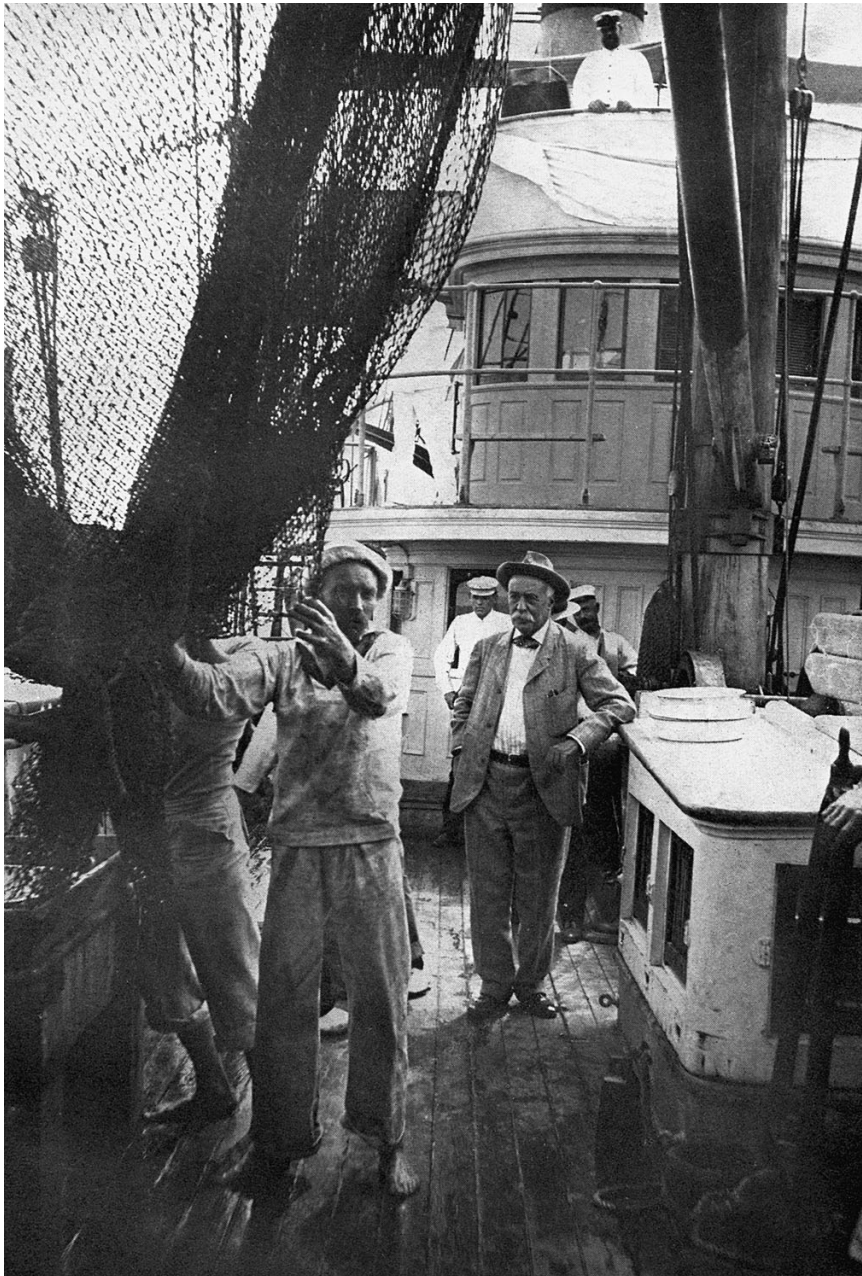


Figure 11.—Agassiz on the back deck of the *Albatross* after a trawl has been emptied (source: “Letters and Recollections of Alexander Agassiz” edited by G. R. Agassiz).

Continuing his line along between Chatham and Indefatigable Islands,

Agassiz was disappointed in his poor hauls:

On Board the *Albatross*,
Indefatigable Island, April, 1891.

“Here we are at anchor in Conway Bay on the west end of Indefatigable Island, having done all we can afford to do at the Galapagos. We spent nearly three days at Chatham Island, which is the island where a man by the name of Cobos has been having a farm since ‘67; up to a couple of years ago he worked it with convicts, but they gave so much trouble and it was so dangerous for him and his family that he applied to the Ecuadorian Government to remove them, and now has regularly paid workmen, a colony of about three hundred including women and children (Fig. 16). He has now laid out quite a large cattle ranch, about twenty thousand head of cattle, a large sugar plantation, a coffee plantation, and a huge vegetable garden. He salts his meats and carries on also an extensive fishery, sending all his plunder to Guayaquil. He has a small trading schooner which goes during the season about once a month to the islands. It was quite funny to find Baur’s⁴ letter had just reached him, a few day [sic] before we got there, by an Ecuador man-of-war, which had been sent evidently to watch us, they thinking the United States Government had some views on the islands connected with the Canal at Panama or Nicaragua! We paid him (Cobos) a visit to his hacienda about six miles from where we were at anchor. He promised to send mules to meet the crowd, but, true Spanish fashion, after we waited for two hours, we decided to start to walk. It had got pretty hot by that time, and the road was nearly impassable from the rain. It is the hot rainy season here now, so you can easily imagine the spectacle presented by the officers after an hour of walking up to our knees in mud in a broiling sun. But at last we met the mules and cooled down toward the last part of the trip. We took lunch in the most primitive manner. Everything very

⁴The naturalist, Georg Baur, then visiting the Galapagos.

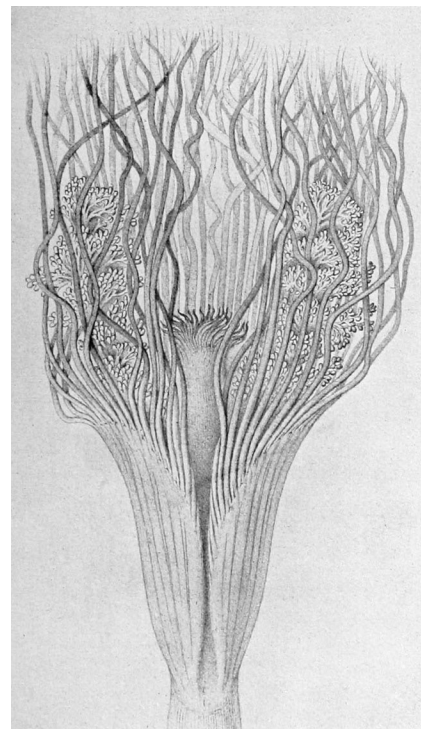
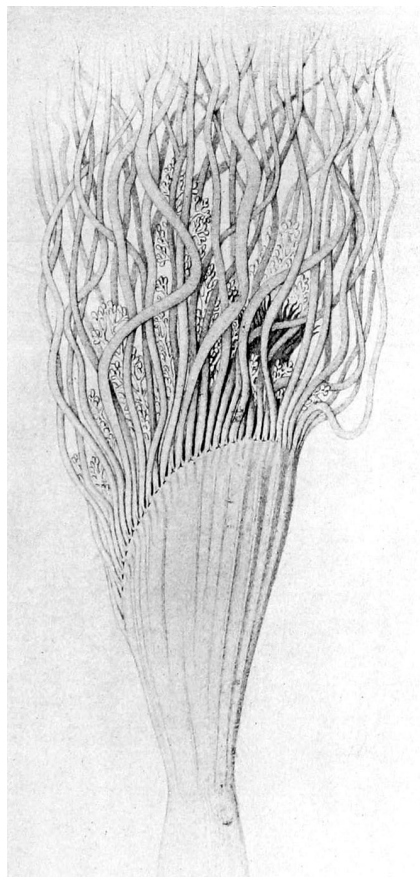
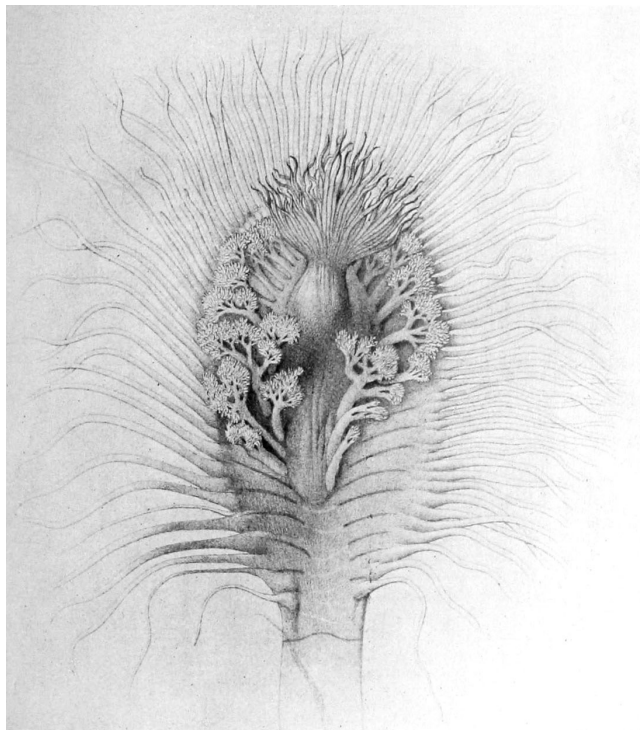


Figure 12.—*Branchiocerianthus urceolus* taken in the Gulf of Panama, near Cape Mala. Drawings by Westergren from sketches by Agassiz (source: Bull. Mus. Comp. Zool. 32(8), plates 1-3).



Figure 13.—*Albatross* surface nets (source: NOAA Central Library).

good, but no comforts of any kind, and dirty beyond description. We sauntered round the village of workmen, a most interesting sight in the way of social economy, and took some fresh mules to ride over the greater part of the island. It is really quite pretty when you get up well along the mountain-side, about two thousand feet, and pass above the tangle of cactus and mimosa, which makes the lower slope of the island nearly impassable.

“The doctor of the ship was most busy during our stay. He had all the ills of the population to attend to, for there is no physician settled on the plantation! The men shot a good lot of birds, and Mr. Townsend has been a most hard-worked man skinning the plunder.

I spent my time on shore collecting rocks, botanizing, and catching insects, and it seemed quite natural to be going round again with a butterfly net. After endless delays we succeeded at last in getting our provisions on board and sailed for Charles Island. That has an old abandoned plantation, the first of the islands where the Captain wanted to give the men shore liberty to fish, bathe, and get all the fruit they wanted, as there were no liquor shops in the way. We stayed there one day; the men had their fill, and I spent my time much as I did on Chatham.

“Next we went to a small island called Duncan [Fig. 17], hoping to get a lot of the gigantic land tortoise and lizards peculiar to the island. We found plenty of

the latter, but only got one of the former; this I was sorry for, as I depended upon our catch to fill up the Galapagos Islands group in the Pacific Exhibition Room at the Museum of Comparative Zoology. Still I think the *Hassler* brought some turtles, and I will have [Samuel] Garman make an exhibit of the reptiles of the group anyway. Townsend is to give me a set of the birds, so that we can make a show at least in the space reserved for oceanic islands in the Pacific Room. At Duncan, I spent the day tramping, hoping to get a turtle or so, but only got very warm and greatly enjoyed the bath at the end of the day in a beautiful clear coral beach where I paddled round until I got well cooled. After dark we steamed to Indefatigable where I write this, and



Figure 14.—*Albatross* offshore, Charles Island (source: Bull. Mus. Comp. Zool. 23(1), plate XX).

shall start early tomorrow on our regular dredging trip again, and nothing ought to interfere to keep us from dredging to our hearts' content from here to Acapulco."

Shortly before reaching Acapulco he continues:

"Here we are within three hundred miles of Acapulco, and a more disgusted individual it would be difficult to find. After leaving Indefatigable Island we began to dredge; and I fondly hoped on the weather side of the Galapagos to find a very rich fauna and to make splendid hauls. But time after time the trawl came up with about a pint of most uninteresting specimens, or else it came up torn to pieces, as the lava bottom played havoc with the nets, and so it kept up till we left Culpepper Island, the most northerly of the islands; and I hoped that at least on the sea bottom of the deep basin, when out of the influence of the lava fields of the islands, we

should get some good deep-water hauls. But there again, that part of the Pacific proved as barren as the rest, and the piece of sea I had been congratulating myself that the *Challenger* left for me, has been a great disappointment. We still have the chance off Acapulco, now when within sight of land, to get something on the continental slope. I settled, however, once for all the fact that below two hundred fathoms at sea there was no animal life, and the pelagic people will now have to stop sailing into me, and take a back seat. Day before yesterday we struck a regular trade-wind blow and I was as sick as I could be, and as luck would have it I could not find my Leavitt seasick pills, so made myself as comfortable as I could. Of course no work could be done, and yesterday the weather moderated for us to work again and my stomach resumed its usual placidity. It's funny what things you wish to eat while trying to get well. I managed to eat a little pineapple, some

fried bananas, and sour-kraut! It seems a queer combination, but worked admirably and kept me well alive."

On their arrival in Acapulco he writes:

"We are in the midst of coaling, and a more filthy place than the *Albatross* is just now, you cannot imagine. I begin to realize what I escaped at Panama. I have not gone ashore here to live because the hotel is such a frightful hole that even I, accustomed as I am to Spanish ways, could scarcely stand it. We spent yesterday making official calls to the Governor of the Province and the Captain of the Port. The former is a very fine specimen of a Spaniard. He was with Diaz in the defense of Puebla, made prisoner, escaped from the French, and is in every way a very interesting man, well educated, speaks French and English, and has a very good-looking and pleasant daughter educated in San Francisco.



Figure 15.—Charles Island, Black Beach (source: Bull. Mus. Comp. Zoology 23(1), plate XIX).

“I see you have also the common idea that Panama is deadly and the climate frightful. The whole thing is a mistake and if people who go there will observe the ordinary precautions, there is not the least danger.”

To Mrs. C. L. Peirson⁵
Acapulco, April 13, 1891.

“We arrived here last night, and among other letters I was pleased to find two from you. I expect from your many dissipations to find you and Charlie quite poorly—it seems funny to think of anybody’s going to dine! I hear a good deal about grub on board, but nothing of the kind that could be called a dinner by our friend Ward McAllister⁶. I think I shall quite enjoy a good dinner served

with some style, but it does not look as if I should get one very soon, for I shall have to trot to Calumet⁷ soon after reaching Cambridge and see if there is anything left to pay for the coal bills of the *Albatross*. We are just laying in two hundred tons, at twenty dollars, and have had that pleasure twice before at Panama, so I feel quite poor. This is quite a quaint medieval place, has not changed an atom from the time it used to be the great rendezvous of the Spanish galleons sailing from Manila and sending their treasures overland to Vera Cruz for old Spain. Fort San Diego looks much as it must have in those days, and is of course today perfectly useless. It seems strange to me to be here again. I spent six weeks here in ‘59, a young

chap with my whole life before me, and I remember very distinctly the week I passed here again on my way home to be married; it seems only yesterday. Little did I dream in those days of what I should have to go through. I had everything to live for then, and it has been pretty uphill work for a long time. But I ought not to complain, or at least the world does not think so. I have been in all I have undertaken most successful from the world’s point of view, but from mine it has lost its charm long ago.

“My trip is now drawing to a close. We sail day after tomorrow and should reach Guaymas the 25th. Then I shall leave the *Albatross* and shall not be sorry to be wending my way homeward. This will make nearly three months at sea, and that is quite enough for one season. I have, however, been most comfortable. The officers have done all they could to make the cruise a

⁵His sister-in-law.

⁶A notable figure in New York society.

⁷Agassiz was the president of the Calumet and Hecla Mining Company, a copper mine in upper Michigan.



Figure 16.—Chatham Island plateau looking east from hacienda (source: Bull. Mus. Comp. Zool. 23(1), plate XVII).

success, and I shall have accomplished a project I had almost given up. It has not been quite what I anticipated, but has amply repaid me for the time spent.”

On leaving Acapulco the cruise continued up the Gulf of California; since the character of the bottom, as given on the charts, indicated nothing different from what had been dredged off the coast of Acapulco, the ship steamed as far as Cape Corrientes without making a haul. Here they brought up nothing but mud and decayed vegetable matter, so they kept on up the Gulf of California till off the Tres Marias. Here some good hauls were made, though the character of the bottom did not change materially as the *Albatross* went farther north into the Gulf. They found the trawling most

difficult from the weight of mud brought up in the trawl, but occasionally a rich haul more than repaid them for the less productive ones.

“Two of the hauls are especially worthy of mention as being characteristic of the deep-water fauna of the Gulf of California, one made in 995 fathoms, and the other in 1,588 fathoms. We obtained in these hauls a number of *Ophiomusium* and *Ophiocreas*, some specimens of *Schizaster*, a new genus allied to *Paleopneustes*, and also the same species of *Cystechinus*, with a hard test, and of *Phormosoma*, which we had obtained before on the line from the Galapagos to Acapulco.”

The *Albatross* reached Guaymas on the afternoon of April 23, where Agas-

siz left the ship and made directly for the East by rail. The collections were afterwards distributed, to be worked up, among the best specialists anywhere available, and proved far richer than one would gather from Agassiz’s letters at the time. Writing of the expedition years later, he says:

“We spent more than two months dredging and trawling with great activity, and succeeded in bringing together in that time a collection of deep-sea forms which probably has not had its equal in any other expedition. I had always hoped sometime to work with Captain Tanner, and it was natural that with our combined experience we should have been as successful as we were. That we had worked hard was seen at the end of our trip. At Guaymas, when I left the



Figure 17.—Duncan Island (source: Bull. Mus. Comp. Zool. 23(1), plate XXII).

ship, we were neither of us in condition to do another stroke of work.”

During this cruise Agassiz made a special study of vertical distribution of pelagic fauna, or the depth to which floating animals may be found beneath the surface. Some naturalists, especially the staff of the *Challenger*, and more recently Dr. Carl Chun, had reached the conclusion that animal life extended to great depths in the ocean.

But the *Challenger* experimented on this question only during the last part of her cruise, and did not use nets that could be closed before being drawn up, so that they might collect anything on the way to the top of the water. This is the so-called differential method, which Agassiz always regarded with the greatest distrust. For example, suppose that an open net is drawn up vertically from one hundred fathoms, and a second from two hundred fathoms. By this method it is assumed that anything found in the second net that was not in the first net must come from between one hundred and two hundred fathoms. Dr. Chun used a net which, after being towed at a given depth, could be closed before being drawn to the surface. But most of

his work was done in the Mediterranean, where the conditions are entirely different from those in the open sea, and he himself says he had difficulty in closing his net properly.

It will be remembered that in his cruises in the *Blake*, Agassiz had investigated this question with the Sigsbee Gravitating Trap (Fig. 18), by means of which it was possible to filter a column of water of any desired height at any given depth. With this instrument he had been unable to get life at one hundred and fifty fathoms. He brought on board the *Albatross* a net similar to that used by Dr. Chun (Fig. 19), made for the expedition by Ballauf of Washington. This was not found to work satisfactorily and was discarded after a first attempt. But, “thanks to the ingenuity of Captain Tanner,” he and Agassiz between them devised an arrangement known as the “Tanner” net (Fig. 20). This was so weighted that it went down bottom first, thus preventing anything from getting into the net on the way. It was then towed for a time at any desired depth, and before being hauled to the surface a messenger was sent down that released two weights which tightly closed the lower part of

the net, leaving the upper part open, to catch specimens on the way to the surface. On account of the simplicity of its construction and the accuracy of its action, Agassiz always considered this closing net far more reliable than any other similar contrivance.

The results of a very considerable use of the Tanner net on this expedition led him to believe that in the open ocean there is a very marked falling-off in animal life below two hundred fathoms. Later experiences, though they did not alter his general conclusions, would seem to have somewhat extended the depth to which he believed life to extend.

During his last expedition in 1907, Agassiz said, in conversation, that from the results of his own investigations he was of the opinion that in the open ocean there was a great intermediate belt between the pelagic fauna and the species living at or near the bottom, where there was practically no life, nothing but the falling bodies of dead animals. Where the results of other observers had led to a different conclusion, he was inclined to attribute it to the defective working of the apparatus used. His experience in the Gulf of California, on the other hand, led him to believe that in a comparatively closed sea there may be a mixture of the pelagic species with the free swimming animals that live at or near the bottom.

This was with one exception the last of Agassiz’s expeditions that was purely zoological. The main object of his subsequent voyages was the investigation of coral reefs and coral islands, and the questions arising from the study of their formation. During the latter part of his life he does not appear to have been greatly interested in the question of the vertical distribution of life in the ocean. On only two of his later trips did he ever use a Tanner net. On the steam yacht *Wild Duck* in 1893, he made some casts with one off Havana, and a few in the Tongue of the Ocean in the Bahamas, which led him in no way to modify his views.

Some months after this last expedition, he says, in writing to Dr. Wilhelm Giesbrecht (Fig. 21):

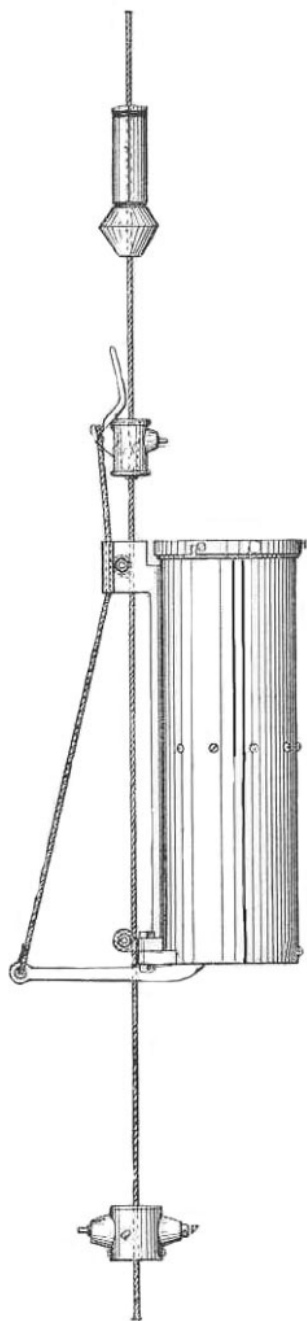


Figure 18.—Sigsbee Gravitating Trap (source: Bull. U.S. Fish. Comm. 1894, plate 9).

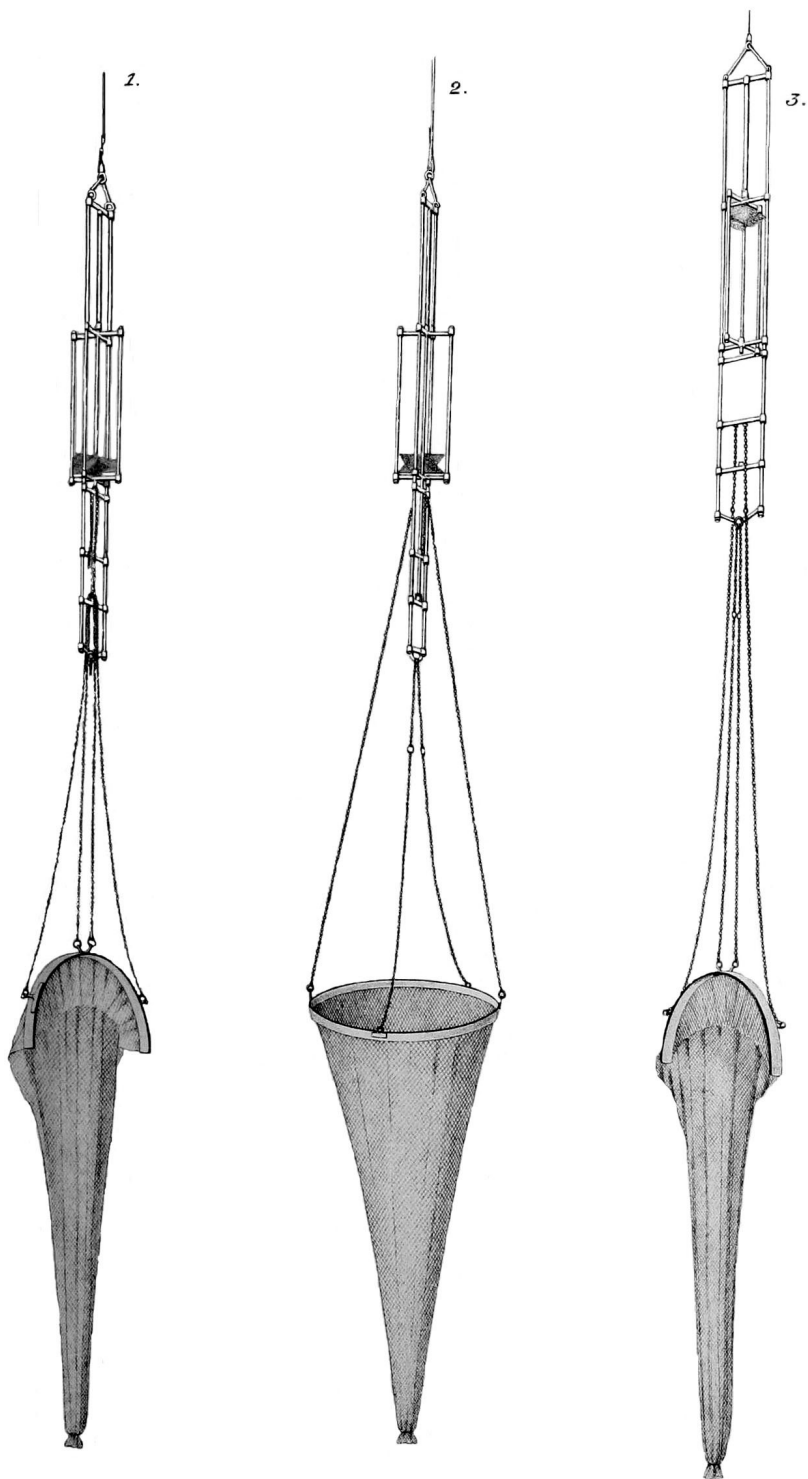


Figure 19.—Modified Chun-Petersen tow-net. 1) net ready to lower, 2) net opened, ready to tow horizontally, and 3) net closed, on its way to the surface (source: Bull. Mus. Comp. Zool. vol. 23(1), plate I).

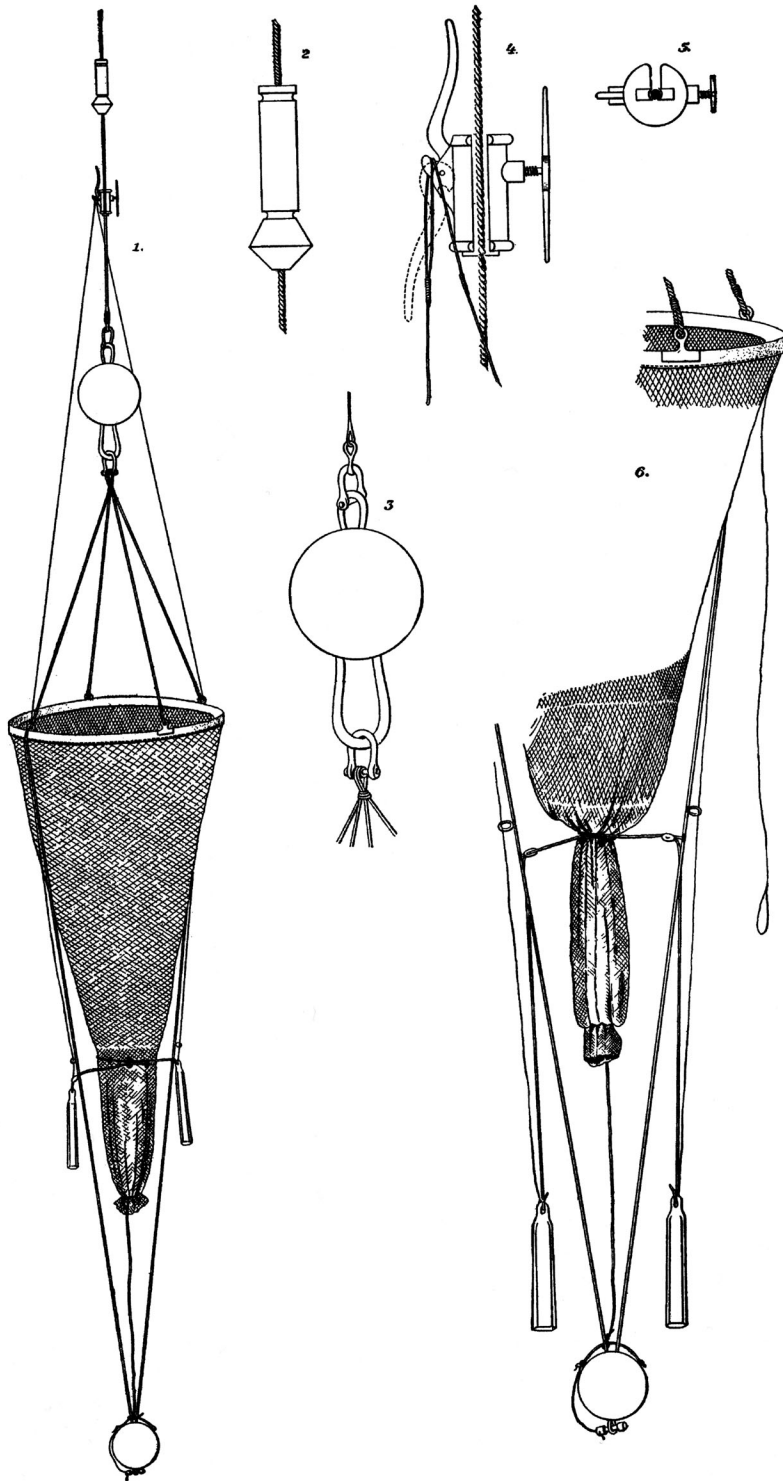


Figure 20.—Tanner deep-sea tow-net. 1) net open, 2) messenger for closing net, sliding on wire rope, 3) sinker attached above the net, 4) bell crank tripped by messenger to liberate the slings, 5) attachment of bell crank to wire rope, and 6) lower part of Tanner net when closed (source: Rep. U.S. Fish. Comm. 1889–1891, plate 1).

“I do not wish in any way to be obstinate about my views as to the extension of pelagic life—not necessarily surface forms—to great depths. All I care to know positively is, whether at sea, far from land, the sheet of water below 250 or 300 fathoms is populated densely or so sparsely as to enable us to say that animal life practically ceases at the depths of 250 to 300 fathoms. I am not fighting for any theory, I am only stating my experience, and it is very strange that I have so invariably been unsuccessful in tracing the existence of animal life below the above-mentioned limits, while others have always found something. I have no theory. I have merely tried to account for the differences of results obtained by Chierchia, Murray, Chun, and others by some rational explanation, and when I see one net after another abandoned or condemned in successive expeditions, I naturally condemn the results which accompanied and were deduced by them. But the writers of the results do not seem to think that the one includes the other.”

In the Eastern Pacific Expedition of the *Albatross*, in 1904–05, Agassiz again used the Tanner net a few times,



Figure 21.—Wilhelm Giesbrecht (1854–1913) preeminent German copepodologist on staff at the Naples Zoological Station (source: Naples Zoological Station).

bringing up specimens (especially certain species of jellyfish) from three hundred and four hundred fathoms. He is apparently at that time not sufficiently interested in the matter more than to mention the facts; the only comment in his notebooks of the voyage being, "nothing of any size below 350 to 400 fathoms."

The problem that Agassiz had always considered of greatest interest in connection with his deep-sea work was the comparative study of the marine fauna on the two sides of the Isthmus of Panama. When all the reports of the numerous specialists who were working on the various collections of the *Blake* and the *Albatross* Expedition of 1891 were completed, he had always hoped to summarize the results in a Panamic Report in which he expected to establish some interesting conclusions. Of this subject he says in his presidential address before the International Zoological Congress in Boston in 1907:

"Much has been written on the relationship of the marine animals of the Caribbean and of the Panamic region, but the speculations are all based upon data supplied by collections made upon the littoral regions. It was not until the collections made by the *Blake* on the Atlantic and Caribbean side, and by the

Albatross on the Panamic side, were studied, collections extending to the deepest waters of both regions, that we were able to speculate with some degree of certainty upon the causes which led to the existence of the peculiar fauna characteristic of the deep waters of the Caribbean, a fauna more closely allied to the Panamic deep-water fauna than to that of the Atlantic, and suggesting that after the formation of the Windward Islands, which, in great part, cut off the Caribbean from the Atlantic, there must have been a free connection with the Panamic region of a depth greater than that which connected it with the Atlantic.

"It of course became necessary to carry on geological surveys to determine the age at which these connections were established, and again closed, to obtain some measure of the time elapsed necessary to differentiate the marine fauna of the two sides of the Isthmus of Panama. While the length of this period can only be vaguely inferred, it gives us at any rate the comparative measure of the changes which have taken place in these faunae from the time when the marine fauna of the later Cretaceous was passing into the older and more recent Tertiaries, and until the existing state of things was established. The preliminary geological studies I carried on in connection with the study of the

West Indian coral reefs, necessary to determine the age of the development of the larger Antilles and of the Windward Islands, have been extended for me by Hill and others, so that we now have a fair idea of the geological sequence of events in the growth of the Caribbean area.

"The careful, comparative study of the collections of the *Blake* and *Albatross* is now nearly complete,—a study carried out by specialists is absolutely essential, for no mere superficial sketch even by an experienced zoologist will suffice in drawing conclusions of any value and bring out the minute, interesting, fundamental details which no general zoologist can hope to grasp. Whatever final value the correlation of these Reports may have will be due to the assistance I have received from my collaborators in so many special fields, and my indebtedness to them I find it difficult to express."

Unfortunately at the time of his death there were a few reports of the *Blake* and a considerable number of the *Albatross* Expedition still unfinished, so the "Panamic Report" was not written. All the unfinished reports of the specialists working on collections from any of Agassiz's expeditions will, however, eventually be published from a fund he left for this purpose.