GREAT INTERNATIONAL FISHERIES EXHIBITION.

LONDON, 1883.

UNITED STATES OF AMERICA.

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DESCRIPTIVE CATALOGUE

OF THE

COLLECTION ILLUSTRATING THE SCIENTIFIC INVESTIGATION OF THE SEA AND FRESH WATERS.

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.

SECTION G.

INTRODUCTION

Scientific investigations with reference to aquatic life have always received liberal support and encouragement in the United States, alike from National, State, and private organizations, and individuals of wealth. With its long stretches of sea-coast, facing the two great oceans, and extending from near the tropics far beyond the Arctic Circle, and with its many large river systems and innumerable inland lakes, some more deserving of the name of inland seas, this country possesses within its own domains abundant materials for the study of nearly every class of aquatic phenomena, and of nearly all the more important groups of aquatic animals and plants. Since early times these subjects have furnished interesting problems of research to American students of natural history, who, proportionately with the unparalleled growth of the country, have rapidly increased in numbers, and now constitute a large working force.

In consonance with this increase has been the advancement made in our knowledge of the aquatic fauna and flora of the country, which are to-day quite well made out as regards their more characteristic features, notwithstanding that much of the information we have regarding them is exceedingly superficial. Not less interesting in its way has been the development of methods of research, especially during late years, in connection with marine explorations.

The greater portion of the scientific work accomplished, aside from purely anatomical and physiological studies, has been subsidiary to explorations undertaken for practical purposes, and a history of such investigations involves an account of many important industrial and commercial surveys. Exploring parties have seldom been organized for work, at home or abroad, without including one or more naturalists in the corps, and hence nearly all important explorations, of whatever character, have contributed in greater or less proportion to our knowledge of aquatic forms of life and the conditions under which they live.

As in other countries, governmental organizations, through the liberal means generally at their disposal, have accomplished the greatest results. State surveys and fishery commissions have also performed a good work, and private expeditions and societies have added their share.

The United States National Museum, at Washington, established in 1846, is the repository for all scientific collections obtained by national explorations; and the Smithsonian Institution, although substantially independent in its organization, holds close relationship with the Government as an advisory board in scientific matters, and as the custodian of the National Museum. The Smithsonian Institution, since its foundation in 1846, has therefore exerted a powerful influence in regard to American scientific research, and has planned and generally supplied the equipments for natural history collecting to nearly all Government expeditions, as well as to many private surveys and individuals working wholly or in part under its direction.

Most of the national surveys hitherto undertaken have been limited to the territory of the United States and the adjacent waters, although many interesting foreign explorations have been carried on by the Navy Department, the Department of State, and private individuals and organizations. Aside from private enterprises, the surveys of the interior of the United States have been mainly conducted under the Departments of War, and of the Interior, the United States Fish Commission, and the several

States; and those of the sea-coasts by the United States Fish Commission and Coast Survey, the Treasury and War Departments, and individuals working in the interest of the Smithsonian Institution. The surveys of Alaska have been made by the Western Union Telegraph expedition, the United States Coast Survey, the Signal Service Bureau of the War Department, and the Treasury Department. Extensive explorations, both at home and abroad, have been carried on by, or under the auspices of, numerous American societies and museums of natural history, and colleges, and notably by the Museum of Comparative Zoology of Harvard College.

Following is given a brief summary of the more important American explorations which have contributed in greater or less degree to a knowledge of aquatic life and the conditions of its existence. Investigations by or under the Government are first considered, and afterwards those by museums, colleges, and private individuals. In connection with the Navy Department, Coast Survey, and Fish Commission, the improvements recently made in the appliances and methods of deep-sea sounding and dredging are briefly described.

THE UNITED STATES AND ADJACENT REGIONS, NOT INCLUDING ALASKA.

The United States Coast and Geodetic Survey.—Although a Bureau of the Treasury Department, this survey has much in common with the Navy, as regards the character and methods of its surveying work, and a large proportion of its members of all grades have been officers detailed from the latter service. Its operations, however, are limited to the vicinity of the coasts of the United States, where the depths of water are seldom very great, and where the phenomena encountered are more diverse. The charts, relief models, and coast pilots exhibited will serve to explain the nature and extent of the hydrographic work thus far accomplished, which consists of observations of depth, of velocity and direction of currents, of bottom, intermediate, and surface temperatures, of the contours of the coast line, &c. In all instances where important bottom specimens have been obtained in sounding, they have been carefully preserved and labeled, and while several reports have already been published upon the subject, vast quantities of such material still await examination.

The sounding appliances now employed by the Coast Survey are probably more perfect than those of any similar service of any country. For the greater depths of water piano-forte wire is used, on the principle of Sir William Thomson, with the improved machine of Commander Sigsbee, which is fully described in the catalogue. In connection with the Navy Department, we have given a brief account of the introduction of steel wire for sounding purposes by the United States Navy. In August, 1874, one of the Thomson sounding machines of the original pattern, was furnished to the Coast Survey steamer Blake, in charge of Commander Howell, United States Navy, and then sounding in the Gulf of Mexico. But few trials were made with it, however, before Lieutenant-Commander Charles D. Sigsbee, United States Navy, succeeded in command of the steamer, in December, 1874. Prior to taking this command, Mr. Sigsbee had planned the original pattern of his own machine on the same principle, shown on plate 7 of Sigsbee's "Deep-sea sounding and dredging" (exhibited). Sigsbee's idea in improving on the original Thomson pattern was, in his words, to obtain a machine "that might be worked with fewer demands on the watchfulness and ingenuity of those having it in charge." This first pattern was used on the Blake during the remainder of his connection with that steamer, or until 1878, when he was succeeded in command by Commander Bartlett, United States Navy. Before his detachment, however, he had already planned a second machine (shown in plates 8 to 12), embodying the improvements suggested by three years' trial and experiment with his original pattern. The first one of this kind was supplied to Commander Bartlett in 1878, and was continued in use for two or three years with the best of results; but in 1880 it was in turn superseded by a third pattern, containing still further improvements. It is this latter machine which is described in the catalogue, and of which a model is on exhibition. Being thus fully represented and discussed, no further remarks on the subject are necessary, excepting that it may be just to Sir William Thomson to repeat the statement made by Commander Sigsbee in the account of his improved machine, that, "in point of accuracy, the original form of the machine by Sir William Thomson was successful from the start, and it is particularly to be understood that the sufficiency of the machine in that respect is fully recognized."

In addition to his sounding machine, Commander Sigsbee has also introduced many improvements in connection with the accessory appliances used with it. Among these may be mentioned the modification of Captain Belknap's sounding cylinder, and the Sigsbee water-specimen cup, which are fully discussed in the catalogue.

In moderate depths of water, the Coast Survey generally makes use of an ordinary commercial pattern of sounding lead for recovery, with the Stellwagen specimen-cup attachment; but in considerable depths a sounding rod or cylinder is employed, in connection with a perforated cannon ball of the requisite weight. This is, therefore, on the principle of Professor Brooke, excepting that the sounding rod now in use is of a later pattern (the Sigsbee-Belknap cylinder), and the method of attaching the shot is more reliable, as described in the catalogue.

Turning now to the improvements made in the line of deep-sea dredging and trawling, we find that, prior to 1877, in such dredging operations as were occasionally carried on by the Coast Survey, the old methods and appliances were always employed. It remained for the Blake, under Commander Sigsbee, and with Professor Alexander Agassiz in charge of the dredging work, to effect for deep-sea dredging what had just previously been done for deep-sea-sounding. In fact, during those cruises of the Blake from 1877 to 1880, in which dredging formed an essential feature of the investigations, the methods of deep-sea dredging were almost completely revolutionized. On the suggestion of Professor Agassiz, steel-wire dredge rope was first tried for dredging purposes, in the winter of 1877–'78, and proved a complete success, its great superiority over the old hempen rope being soon demonstrated. Its small size (1⅛ inches in circumference), its great durability, and the greater ease with which the dredge or trawl can be landed on the bottom by its use constitute its chief qualifications.

It was found that when the common form of dredge fell upon soft mud or ooze in deep water, it became at once filled or clogged with the bottom soil, from its tendency to dig too deeply into the bottom, and was thereby prevented from doing its proper work. To remedy this defect, a new style of dredge was improvised (called the Blake dredge in the catalogue), consisting of a rather large and light rectangular iron frame, attached to a scraping mouth frame, of which the scraping edges are straight and not flaring. The dredges of this pattern rest flat upon the bottom and are very effective in their results, on soft materials.

The beam-trawls were modified at the same time so as to work either side down—a great convenience in deep water, where it is often impossible to lower the ordinary pattern so that it will rest right side up on the bottom. Another important invention of these cruises was the Sigsbee gravitating trap, for obtaining evidence as to the quantity of animal life between any two given depths.

The dredging explorations of the Coast Survey on the eastern coast of the United States have been of a very interesting nature, and much pioneer work has been successfully accomplished. Deep-sea dredging was inaugurated May 17, 1867, in the region of the Gulf Stream, off the south coast of Florida, by the steamer Corwin, Count L. F. de Pourtales, then an assistant of the Survey, being in charge of the dredging operations. This cruise was undertaken for the purpose of sounding out a line for a telegraph cable between Key West and Havana. Only a few dredgings (in depths of 90 to 350 fathoms) were made the first season, on account of the breaking out of yellow fever on board the steamer, but "the highly interesting fact was disclosed that *animal life exists at great depths, in as great a diversity and as great an abundance as in shallow water.*" During 1868 and 1869, the same series of dredgings was continued, by the steamer Bibb, in the Florida Straits, between Cape Florida and Tortugas, and were carried down to a depth of 700 fathoms, with equally interesting results. The first report of these investigations was published by Mr. Pourtales in December, 1867, being a brief account of the first year's work, with descriptions of many of the species of animals obtained. More complete reports have since been issued by the Museum of Comparative Zoology of Harvard College, under which auspices nearly all of the deep-sea dredging of the Coast Survey on the eastern and southern coasts of the United States have been accomplished. The relations which have long existed between this Museum and the Coast Survey are more fully discussed in connection with our account of the former institution.

During 1871 and 1872, the Coast Survey steamer Hassler, which had been built for service on the western coast, made her trip from the Atlantic coast to San Francisco, via Cape Horn, having on board Prof. Louis Agassiz and a party of naturalists, including Mr. Pourtales, in charge of dredging operations. Arrangements had been made whereby such natural-history explorations as would not interfere with the regular work of the survey might be carried on in the course of the long voyage. The expenses of the civilian party were paid by private subscriptions raised in Boston. Dredgings were made mainly in the vicinity of the Barbadoes, and along the east and west coasts of South America, and collections were also obtained from the surface and from the shores wherever the vessel touched. The principal points of interest visited were St. Thomas, the Barbadoes, Rio de Janeiro, Montevideo, the Straits of Magellan, many places on the west coast of South America, Juan Fernandez, the Galapagos, and Panama.

In 1872, 1873, and 1874, for a short period each summer, the Coast Survey steamer "Bache" was detailed for dredging work in the Gulf of Maine, in the interest of the United States Fish Commission. These were the first series of off-shore dredgings made on this section of the coast, and they were carried down to a depth of 430 fathoms.

In 1877 began that most interesting series of explorations by the Coast Survey steamer "Blake," during which the methods of deep-sea dredging and sounding were so greatly improved, as has been described above. The dredging operations were in charge of Mr. Alexander Agassiz. The first cruise, during which Commander Sigsbee, United States Navy, was in charge of the vessel, lasted from December, 1877, to March, 1878, and extended from Key West to Havana, and thence westward along the north coast of Cuba; from Key West to the Tortugas, the northern extremity of the Yucatan Bank and Alacran Reef, to Cape Catoche, and across to Cape San Antonio; thence back to Key West, and from there to the mouth of the Mississippi River. Seventy-nine casts were made, the deepest being in 1,920 fathoms. During the second cruise, from December, 1878, to March, 1879, under Commander Bartlett, United States Navy, dredgings were made from Key West to Havana; thence to Jamaica, through the old Bahama Channel and Windward Passage, and from Jamaica to St. Thomas, along the south coasts of Hayti and Porto Rico. From St. Thomas the dredgings were continued southward as far as the 100-fathom line off Trinidad. This season over 200 successful casts of the dredge and trawl were made in all depths down to 2,412 fathoms. The third cruise, from February to May, 1880, covered the western Caribbean Sea, between Cuba, Jamaica, and Honduras; 22 hauls were made, the deepest in 961 fathoms. The fourth cruise, during the summer of 1880, was devoted to running several lines of soundings and dredgings off the Atlantic coast of the United States, between George's Bank and the latitude of Charleston, in depths of 24 to 1,632 fathoms; 47 dredge and trawl hauls were made.

The general scientific results of these explorations have been published by Mr. Agassiz in several reports, contained in the Bulletin of the Museum of Comparative Zoology, and special descriptive reports on many of the groups of animals obtained have also been issued.

Many of the Coast Survey tidal observers, stationed at different places along both the east and west coasts, have contributed largely to a knowledge of the marine fauna in the vicinity of their stations. Among these have been several trained collectors and naturalists, appointed on the recommendation of the Smithsonian Institution. One of the most indefatigable collectors was Mr. John Xantus, who, prior to his appointment on the Coast Survey, spent over a year, from the summer of 1857 to the fall of 1858, at Fort Tejon, California, in making a complete collection of the zoology of that region. In April, 1859, he went as tidal observer to Cape Saint Lucas, Lower California, where he remained until 1861, keeping up, during the entire period of his stay, the most active field work in all branches of zoology, marine fishes and invertebrates constituting a very important feature of his collections, which were as nearly exhaustive of the fauna, as was possible in two years' time. His operations extended some distance up both the gulf and ocean sides of the peninsula of Lower California, and to Mazatlan, in Mexico. His notes were very full and comprehensive, and his collections were all received at Washington in the best of condition. In 1862, as an agent of the State Department, he visited Manzanillo, Western Mexico, and making that place and Colima his headquaters, he collected in all directions, but especially toward the interior mountainous region, obtaining most valuable results regarding the distribution of animals, including both fresh-water fishes and mollusks.

During 1853-'55, Mr. R. D. Cutts, Assistant on the Coast Survey, then surveying on the coast of California, made valuable collections of fishes for the Smithsonian Institution, and from 1854 to 1855, Lieutenant W. P. Trowbridge, United States Army, tidal observer, collected in the same region, sending to Washington a very large assortment of marine fishes and invertebrates. From 1854 to 1859, Dr. Gustavus Wurdemann, of the Coast Survey, devoted his spare intervals of time to collecting marine animals along the coast of the Southern States, from Louisiana to South Carolina, and the collections supplied by him were the most complete of any obtained from that region up to the time of his death, in 1859.

Since 1860, numerous small collections have been received, from time to time, from tidal observers and other employés of the Coast Survey, aside from the dredging explorations above described.

In this connection may be mentioned the incidental collections made since 1881 by Lieutenant Henry C. Nichols, United States Navy, in command of the Coast Survey steamer "Hassler," on the west coast of North America, from Alaska to Mexico and the Gulf of California. The collections received from Lieutenant Nichols at numerous intervals have contained many interesting discoveries both among fishes and invertebrates.

The United States Commission of Fish and Fisheries was established in 1871, in accordance with a joint resolution of Congress, authorizing the appointment of a commissioner of fish and fisheries, whose duties were defined as follows: "To prosecute investigations on the subject (of the diminution of valuable fishes), with the view of ascertaining whether any and what diminution in the number of food-fishes of the coast and the lakes of the United States has taken place; and, if so, to what causes the same is due; and also whether any and what protective, prohibitory, or precautionary measures should be adopted in the premises, and to report upon the same to Congress." The resolution further specified that the commissioner to be appointed should be a civil officer of the Government, of proved scientific and practical acquaintance with the fishes of the coast. Professor Spencer F. Baird, at that time assistant secretary of the Smithsonian Institution, received the appointment, and entered at once upon his duties.

The plan of work adopted included "the systematic investigation of the waters of the United States and the biological and physical problems which they present; the investigation of the methods of fisheries, past and present, and the statistics of production and commerce of fishery products; and the introduction and multiplication of useful food-fishes, especially in waters under the jurisdiction of the General Government." We need consider here only that phase of the Fish Commission which relates to the scientific investigation of the waters.

The newly-appointed Commissioner, with a just appreciation of the bearing which all scientific problems relating to aquatic life have upon the fishery question, began at once upon a liberal and far-sighted policy, which has been productive of most satisfactory results, and probably no similar commission of any country of the world has made more rapid advancement or been more successful in its application of scientific results to practical aims. One of the first steps in entering upon the new project was to secure the services of eminent specialists in the different groups of aquatic animals and plants, as associates and assistants in making collections and observations, and in reporting upon the different classes of objects and phenomena which come within its scope. In the selection of his corps Professor Baird has been exceptionally fortunate, as the many valuable reports issued under his direction amply testify. The small appropriations at his command in the beginning made it necessary to depend largely upon volunteer assistance, and many of the most important scientific results have been obtained through the aid of unpaid labor.

In the summer collecting work, several college students have participated nearly every year, for the sake of the training they could thereby obtain, and their services have been of the greatest assistance to the Commission.

As by far the most important of the American fisheries center upon the New England coast, this region demanded first attention, and during every summer, but one, since the Commission was started, a well-organized scientific party, in charge of the Commissioner, has systematically explored its waters with every known appliance suited to the purpose. During the first two years nearly all the dredging and trawling work was accomplished with the aid of small sail boats or steam launches, and the hauling-in was done by hand. From the third to the ninth year, through the liberality of the Navy Department, small naval steamers or tugs were detailed for the use of the Commission, and enabled the explorers to extend their operations to greater depths and to a greater distance from land. In the summer of 1880, the Fish Commissión steamer "Fish-Hawk" was first available for scientific investigations, and being furnished with all the improved dredging appliances, that had been lately introduced by the Coast Survey, as well as with those previously used by the Fish Commission, and with a sounding machine for the use of piano wire, it was possible to still further enlarge the field of work, and increase the accuracy and rapidity of observations.

The present spring (1883) there has been added to the Fish Commission fleet another and much larger exploring steamer, the "Albatross," which combines every necessary convenience to adapt her to the requirements of marine research in all its branches. She has been built expressly to explore the off-shore fishing grounds, and study the distribution and habits of all the useful species of fish, whether bottom-feeding, like the cod and halibut, or surface-schooling, like the mackerel and menhaden. But her operations will not be limited to the practical side of the fishery question, for she will also engage in deep-sea sounding and dredging and in the taking of oceanic temperatures, and, in fact, in all researches bearing upon the biology of the ocean. She was only completed in February last, and the few trips she has yet made have been mainly for the purpose of testing her machinery and scientific appliances which are now in perfect running order. Her first regular cruising will begin about July 1. Her outfit is very complete, and comprizes all the most approved appliances now recognized by fishermen and naturalists for collecting marine specimens. Many novel features have also been introduced, as described in the catalogue, and she is regarded as the most perfect floating workshop and laboratory for scientific research ever constructed.

The several steamers which have been in the service of the Commission, as well as those now belonging to it, have all been manned by naval crews and commanded by naval officers, to whose untiring zeal and deep interest in the exploring work is largely due the successful results of dredging. Commander (now Captain) L. A. Beardslee, United States Navy, was in charge of the dredging steamers from 1873 to 1875, inclusive, and again in 1878; Lieutenant-Commander (now Commander) A. G.

Kellogg, United States Navy, in 1877; and Lieutenant (now Lieutenant-Commander) Z. L. Tanner, United States Navy, from 1879 to date. The latter officer is now in command of the steamer "Albatross," which was constructed and equipped under his direct supervision. His previous four years of service on the Commission's steamers, "Speedwell" and "Fish Hawk" especially qualified him for this duty, which has been discharged to the satisfaction of all.

In the sea-coast exploring work of the Fish Commission, the department of fishes was, during the first two or three years, under the immediate supervision of the Commissioner, with the assistance of Professor Theodore Gill and Mr. G. Brown Goode. Since then Mr. Goode has taken direct charge of this department, with the co-operation of Dr. Tarleton H. Bean, and the assistance of many others. Mr. J. W. Milner, Assistant Fish Commissioner from 1871 to 1877, took charge of the fresh-water fishery investigations up to the time of his death, the latter year. Professor A. E. Verrill, of Yale College, has had charge of the dredging operations, and the section of marine invertebrates, and has been assisted for variable periods by many naturalists and students of zoology, who have studied special groups of animals, or aided in the general work of collecting, assorting, and identifying materials. Among the associates and assistants who have taken a more or less prominent part in this line of research may be mentioned Professor S. I. Smith, Mr. Oscar Harger, and Mr. J. H. Emerton, of Yale College; Professor A. S. Packard, jr., of Brown University; Professor Joseph Leidy, of Philadelphia; Professor Alpheus Hyatt, of Boston; Mr. Sanderson Smith, of New York; the late Dr. P. P. Carpenter, of Montreal; Dr. E. B. Wilson, of Johns Hopkins University; Professor S. F. Clarke, of William's College; Professor H. E. Webster, of Union College; Professor W. N. Rice, of Wesleyan University; Professor J. E. Todd, of Tabor College; Drs. J. H. Kidder and T. H. Streets, United States Navy; Mr. William H. Dall and Mr. R. Rathbun, of Washington; Mr. Caleb Cook, of Salem; Professor L. A. Lee, of Bowdoin College; and Messrs. B. F, Koons, H. L. Bruner, and Edwin Linton. The marine algæ have been intrusted to Professor William G. Farlow, of Harvard College, and Professor D. C. Eaton, of Yale College. The dredging operations have been superintended by Captain H. C. Chester, whose skillful management of the different appliances of research have rendered his services of the greatest value to the exploring work. Mr. Vinal N. Edwards, an experienced collector, has been retained permanently at Wood's Holl, Massachusetts, since 1871, for the purpose of making observations and collections outside of the regular summer season. His contributions toward a knowledge of the fauna of that region have been very extensive.

In conducting the summer explorations, it has generally been customary to select a different place each season as a central station, from which collecting goes on in all directions. The object of these annual changes has been to cover every portion of the coast, all of which is of great zoological and practical interest. A suitable laboratory is fitted up with the requisite number of tables to accommodate the specialists and assistants, and with aquaria, storage shelves, and other conveniences, and all of the specimens collected are brought there for study and preservation. In addition to the regular systematic, anatomical and embryological studies of the different species of animals, careful preparations are made for museum display, and large quantities of duplicates of all the species obtained in abundance are saved for distribution to institutions of learning throughout the country, and for use in making exchanges.

The entire New England coast has already been quite fully explored, from the shore down to considerable depths of water. Every possible method of obtaining specimens and information has been resorted to. Shore collecting, by means of the seine, spade, dip-net, and other simple contrivances has been especially thorough. Beyond slight depths all of the various kinds of dredging appliances have been used, and many new forms of apparatus have been devised for special purposes. The fish pounds, weirs, &c., have been constantly visited, and the fish markets have been closely watched for any new treasures they may reveal. The services of the fishermen have also been enlisted to save and bring in any odd creatures that may be caught by their hooks or nets. After thirteen years of such thorough collecting as has been detailed, it is natural to suppose that a very good general idea of the character of the aquatic fauna of the New England coast has been obtained.

An especial feature of the summer's work during several years has been the photographing of fishes and fishing scenes, by Mr. T. W. Smillie, whose numerous views on exhibition need no words of praise from us.

The necessity of a permanent marine station, with suitable arrangements for more careful embryological and anatomical, as well as systematic studies, and for the purposes of fish-breeding, has been felt for several years, and preparations toward the accomplishment of such a project are now nearly completed. The place selected is Wood's Holl, Massachusetts, where all the surroundings are especially favorable for a marine zoological laboratory. Strong tidal currents produce a constant circulation of pure sea water, even close in to the shore, and fresh-water streams are entirely absent from the vicinity. The temperature of the water is also suitable, and no locality on any part of the eastern coast has been more highly regarded for the study of free-swimming larval forms of marine animals at all seasons. The scheme proposed is exceedingly comprehensive, and contemplates, in addition to the usual laboratory buildings and fixtures, several large open basins, in direct communication with the surrounding water, for the study of the life histories and the habits of marine fishes and invertebrates, especially those of economic importance. These basins will be inclosed in a large wharf, intended for the use of steamers of the Commission. It is proposed to have these improvements completed by the summer of 1884, and thenceforward they may be used at any or all seasons of the year, as is desirable.

In 1871, the first year of the Fish Commission, the summer station was at Wood's Holl, and about 250 hauls of the dredge and beam trawl were made in the surrounding region. In 1872, Eastport, Maine, became the headquarters, and the explorations covered both the shallow and deeper areas at the mouth of the Bay of Fundy, down to a depth of 106 fathoms; 235 dredge hauls were made. In 1873, with headquarters at Portland, Maine, 149 dredging stations were made in and about Casco Bay; and in 1874, with headquarters at Noank, Connecticut, 223 casts of the dredge and trawl were made in the eastern part of Long Island Sound. During two or three weeks of each summer, from 1872 to 1874, inclusive, the Fish Commission was allowed the use of the Coast Survey steamer "Bache," for dredging purposes in the Gulf of Maine and the region of George's Bank, where many valuable results were obtained. In 1875, Woods' Holl was again selected as the summer station, and 169 dredge hauls were made in the region of Vineyard Sound. The Centennial year, 1876, was devoted to arranging and displaying the results of the investigations of the Commission at the Philadelphia Centennial Exhibition, and no systematic explorations were carried on. Salem, Massachusetts, was made the central station during the first part of the summer of 1877, but from the last of August until October, while the Commission of arbitration on the fishery claims was in session at Halifax, the station was removed to the latter place. On the passage from Salem to Halifax, a complete and interesting line of dredgings was made across the Gulf of Maine, and later numerous deep hauls were successfully taken off the coast of Nova Scotia. Gloucester, Massachusetts, became the station in 1878, and Provincetown, Massachusetts, in 1879, during which years the explorations covered Massachusetts Bay, and extended off the coast of Massachusetts into depths of 175 fathoms. From 1877 to 1879, inclusive, 378 hauls were made with the dredge and trawl.

While at Gloucester, in 1878, a scheme for obtaining marine animals of all kinds from the offshore fishing banks was successfully inaugurated, through the aid of the Gloucester cod and halibut fishermen, to whom the Fish Commission is chiefly indebted for its knowledge of the fauna of those unexplored areas. Large quantities of fishes and invertebrates, of no economic value, are constantly being caught on the hooks or entangled on the lines of the fishermen, who, considering them of no importance, generally throw them away, excepting in the case of hardy corals and like objects. Being convinced of the value of such specimens to the objects of the Commission, a few intelligent fishing captains expressed a willingness to carry with them on their trips tanks of alcohol for the preservation of any "curios" they might obtain. The success attending the first ventures, excited a lively interest among the fishermen, and the demand for tanks soon became quite general. In fact, the idea came to prevail on some of the fishing schooners that the presence of a collecting tank was essential to a good fare, and they would not go to sea without one. The different schooners often vied with one another in the extent and value of their captures, which were frequently of great interest. The practice of carrying tanks continued without cessation for a period of about three years, and the number of contributions exceeded 900. Many of these contributions, moreover, filled an entire tank, which may have contained a hundred or more specimens, and a large number of species. The showing made by the Gloucester fishermen in the cause of science has certainly been very creditable, and their entire work was carried on without remuneration. One of the most indefatigable of these collectors was Captain J. W. Collins, whose "aids to science" were very extensive; he has since become a member of the Commission.

Three interesting collecting trips to the fishing banks grew out of these investigations. The first was made in 1878, by Mr. R. L. Newcomb, to the Grand Banks, with Captain Collins, and the second and third in 1879, by Mr. N. P. Scudder, to the halibut banks of Southern Greenland, and by Mr. H. L. Osborn to the Grand Banks.

In 1880 the regular summer station was established at Newport, Rhode Island, from which place the steamer "Fish Hawk" made her first dredging cruises to the Gulf Stream slope. This latter region proved so rich in animal life that it was decided to return to it in 1881, and again in 1882, but the headquarters were transferred to Wood's Holl, which offered superior accommodations as a harbor and laboratory station. From 1880 to 1882, inclusive, 385 dredging and trawling stations were made, mainly in depths of 50 to nearly 800 fathoms. The results of these explorations have far exceeded all possible expectations, and have demonstrated the existence of an extremely rich faunal belt, following the line of the inner edge of the so-called Gulf Stream slope, from as far south at least as off Cape Hatteras to the great fishing banks off the British Provinces. The great flood of material resulting from these investigations has greatly enriched the collections of the Fish Commission, and afforded a vast number of unique types for study.

Voluminous reports on the discoveries made by the Fish Commission in connection with its regular marine researches are contained in the collection of scientific literature exhibited. Up to date, nearly 1,900 hauls have been made with the different kinds of dredging appliances, including the common form of dredge, the rake dredge, the Blake dredge, the single and double beam trawls, and the tangles. At the majority of dredging stations careful temperature observations have been taken both at the surface and bottom, and often at intermediate depths, and many specific gravity observations have also been recorded. The towing-nets have been freely used principally at the surface, but also very frequently at intermediate depths and at the bottom. In connection with embryological studies of marine invertebrates, they have been constantly utilized, especially at Wood's Holl. Over 700 hauls of the seine have been made by the fishmen along the shores, and at the mouths of rivers in the neighborhood of the summer stations. On most of the dredging trips of the steamers to deep water, it has been customary to set several long cod trawl-lines, similar to those in use by the Banks fishermen, in order to capture such bottom fish as are too active to be caught in the beam trawl. Many valuable additions to the fauna have been made by this means. Among many interesting researches out of the ordinary line may be mentioned those of Dr. J. H. Kidder, United States Navy, at Provincetown, in 1879, on the animal heat of fishes, in which large numbers of specimens were experimented with; those of Captain L. A. Beardslee, United States Navy, on the errors to record in the Miller-Casella deep-sea thermometers; and those of Professors Verrill and Rice, on the action of poisons on certain marine invertebrates, with a view to killing them in an expanded condition, suitable for study.

Important series of temperature observations have been conducted for the benefit of the Commission as follows: By the light-house keepers along the Atlantic coast; by the menhaden fishermen on their fishing trips; and by the Signal Service observers stationed on the interior rivers and lakes. Valuable assistance has also been rendered by the life-saving crews stationed along the coast, who are under instructions to report by telegraph to the Fish Commissioner the appearance or stranding of any unusual large fish or cetacean in the neighborhood of their station. Several interesting discoveries have already been made by this means, and also by information from light-house keepers.

Very many important improvements have been made by the members of the Commission, from time to time, in dredging and other appliances of research, which are fully described in the catalogue. The most noteworthy of these are the rake dredges, tangles, table and cradle sieves; the Tanner sounding machine, for use with wire; and the Bailie-Tanner deep-sea thermometer case.

According to an official report of the Commission, published in 1880, 800 species of marine invertebrates had been recorded from the New England coast, and adjoining regions, prior to 1871. To this number the Fish Commission added up to, but not including, the summer of 1880, about 1,000 described species, which were either new, or previously regarded as extra limital, making a total of 1,800 species of marine invertebrates known to inhabit this region at the close of the first decade of the Commission. In this enumeration no account has been taken of several groups of invertebrates on which no special studies have as yet been made. The same report records the discovery, during the same period, of over 100 species of marine fishes from the eastern coast of the United States, of which one-half were new to science, and several of economic value. Forty species were from north of Cape Cod, and 17 from the coast of the Gulf of Mexico, the remainder being from the intervening region. In addition to the above, over 60 species of fishes were added to the fauna of the Pacific coast, through the efforts of the Fish Commission. Since 1879, the scientific results have been even greater in proportion than previously, and about 40 species of fishes have been added to the New England region, increasing the number of species known from that section of the coast to over 230.

No enumeration has been lately made of the invertebrate additions, but they amount to several hundreds, and are mainly from the region of the Gulf Stream slope off the New England coast, in depths of 100 to 800 fathoms. This region is undoubtedly one of the very richest in the world, both as regards the abundance and variety of animal life. It will be again included in the scope of the explorations for 1883.

While the systematic explorations of the Fish Commission have not yet been extended to the Pacific and Gulf coasts, nor to the southward of Cape Hatteras, on the Atlantic coast, special collectors have aided greatly in developing the littoral and shallow-water faunæ of those regions. The census operations of 1880 gave a new impetus to this work, and the special coast experts were instructed to make large collections, wherever they went. These researches were also extended to the region of the Great Lakes and to the interior rivers. A large amount of valuable material bearing upon both the salt and fresh water fisheries of the United States and the food of fishes was the result.

In 1871, the late Mr. J. W. Milner, Assistant Fish Commissioner, began a series of careful explorations of the Great Lakes and other fresh-water areas, which he carried on more or less continuously up to the time of his death, in 1879. The first year was devoted exclusively to Lake Michigan, where, in addition to other collecting, numerous dredgings were made in depths of 30 to 144 fathoms. The invertebrates obtained were referred to Dr. William Stimpson, at Chicago, for study, but they were soon afterward destroyed in the great fire of October, 1871, before they had been carefully examined. During 1872 and one or two years following it, Lake Superior and the other more eastern lakes were explored in considerable detail; but Mr. Milner's services were soon demanded for the more important problem of fish culture and distribution, which thereafter occupied the greater part of his time. In 1879, however, while in Florida for the benefit of his health, he made interesting collections of fishes, mainly on the west coast. After his death his duties were assumed by Major T. B. Ferguson, the present Assistant Commissioner, who has charge of the propagating work.

Mr. C. G. Atkins, in charge of the hatchery at Bucksport, Maine, has made frequent contributions, especially of fresh-water fishes from the State of Maine. During 1871, Dr. H. C. Yarrow, United States Army, stationed at Fort Macon, made a careful study of the food-fishes of the North Carolina coast for the Commission, and obtained large collections of fishes and marine invertebrates. Mr. Silas Stearns, of Pensacola, Florida, has, for a number of years, acted as an agent of the Fish Commission on the coast of the Gulf of Mexico, studying the fisheries, and making collections of all kinds of marine animals. Through his exertions, several new species have been added to the fauna of that region.

Mr. R. E. Earll and Colonel M. McDonald conducted the census investigations of the general fisheries of the Southern Atlantic coast, during 1880, and made extensive collections of economic and other fishes and invertebrates. During the same period, Mr. Ernest Ingersoll accomplished like results for the oyster and other economic mollusks. In 1876, Mr. L. Kumlien collected in Texas, and more recently Dr. R. W. Shufeldt, United States Army, has been studying in great detail the aquatic fauna of the Mississippi Delta, which has hitherto received but little attention. Mr. E. G. Blackford and Mr. Fred Mather, of New York, have both rendered important services to the Fish Commission ever since its organization, especially with reference to the extensive fisheries which center at New York City. In 1874, Mr. Mather also made a large collection of fishes in Michigan, and since then in New York, Long Island Sound, and elsewhere. Captain N. Atwood, of Provincetown, Massachusetts, and Mr. S. Powel of Newport, Rhode Island, have aided the Commission greatly by numerous contributions from time to time.

On the Pacific coast, the more important explorations have been by Professor D. S. Jordan and Mr. C. D. Gilbert, who carried on the census investigations of that region, and made enormous collections of fishes, embracing over 60 new species. They also obtained an abundance of invertebrates. Mr. J. G. Swan, of Port Townsend, Washington Territory, has, from time to time, sent valuable zoological contributions from the region of Puget Sound; and Mr. Livingston Stone has collected extensively in the fresh waters of the Western States and Territories, and especially in California and Oregon. Other naturalists and collectors on the west side to whom the Fish Commission is greatly indebted for materials and observations are Professor R. E. C. Stearns, Mr. Henry Hemphill, Mr. L. Belding, Mr. W. N. Lockington, and Mr. Andrea Larco.

In connection with the work of fish-hatching, which is described in another section, very interesting and valuable embryological studies have been made by Mr. J. H. Ryder, of the Fish Commission, and Professor W. K. Brooks and Mr. H. J. Rice, of Johns Hopkins University, on the oyster, shad, mackerel, and many other important food-fishes.

War Department.—Explorations of Colonel Totten, United States Army, in marine zoology, along the New England coast, beginning about 1834. Exploration of the Red River of Texas, in 1851–'52, by Captains R. B. Marcy and George B. McClellan; collections of fishes mainly. Zoological collections at the Tortugas, Florida, by Captain H. G. Wright, from 1851–'54; fishes mainly.

Explorations and surveys for a railroad route from the Mississippi River to the Pacific Ocean, from 1853 to 1857, under the direction of the Secretary of War, according to acts of Congress in 1853 and 1854. These explorations were carried on by some seven or eight distinct parties, each under command of an officer of the Army, and covered a vast area of territory lying between the parallels of 32° and 47° north latitude, the greater portion of which was previously unknown to science. The surgeons attached to each of the parties, and also several of the line officers, devoted much of their time to natural-history investigations and accomplished very flattering results. As might be naturally inferred, most attention was paid to the terrestrial animals, but very large collections were made of fresh-water fishes everywhere, and of marine animals in the vicinity of Puget Sound. Each party was fully supplied with all the necessary collecting apparatus, and were given complete instructions as to the manner of making natural history collections. The explorations along the forty-seventh parallel of latitude, from Saint Paul, Minnesota, to Puget Sound, were in charge of Major Isaac I. Stevens, afterwards governor of Oregon Territory, and were begun at both ends of the route at the same time. Dr. G. Suckley, United States Army, acted as naturalist of the eastern section, and Dr. J. G. Cooper of the western, both giving nearly their entire time to zoological investigations. After the abandonment of the expeditions, Doctors Suckley and Cooper continued their collecting for some time on the northwest coast, the former being stationed as surgeon at Fort Steilacoom, and the latter working in the vicinity of Shoalwater Bay. The collections sent home by these two naturalists were very large and of extreme value; they embraced every department of zoology, and included large quantities of marine and fresh-water fishes and marine invertebrates. Their explorations of Northern Oregon and Washington Territories were especially thorough, both as regards the sea-coast and interior waters. Dr. C. B. R. Kennerly was naturalist of the route along the thirty-fifth parallel, under Lieutenant A. W. Whipple, and collected large quantities of fresh-water specimens along the route, and of marine specimens in the vicinity of San Francisco, California.

Collections of fresh-water fishes in Texas and Northern Mexico by Lieutenant D. N. Couch, in 1853. Exploration of the Brazos River, Texas, in 1854, by Captain R. B. Marcy, Dr. G. G. Shumard, naturalist. Exploration of the Black Hills (Upper Missouri and Yellowstone Rivers), in 1856–'57, by Lieutenant G. K. Warren. Survey of a wagon road from Fort Riley to Bridger's Pass, under Lieutenant F. T. Bryant, in 1856–'57. Explorations of a canal route across the Isthmus of Darien, in 1857, under Lieutenant N. Michler, A. Schott, naturalist. Explorations in Kansas, Nebraska, and Utah, by Dr. G. Suckley, in 1859. Large collections of zoology at the Tortugas, Florida, by Captains H. G. Wright and D. P. Woodbury, in 1859, and along the Atlantic coast of the States, by Lieutenant J. D. Kurtz, in 1860. Collections of marine invertebrates, chiefly mollusks, from the Gulf of California, by Captain C. P. Stone, in 1860.

Explorations of Dr. Elliott Coues, in the Western States and Territories, since 1860, a portion of the time as chief naturalist of Hayden's Geological Survey; on the coast of Labrador in 1860, and at Beaufort, North Carolina, in 1868. Geological survey along the fortieth parallel of north latitude, under Clarence King, from 1867–1879. Very large collections of marine fishes and invertebrates from the Atlantic coast, in the vicinity of Fort Macon, North Carolina, during 1870 and 1871, by Dr. H. C. Yarrow.

Explorations and surveys west of the one hundredth meridian, under the direction of General A. A. Humphreys, Chief of Engineers, by Lieutenant George M. Wheeler in charge, from 1872–'79. The naturalists of this survey were Dr. H. C. Yarrow, Mr. H. W. Henshaw, Professor Newberry, Mr. Charles E. Aiken, Dr. J. T. Rothrock, and Oscar Loew, and their field of operations included the fresh-water lakes and rivers of Utah, Colorado, New Mexico, Arizona, and Western and Southwestern Nevada, Salt Lake, Utah Lake, and other salt-water lakes, and the Pacific coast in the vicinity of Santa Barbara, California.

Survey of the northern and northwestern lakes and rivers, under General C. B. Comstock, United States Army, Corps of Engineers. In August and September, 1871, Professor S. I. Smith, of Yale College, conducted a successful series of dredgings, covering nearly the entire area of Lake Superior, in connection with this survey. The greatest depth attained was 169 fathoms. Bottom and surface temperature observations were also taken by Professor Smith, as well as by the survey in the course of its regular work.

Collections of fresh-water mollusks from New Mexico and Arizona, in 1876, by Lieutenant W. L. Carpenter. Explorations of Captain Charles Bendire, while stationed in several of the Western States and Territories, and especially in California, Arizona, Oregon, and Washington Territory, mainly with reference to the fresh-water fishes (*Salmonidæ*) and cray-fishes.

Exploration of the Mississippi Delta, in 1882 and 1883, by Dr. R. W. Shufeldt, United States Army.

Interior Department.—Explorations for a wagon road to California, by way of the South Pass, in 1857–'58, Dr. James G. Cooper, naturalist. United States and Mexican Boundary Survey, from 1851–'55, under Colonel J. D. Graham and Major W. H. Emory, United States Army. The collections of zoology were extensive and covered the region of the Rio Grande River, from Eagle Pass to its mouth.

Hayden's Geological Survey. The most extensive series of scientific explorations under the Interior Department and General Land Office have been those of the so-called Hayden's Surveys of the Western Territories, which, although organized mainly for geological investigations, have accomplished much in the way of making known the aquatic fauna of the extensive region included within its scope, being almost the entire western half of the United States, with its many large river systems and lakes, These surveys were begun in 1867, and continued until the reorganization of the system of geological surveys in 1879. Several naturalists were attached to the field parties every year, many of them being volunteers who took these opportunities to make collections in their special lines of research. Many valuable contributions have been published from time to time on the collections of aquatic animals obtained. Among the prominent naturalists interested in aquatic forms, who participated in these surveys, have been Dr. Elliott Coues, Professor E. D. Cope, Dr. Joseph Leidy, Professor A. S. Packard, jr., and Mr. Ernest Ingersoll.

State Department.—Survey of the northwestern boundary line, under Archibald Campbell, Commissioner, from 1857 to 1861, Dr. C. B. R Kennerly surgeon and naturalist. Large collections were made in Puget Sound and at the mouth of Fraser River. The same survey was continued farther east during 1873–'74, with Dr. Elliott Coues, United States Army, as naturalist.

Treasury Department.—To Captain C. M. Scammon, of the Revenue Marine, stationed on the west coast of North America, we are indebted for a valuable series of observations on the whales and other cetaceans of the North Pacific Ocean, extending through several years. His contributions to the National Museum have been very extensive. and include the skeletons and skulls of numerous species of cetaceans.

During the spring of 1883, arrangements were made with the Life-Saving Service of this Department, whereby the stranding of any large animal of unusual appearance in the neighborhood of any of the life-saving stations is telegraphed at once to the United States Fish Commissioner. Through this means several important discoveries of large marine fishes and cetaceans have already been made, and the specimens sent to Washington in suitable condition for study and preservation. Similar information and specimens have also been received from light-house keepers on the Atlantic coast.

Smithsonian Institution.—The following natural history explorations of a more private nature were conducted, wholly or in part, under the auspices of this institution.

Fishery investigations of Professor S. F. Baird. During the earlier period of his connection with the Smithsonian Institution, and for several years previously, Professor Baird spent the summer months mainly in exploring the fresh waters of the Northeastern United States, and in making large collections of fishes and reptiles. The area covered by his researches included the Eastern and Middle States, Virginia, Ohio, Indiana, Illinois, Michigan, and Wisconsin, the Great Lakes, the Saint Lawrence River, and the Ohio River. The summers of 1854 and 1855 were devoted to a study of the fishes of the New Jersey coast, in the vicinity of Beesley's Point. In all of these explorations very large collections were made. Professor Baird's work as United States Fish Commissioner has already been spoken of.

Robert Kennicott and the Hudson's Bay Company. From 1853 to 1859, Mr. Kennicott carried on extensive explorations in Illinois, Minnesota, and the region of Lake Winnipeg, making interesting collections of aquatic and terrestrial animals. In 1855 he brought together, for the Agricultural Fair, at Chicago, Illinois, one of the most complete State collections of natural history ever made up to that time, and a large part of which was later contributed to the Smithsonian Institution. From 1859 to 1861, under the auspices of the Smithsonian Institution, the Chicago Academy of Sciences, the Chicago Audubon Club, and the University of Michigan, and with the assistance of the officers of the company, Mr. Kennicott conducted a series of explorations along the line of the Hudson's Bay Company's posts, from the Red River settlement, along the Red River of the North and the Mackenzie River, to the headwaters of the Yukon River, bringing back with him immense collections, representing the aquatic fauna of the entire region visited. Many valuable collections of fishes have also been received at intervals, since 1859, from the officers of the Hudson's Bay Company, and especially from Mr. R. McFarlane, and Mr. McDougal, between 1860 and 1868, the former collecting in the vicinity of Fort Anderson, on the Arctic Ocean, the latter in the Mackenzie River district.

In 1854, Dr. P. R. Hay and the Rev. A. C. Barry, of Racine, Wisconsin, made large contributions of fishes, the former from Western Missouri and Kansas, the latter from Northern Wisconsin.

Explorations on the Atlantic and Gulf coasts: Dr. William Stimpson, from 1850 to 1871, on the New England coast, and the coasts of North Carolina and Florida; marine invertebrates mainly. Charles Girard, at Charleston, South Carolina, in 1851, and at various other localities from 1848 to 1858. Professor Theo. Gill, at Beaufort, North Carolina, the West Indies, and Newfoundland, during 1859–'60. Dr. J. G. Cooper, in South Florida, in 1859. Dr. J. B. Holder, at the Tortugas, Florida, in 1860. Mr. S. T. Walker, Florida, 1879; and Mr. Henry Hemphill, Florida, 1882–'83. In 1882, Mr. Winifred Stearns, of Amherst, Massachusetts, in company with several college students, made a collecting tour to Labrador, which was productive of good results, especially in the line of marine invertebrates.

Explorations on the Pacific coast: Mr. E. Samuels, in 1855, under the auspices of the Smithsonian Institution and the Boston Society of Natural History, made large collections in California, and, in 1858, Mr. A. S. Taylor, collected at Monterey, in the same State. Mr. J. G. Swan, at Puget Sound, from 1860 to date; collections of all characters, including marine animals. Dr. C. A. Canfield, at Monterey, and other localities in California, from 1860 to 1867. Rev. Joseph Rowell, Dr. W. O. Ayres, and Professor R. E. C. Stearns; large collections of shells from the Pacific coast. Mr. Henry Hemphill; numerous collections of marine invertebrates from California, 1874 to date.

Interior of the United States: Explorations of Arizona, Indian Territory, the Southern States, etc., by Dr. Edward Palmer, from 1866 to date, mainly for ethnological materials, but also with good results in the way of aquatic animals. Collections of fishes from Pennsylvania by Dr. T. H. Bean, since 1874.

State Surveys.—State organizations, either as natural history surveys or fishery commissions, have accomplished a great deal in the way of making known the aquatic fauna of their territories. Among the first of the States to undertake purely scientific explorations in this direction were Massachusetts and New York, both of which States have published standard works upon the subject. A large majority of the States have since done more or less good work in the same line. Nearly every State now has its fishery commission, the specific object of which is the protection or propagation of food fishes, but some of these have also rendered generous assistance in the line of pure science.

Illinois has a central zoological station at Normal, under the charge of Professor S. A.

Forbes, to which are referred all zoological problems of interest to the State. In connection with his other duties, Professor Forbes has conducted careful zoological surveys of many of the lakes and rivers of the State, including the southern part of Lake Michigan.

In this connection, reference might also be made to private fishing clubs and to amateur and professional fishermen, who are making constant contributions regarding the habits and distribution of fish.

ALASKA.

Western Union Telegraph Expedition.—This expedition to ascertain and survey the most feasible route for a line of telegraph from the United States to Bering Straits, in Alaska, thence to connect with a similar line through Siberia to Russia, although without practical issue so far as the construction of a telegraph line was concerned, gave excellent scientific results, and afforded the means of studying the fauna and flora of a previously unexplored region. The party was organized on a military basis, with Captain Charles S. Buckley, engineer in chief; Captain Charles M. Scammon, chief of marine; and Mr. Robert Kennicott, chief of the scientific corps. A steamer and four sailing vessels were at their disposal. The scientific corps consisted of the following members, in addition to the chief: William H. Dall, H. M. Bannister, Ferd. Bischoff, H. W. Elliott, J. T. Rothrock, and Charles Pease. They left New York for San Francisco in April, 1865, by way of the Isthmus of Nicaragua, and spent some three weeks at the latter place making collections. Arriving at San Francisco in May, Messrs. Bannister, Elliott, and Rothrock soon left for British Columbia, while the rest of the party remained until the middle of July, studying the fauna and making extensive collections. In July, Mr. Kennicott, with the balance of his party, sailed for Alaska, touching at Vancouver's Island on the way. He visited Sitka, the Shumagin Islands, and Saint Michael's, establishing himself at the latter place for a prolonged series of explorations. In the meantime Mr. Dall, with the main party, proceeded to Plover Bay, Eastern Siberia, and thence to Petropavlovsk, Kamschatka, returning to San Francisco in November, 1865. Several weeks of January, 1866, were spent by Mr. Dall at Monterey, California, in zoological collecting, but in July of the same year he returned to Saint Michael's, Alaska, by way of Plover Bay, arriving at the former place in September, only to find that Mr. Kennicott had died several months before. The direction of the survey thenceforward devolved upon Mr. Dall, who remained in the country more than two years longer.

The winter of 1866–'67 was spent at Nulato, and in the spring of 1867 Mr. Dall started up the Yukon River for Fort Yukon, returning again down the river to its mouth, and thence going by sea to Saint Michael's. Here ended the explorations in the interest of the telegraph company, but Mr. Dall continued his natural history observations and collecting at his own expense. His field of operations was much the same as during the previous year, the winter being spent at Nulato, and the descent of the Yukon commenced in the spring. The better part of the collecting season was spent in the Yukon Delta, after which Mr. Dall returned to San Francisco by way of Saint Michael's and the Pribiloff and Aleutian Islands. The collections obtained by the telegraph expedition and Mr. Dall consisted principally of birds and mammals, but also included a full series of all the fishes then known to inhabit the Yukon River, and many marine fishes and invertebrates from the various localities visited. The expenses of the original collecting outfit were shared conjointly by the Smithsonian Institution and the Chicago Academy of Sciences, but after the abandonment of the expedition Mr. Dall received no outside aid.

United States Coast Survey.—In 1871, Mr. William H. Dall began a second series of explorations of Alaskan waters, under the auspices of the Coast Survey, as an assistant of that survey, and although the collecting of zoological specimens was incidental to the primary objects of the explorations, an immense amount of natural history material has already been obtained and in large part described. The first cruise, made with the Coast Survey schooner "Humboldt," included the region of the Aleutian Islands, from Unalashka eastward, and was continued from August, 1871, to September, 1872. The second cruise, with the Coast Survey schooner "Yukon," in 1873, embraced the western half of the same group of islands. In 1874 the schooner "Yukon" first proceeded to Sitka, and thence followed along the coast as far as Unalashka. From this place it visited the Pribiloff Islands and Nunivak Island, and thence skirted the Alaskan coast southward to the point of departure.

In April, 1880, Mr. Dall, accompanied by Dr. Tarleton H. Bean, of the United States National Museum, left San Francisco for Alaska by the regular passenger steamer, and joined the schooner "Yukon" at Sitka. The course taken this year agreed in part with that of 1874, but many additional places were visited and the explorations were extended to the Siberian coast and to Point Belcher, in the Arctic Ocean. Collections were principally obtained from the following localities: Sitka, Port Althorp, Port Mulgrave, Cook's Inlet, Kodiak, Shumagin Islands, Belkoffsky, Unalashka, Saint Paul's Island, Plover Bay (Siberia), Cape Lisburne, Icy Cape, Point Belcher, Eschscholtz Bay, Port Clarence, Big Dromide Island, and Saint Mathew's Island.

Aside from the regular surveying work, most attention was paid to collecting marine animals of all kinds, and fresh-water fishes. The dredge was in constant use, and much valuable material and data were also obtained from the natives. Dr. Bean, as the guest of the Coast Survey, was enabled to devote his entire time to natural history investigations, and made the trip mainly for the purpose of studying the fish fauna of Alaska, from both a scientific and practical standpoint.

All of the Alaskan collections of natural history made by the Coast Survey are now safely housed at the National Museum in Washington. Mr. Dall, in an official report, states, regarding them, that "our collection of natural history is very valuable and contains more material for the determination of geographical distribution and specific development than has ever been sent from the west coast before."

Tidal observers in Alaska who have made valuable collections of marine animals have been Mr. W. J. Fisher, stationed at Kodiak, and Mr. McKay, stationed at Fort Alexander, Bristol Bay.

Treasury Department.—Mr. Henry W. Elliott, as an agent of this Department, visited the Fur Seal Islands, Alaska—Saint Paul, and Saint George—in 1872–'73, and made many large collections of marine fishes and cetaceans, and many sketches illustrative of the habits of seals and the seal fisheries. The revenue cutters "Corwin," Captain Hooper, and "Richard Rush," stationed in Alaskan waters, have both rendered efficient service in the field of marine zoology.

Signal Service Bureau of the War Department.—Much valuable aid has been rendered zoological science in this important section of the War Department by observers stationed in Alaska and the northern portion of Eastern North America. In making appointments for these distant stations, the Signal Service Bureau has generally accepted candidates recommended by the Smithsonian Institution, who are especially qualified to carry on zoological investigations in addition to their other observations. These observers have already made very extensive contributions in all departments of natural history, among which the marine animals are prominently represented.

Mr. Lucien M. Turner was stationed at Saint Michael's, Norton's Sound, Alaska, from 1874 to 1877, and in 1879 went to the Aleutian Islands, where he had charge of several temporary stations at different localities besides the main station at Sitka. In journeying from place to place, he was able to bring together a vast amount of material, all of which has been received at Washington in good condition. In 1882, Mr. Turner was transferred to a new station at Fort Chimo, Ungava Bay, Northern Labrador, where he now is, fully equipped for all kinds of collecting.

Mr. E. W. Nelson replaced Mr. Turner at the Saint Michael's station, where he remained, doing the same class of work for about four years. At the close of this service, he made a trip in the revenue cutter "Corwin," to Wrangel Land, in the Arctic Ocean, touching at various interesting points in Bering Sea, and returning to the

United States in the winter of 1881–'82. Mr. Nelson's collections are of the same character as those of Mr. Turner, and are very extensive.

In 1881 a party of observers, under Lieutenant Ray, United States Army, and including two trained naturalists and collectors, Mr. John Murdoch and Mr. Smith, were sent by the Signal Service Bureau to Point Barrow, Alaska, in the Arctic Ocean, one of the series of international signal stations, where they still remain. They were visited in 1882 by a relief party, which brought back from there an interesting collection of aquatic animals and ethnological specimens, and still larger collections are promised for this year.

Smithsonian Institution.—The Alaska Commercial Company, through its officers and agents in San Francisco and Alaska, has not only rendered every possible aid to Alaskan explorations, on behalf of the Smithsonian Institution, but has also made many valuable contributions in zoology, especially with reference to the seals and seal fisheries. From Mr. Henry Elliott, an agent of the company, especially valuable specimens, drawings, and observations, mainly illustrative of the habits of seals, have been received.

In 1871, Captain Charles Bryant, in charge of the Fur Seal Islands, sent to Washington a very large collection of the skeletons, skulls, and skins of seals and walruses.

Mr. Leonhard Stejneger is now making a zoological survey of Bering Island, on the coast of Kamtschatka, from which place he has already sent the skulls of two interesting ziphioid whales, and a large collection of bones of the extinct *Rhytina*, or Arctic sea-cow.

FOREIGN.

Navy Department.—The United States Navy lays claim to two of the most important oceanic expeditions of the world, in which the study of aquatic life formed essential features—the Wilkes Expedition of 1838–'42, and the North Pacific Exploring Expedition of 1853–'56. In addition to these, there have been numerous smaller surveys by the same service, which have yielded good results in the same line, and many naval officers have been constant contributors to the National Museum from all quarters of the globe. A more important sphere of usefulness, however, for its bearing upon aquatic life, as well as upon hydrography, has probably been that of deep-sea sounding, in which the United States Navy has always taken a prominent stand. A full account of its achievements in this direction would be impossible here, and we can only refer to the more important steps taken in the improvement of sounding methods. We may, perhaps, be pardoned for quoting in this connection the following paragraph from a recent paper by Captain George E. Belknap, United States Navy, as a deserved tribute to this service as well as to the originator of the present method of using steel wire for sounding.

"The impartial student, whether American or European, will accord to the United States naval service and Coast Survey merited prominence in diligent and persistent effort, inventive appliance, and intelligent adaptation of ideas and methods, from whatever source, towards the satisfactory solution of the problem [of deep-sea sounding]; but it was the good fortune of Sir William Thomson, of Glasgow University, to conceive the best and simplest means of measuring the depths; and to-day, thanks to his genius, it is as easy for the questioning seaman or scientist to bring back answer from the depth of five miles as it formerly was from a quarter of a mile."

The earliest use of wire for sounding purposes, of which we can find mention, was made by the Wilkes United States Exploring Expedition, between 1838 and 1842, on which most of the vessels were supplied with copper wire, about three thirty-seconds of an inch in diameter, and spliced together by means of twisted ends, covered over with solder. The experiments were unsatisfactory, owing to the frequent parting of the wire, and were finally abandoned. The second trial with wire appears to have been made in August, 1849, by Captain Barnett, of H. M. S. "Thunderer," between the Banks of Newfoundland and the Western Islands. The wire was of iron, varying in size from No. 1 to 5, and was wound on a small reel, the sinker used weighing 61 pounds. No restraint was apparently put upon the reel, and the wire broke at two thousand fathoms on the first sounding, which seems to have been the only one attempted.

Three months later, the same year, Lieutenant J. C. Walsh, United States Navy, in the United States schooner "Taney," attempted sounding with English steel wire of Nos. 5, 7, and 8, Birmingham gauge, to the eastward of Bermuda. "The wire was wound on an iron reel (holding about 7,000 fathoms), fitted with brakes or friction bands for its better control in working, and swivels were fitted next the sinker, and at every thousand fathoms, to counteract the tendency to twist. The lengths were marked with copper labels, and the sinker weighed only 10 pounds; but 6 pounds may be added for the weight of the registering machine devised by Maury and used on this occasion." The wire seems to have been of too large a size, the splices too imperfect, and the sinkers too light for the purpose, and the several experiments made were all unsuccessful. On the first trial, some 5,700 fathoms of wire were run out without an indication of bottom, although the depth must have been less than half that distance, when the wire parted near the surface, it was supposed from a defective splice. In the other trials made, the wire generally broke at depths of about 2,000 fathoms, or above the bottom.

We have no further records of the attempted use of wire for sounding from this time until Sir William Thomson began his experiments, in 1872, on the principle that "the art of deep-sea sounding is to put such a resistance on the reel as shall secure that at the moment the weight reaches bottom the reel will stop." A description of the Thomson machine is given in the descriptive catalogue which follows, and need not be repeated here. Thomson made the first trials with his machine in the Bay of Biscay, in 1872, from the schooner-yacht "Lalla Rookh," and although the reel proved too weak to withstand the strain put upon it by the wire in reeling in, the first sounding was accurate. The English Navy, however, declined to use the machine until it could be perfected, a work that has since been successfully accomplished by the naval service of this country. Commodore Ammen, United States Navy, then chief of the Bureau of Navigation, ordered one of the new machines from Thomson as soon as he heard of its successful trial, intending to have it used by the U. S. S. "Juniata," in a line of soundings from New York to Bermuda, in 1873. This project was abandoned, however, and the entire outfit transferred to the U. S. S. "Tuscarora," which received an equipment at San Francisco, in the summer of 1873, for a series of soundings across the Pacific Ocean, between the United States and Japan, "for scientific purposes, and for the purpose of determining the practicability of laying a telegraph cable between those points." Captain George E. Belknap, United States Navy, was in command of the "Tuscarora," and to his skillful management was due the first successful line of deep-sea soundings with piano wire. The equipment of the ship was completed in August, 1873, and she at once proceeded to test her appliances a short distance off San Francisco, making successful soundings in depths of 830 to 1,949 fathoms. The only important defect discovered was as to the strength of the reel, which soon showed signs of weakening and had to be strengthened; a new and larger reel of extra strength was also constructed. Later on, several other minor alterations and improvements, suggested by experience, were introduced in the machine. The original plan was to run the line of soundings from Cape Flattery to Yokohama, Japan, by way of the Aleutian Islands, Alaska, and a beginning was at once made off the first mentioned point. Twenty-five casts were taken in depths down to 2,534 fathoms, before the approach of winter rendered it necessary to discontinue operations until the next year, but in returning to San Francisco a line of 83 casts in like depths of water was successfully completed. In January, 1874, the "Tuscarora" sailed from San Diego, California, on a new route across the Pacific Ocean, via the Hawaiian and Bonin Groups. Twenty-seven days were consumed in making 62 casts, from San Diego to Honolulu, in depths of 71 to 3,050 fathoms; 29 days from the latter group to the Bonin Islands, with 59 casts in depths down to 3,287 fathoms; and 4 days from the Bonin Islands to Yokohama, during which 12 casts were made, the deepest in 2,435 fathoms. After a short delay at Yokohama, the "Tuscarora" proceeded to finish the northern line of soundings, via the Aleutian Islands and Cape Flattery, which occupied the time from June 9 to August 21. Very many casts were made, and exceedingly deep water (the deepest recorded from the Pacific or any other ocean) was encountered off the northeast coast of Japan, at only a comparatively short distance from land, very many of the soundings showing depths below 4,000 fathoms, the deepest being 4,655 fathoms. This cruise of the "Tuscarora" was one of the most, if not the most, remarkable one ever undertaken for sounding purposes, and demonstrated to the fullest extent the superior advantages of steel wire, when rightly applied, over any kind of rope or twine for taking deep-sea soundings. The advantages gained are greater rapidity in working and greater accuracy of results, while the diminished space required for the storage of the wire and machine is also a matter of grave consideration.

Since the successful cruise of Captain Belknap, the Thomson principle of sounding with wire has been universally adopted for all deep-sea sounding operations by the United States Navy and Coast Survey. In connection with his soundings, Captain Belknap made a continuous series of oceanic temperature observations at the bottom and surface, with Miller-Casella thermometers, and obtained abundant specimens of the bottom by means of an improved sounding rod of his own invention (described in the catalogue), and also many samples of water for analysis.

The "Tuscarora" returned to San Francisco on the anniversary of her departure from there to begin the northern line from Cape Flattery, and in the meantime she had traversed some 16,600 miles of ocean and made 483 casts by means of the sounding wire. Subsequently, under other commanders, the "Tuscarora" run a line of soundings from San Francisco to Honolulu, and another from Honolulu to Australia. Still later the same kind of apparatus was used by the U. S. S. "Narragansett," in the Gulf of California; by the "Gettysburg" in the North Atlantic and Mediterranean; by the "Alaska," en route around the Horn; and by the "Essex," in the South Atlantic. The "Gettysburg" obtained the deepest sounding but one yet recorded from the Atlantic Ocean (the deepest having been made by the "Challenger"); while the "Essex" has made the deepest known from the South Atlantic.

To turn from the subject of sounding wire to that of deep-sea leads or sinkers, it is evident that to the American Navy is due one of the most important inventions in that line also. In 1854, Passed-Midshipman (now Professor) J. M. Brooke, United States Navy, devised the detachable sinker, bearing his name, for use in considerable depths of water, and which is released the moment it touches bottom, relieving the strain on the rope, and permitting of the recovery of a sample of the bottom by means of a light iron rod which loosely perforates the sinker. The latter consists simply of a solid iron shot, of the desired weight, with a cylindrical hole through the center for holding the sounding rod, to the upper part of which it is securely slung on the passage downward. The sinkers still used by the United States Navy and Coast Survey in deep-sea work are of the Brooke pattern, but the sounding rods and the method of securing the shot have been greatly improved by Captain Belknap and Commander Sigsbee, in the manner described in the catalogue. Another ingenious detaching sinker, which has been used to some extent in the Navy, was invented by Lieutenant (now Rear-Admiral) Sands, United States Navy, in 1857, and one of the most common leads for recovery in use is furnished with a cup for obtaining bottom specimens, introduced by Lieutenant Stellwagen, of the same service.

Want of space, however, forbids our continuing this discussion of the sounding operations and methods of our Navy, which might be extended to cover many interesting explorations under both the old and new systems of work. Suffice it to say that this department of the service has always displayed the most liberal spirit in regard to zoological research, and has in many small as well as great ways contributed to our knowledge of the fauna of the oceans wherever its ships have gone. The bottom specimens obtained by sounding have always been turned over to the United States National Museum, but only a few of these have yet been studied, for the want of funds. Other services by naval officers are referred to in connection with the Coast Survey. A full set of the hydrographic charts of the United States Navy, showing extent and character of explorations, are exhibited. The following are among the more important natural history surveys of this department.

The Wilkes Expedition.—The United States Exploring Expedition around the World, under the command of Captain (Admiral) Charles Wilkes, United States Navy, was one of the most successful expeditions for scientific purposes ever organized by any government. It left this country in 1838 and returned in 1842. The fleet consisted of six vessels, as follows: Sloop of war "Vincennes," flagship; sloop of war "Peacock," Captain W. L. Hudson; brig "Porpoise," Lieutenant Cadwalader Ringgold; store-ship "Relief," Lieutenant A. K. Long; and the tenders "Sea Gull" and "Flying Fish." The scientific corps consisted of the following persons: Horatio Hale, philologist; Charles Pickering and T. R. Peale, naturalists; J. P. Couthouy, conchologist; James D. Dana, mineralogist; William Rich and J. D. Breckenridge, botanists; Joseph Drayton and A. T. Agate, draughtsmen. Included in the general instructions to the commanding officer was the following paragraph relating to the scientific objects of the survey: "Although the primary object of the expedition is the promotion of the great interests of commerce and navigation, yet you will take all occasions, not incompatible with the great purposes of your undertaking, to extend the bounds of science and promote the acquisition of knowledge."

Leaving Norfolk, Virginia, August 18, 1838, the course lay southward through the Atlantic Ocean, via the Island of Madeira, Cape de Verde Islands, Rio de Janeiro, and the eastern coast of Southern South America, to Terra del Fuego; thence northward along the western coast of South America as far as Callao, and from there to the islands of the Central and South Pacific Ocean, Australia, and the west coast of the United States. The principal places visited in the Pacific Ocean region were the Paumotu Group, Society Islands, Samoan Group, Feejee Islands, Southeastern Australia, New Zealand, the icy barrier of the supposed Antarctic Continent, Kingsmill Islands, Sandwich Islands, and the coast of the United States, from San Francisco to Puget Sound. From the Pacific Ocean the expedition passed by way of the China Sea, Sooloo Sea, and the Straits of Sunda, into the Indian Ocean, making especially large collections at Singapore. From the Indian Ocean, the expedition returned home via the Cape of Good Hope. The collections made in the course of this long cruise embraced every branch of natural history and were exceptionally large. They formed the basis of the United States National Museum at the time of its foundation, and are still among its most interesting features. As many of the regions visited were previously unknown to civilization, the value of the scientific observations cannot be readily overestimated.

As regards marine explorations, most attention was paid to the study of the structure and formation of coral reefs and islands, and the coral, crustacean, molluscan, and fish faunæ. The publications, completed in 1858, comprise 24 volumes of text, mostly quartos, 13 atlases and 2 volumes of charts, covering all the geological, zoological and botanical results of the expedition, in addition to the regular surveying work. The zoophytes and crustacea were described by Professor James D. Dana, in three quarto volumes of text and two folio atlases; the mollusks by A. A. Gould, in one volume of text, and one atlas; the geographical distribution of species by Charles Pickering, in one volume.

In his official Smithsonian report, for 1858, Professor Baird remarks regarding the Wilkes expedition that "The collections made by this naval expedition are supposed greatly to exceed those of any other of similar character ever fitted out by a foreign government, no published series of results comparing at all in magnitude with that issued under the direction of the Joint Library Committee of Congress."

The North Pacific Exploring Expedition, as it is commonly called, has, next to the earlier expedition under Wilkes, given more important zoological results than any similar explorations under the Navy Department. It sailed from the United States in June, 1853, and continued its work through 1854 and 1855, returning in 1856 The great value of its zoological results were due to the untiring zeal of its chief zoologist, Dr. William Stimpson, whose previous studies and explorations particularly fitted him for the position.

This expedition was carried on under an appropriation from Congress in 1852, for "building or purchase of suitable vessels, and for prosecuting a survey and reconnaissance, for naval and commercial purposes, of such parts of Bering Straits, of the North Pacific Ocean and the China seas, as are frequented by American whale-ships, and by trading vessels in their routes between the United States and China." The necessary vessels were procured and equipped in the most substantial manner, and fitted out with all the instruments required for making observations in astronomy, hydrography, magnetism, and meteorology, together with the most complete equipment of natural history apparatus which had ever been taken to sea up to that time. Captain C. Ringgold, who had formerly been connected with the United States exploring expedition under Captain Wilkes, was placed in command; but, being recalled to the United States in 1854, he was superseded by Captain John Rodgers. The squadron was organized as follows: Sloop "Vincennes," bearing the flag of Commander Ringgold; Lieutenant Rolando, commanding and executive officer; Lieutenant J. M. Brooke, assistant astronomer; William Stimpson, zoologist to the expedition; F. H. Storer, chemist and taxidermist; Edward M. Kern, photographer and artist. Steamer "John Hancock," Lieutenant John Rodgers commanding; Charles Wright, botanist to the expedition; A. H. Ames, assistant naturalist. Brig "Porpoise," Lieutenant Alonzo B. Davis commanding; schooner "Fennimore Cooper," Acting Lieutenant H. R. Stevens commanding; storeship "John P. Kennedy," Lieutenant Napoleon Collins commanding.

The vessels left Norfolk in June, 1853, and, after touching at the island of Madeira, proceeded to Hong-Kong, China, via the Cape of Good Hope. On this passage, the sloop "Vincennes" and the brig "Porpoise" passed by the way of Van Diemen's Land, through the Coral Seas, and by the Caroline, Ladrone, and Bashee islands; and the steamer "John Hancock," the store-ship, and the tender by the way of the straits of Sunda and Gaspar, the Carimata and Billeton passages, and the Sooloo Sea. The existence of a civil war in China at the time of the arrival of the expedition at Hong-Kong occasioned some delay in the progress of the exploring work, which was again resumed in the latter part of 1854. Subsequently the expedition proceeded northward, continuing the observations and collecting along the coasts of Japan, and Kamtschatka, in Bering Straits, on the coast of California, and at Tahiti, from which latter place it returned directly home by way of the Cape of Good Hope. The natural history results were of great magnitude, filling many boxes and barrels, and embracing very many new and rare species. The extent and value of the zoological collections may be judged from the following table of the number of species of each group obtained:

	Species.
Vertebrates	846
Insects	400
Crustacea	980
Annelids	220
Mollusks	2,359
Radiates	406
Total	5,211

The plants in their original packages occupied a bulk of over 100 cubic feet.

Soon after his return to the United States, Dr. William Stimpson became the director of the Chicago Academy of Science, to which place nearly all the invertebrate materials of the expedition were transferred. Considerable progress had been made in working up results, and several short papers briefly descriptive of the more interesting groups of animals had been issued, when the memorable conflagration of 1871, which destroyed so large a part of Chicago, completely annihilated the entire collection there, as well as all the MSS. and drawings which had been prepared for publication. The only collections of marine invertebrates which escaped were the corals and a few of the Crustacea, which had been left for study at the Smithsonian Institution, the Museum of Comparative Zoology, and Yale College.

Surveys of lesser magnitude under the Navy Deparment have been the exploration of the River Amazon and its tributaries, in 1852, by Lieutenant W. L. Herndon, during which a very large collection of fresh-water fishes was made. The astronomical expedition to Chili, from 1849 to 1852, by Lieutenant J. M. Gilliss; interesting collections of marine animals. Explorations of the La Plata and its tributaries, from 1854 to 1857, by the U. S. S. "Waterwitch," Captain T. J. Page. Although unaccompanied by a naturalist, Captain Page sent to Washington a very extensive collection of the fishes of this extensive river system.

Survey of the islands of the North Pacific Ocean, in 1873–'74, by the U. S. S. "Portsmouth," Drs. T. H. Streets and W. H. Jones, surgeons and naturalists. Survey of the coast of the Peninsula of Lower California, on both the ocean and gulf sides, by the U. S. S. "Narragansett," Dr. William Evers, surgeon and naturalist. On each of these expeditions large numbers of marine invertebrates and fishes were obtained.

The Polaris Expedition to the Arctic Ocean during 1871 and 1872, under Captain Charles F. Hall, Dr. Emil Bessels, chief of the scientific department. This ill-fated expedition was fitted out by the Navy Department, pursuant to an act of Congress, and sailed from the United States in the summer of 1871. It reached the latitude of 82° 16′ N., the most northern point attained by civilized man up to that time. During the winter of 1871 and 1872, and the following spring, very large collections of marine animals, mainly invertebrates, were made and preserved, but on account of their bulk they had to be left on board the steamer and were lost with her.

Archæological explorations of Dr. J. F. Bransford, United States Navy, in Nicaragua, in 1873, 1876, and 1877, and in Panama in 1875, during which many interesting species of fresh-water and marine fishes and invertebrates were collected.

Transit of Venus Expedition of 1874–'75. Dr. J. H. Kidder, United States Navy, acted as naturalist of the party landed on Kerguelen Island, by the U. S. S. "Swatara," and devoted his entire time to zoological investigations, making large collections of marine animals. Dr. E. Kershner, United States Navy, surgeon of the "Swatara," on this same cruise, added to Dr. Kidder's results many interesting specimens of marine invertebrates from various sources in the South Pacific, and Mr. Israel Russell, photographer of the New Zealand party, collected extensively at that island.

In 1876, Engineer W. A. Mintzer, United States Navy, made interesting collections of marine fishes and invertebrates from the Arctic Ocean, north of Hudson's Straits.

The steamer "Jeannette," under Lieutenant De Long, fitted out by Mr. James Gordon Bennett and the Navy Department, for a cruise through the Arctic Ocean, from the Pacific westward to the Atlantic, was fully equipped for natural history investigations, and up to the time of her abandonment and destruction very large and valuable collections of marine animals and many interesting notes had been made by the naturalist on board, Mr. Raymond L. Newcomb.

In 1881 the U. S. S. "Alliance" visited the region about Spitzbergen, in the Arctic Ocean, in a search for the Jeannette, on the supposition that she had safely traversed the ocean north of Asia, in her westerly course, and, although unsuccessful in the search, she succeeded in making numerous successful dredgings in moderate depths of water off the island of Spitzbergen. The collection sent home was quite large and in good condition; it consisted of marine invertebrates and also of fresh-water fishes. About the same time the steam whaler "Rogers," purchased by the Government, and officered and manned by the Navy, started up on the west side, via Bering Straits, for the same purpose, and with a complete collecting outfit. While wintering in the Arctic Ocean, to the westward of Bering Straits, she accidentally took fire and was totally destroyed, together with a fine collection of marine animals, which had been made by the surgeon on board.

Captain L. A. Beardslee, whose previous connection with the United States Fish Commission had given him an interest in zoological matters, while in command of the sloop of war "Jamestown," in Alaskan waters, from 1879 to 1881, made many interesting observations regarding the marine fauna of that region, and sent valuable collections to Washington.

On the Palos Expedition to Japan and China, under Commander Green, United States Navy, during 1881 and 1882, for astronomical purposes, complete arrangements were made for marine collecting, a very full equipment for that purpose being furnished by the Smithsonian Institution. Dr. F. C. Dale, United States Navy, acted as surgeon and naturalist, and was assisted by Mr. P. L. Jouy, of the United States National Museum. Numerous, very large, and finely-preserved collections of fishes and invertebrates were received from this party from time to time, and they include many interesting species. Neither of the naturalists have yet returned to Washington, and Mr. Jouy is still in Japan, continuing his work independent of the ship.

State Department.—The Japan Expedition of 1853–'55, under Commodore M. C. Perry, United States Navy, to form a treaty with Japan, was sent out in the combined interests of the State and Navy Departments. Natural history collecting was incidental, but much was accomplished in that line.

Many valuable collections of marine invertebrates and fishes have been obtained through consuls and special agents of the State Department, who have been favorably located for such work. Among these may be mentioned Captain Nicholas Pike, consul at the Mauritius Islands, and Colonel A. B. Steinberger, special agent at the Samoan Islands, both of whom have sent to Washington very large and interesting collections.

War Department, Signal Service Bureau.—An observing party, under Lieutenant Greely, United States Army, went to Lady Franklin Bay, Greenland, in 1881, where it is now stationed. No information has been received from this party since the return of the steamer which took it out. Dr. Pavy is the naturalist, and is fully equipped for natural history work. In preparation for this station, a preliminary expedition, called the Howgate Expedition, with Mr. Ludwig Kumlien as naturalist, was sent into the same region in 1877–'78. It visited the shores of Cumberland Gulf and the western coast of Greenland, and obtained many interesting zoological results. Mr. Lucien M. Turner, who was formerly stationed in Alaska, is now at Fort Chimo, Ungava Bay, Northern Labrador, where he expects to devote much time to marine zoology.

Smithsonian Institution.—In 1853, Dr. E. K. Kane, who had been the surgeon of the Grinnell expedition of 1850, went again into the Arctic regions in command of the same brig, Advance, to renew the search for Sir William Franklin. Mr. Henry Goodfellow was naturalist of the expedition, and obtained very large collections, which, however, had to be abandoned. The expenses of this voyage were paid by Mr. Henry Grinnell and Mr. George Peabody, and it was sent out under the joint auspices of the Geographical Society of New York and the Smithsonian Institution.

Since 1858, Captain J. M. Dow, of the Pacific Mail Steamship Line, has made frequent contributions of fishes and marine invertebrates to the National Museum from the west coast of Central America and the Isthmus of Panama. From 1864 to 1866, Dr. A. Schott, as naturalist of the scientific survey of Yucatan, in the interest of the government of Yucatan, sent considerable material of value to Washington.

From 1868 to 1870, Professor F. E. Sumichrast made a thorough natural history exploration of the Isthmus of Tehuantepec, with his expenses partly paid by the Kentucky University, the Boston Society of Natural History, and the Philadelphia Academy of Natural Sciences. According to an official report of the Smithsonian Instittion, "his series of specimens (including many fishes from the west coast) was very complete, and is believed to express essentially the zoological character of an interesting section of Mexico." In 1872, Mr. William Gabb made a natural history survey of San Domingo, and from 1873 to 1875, a similar one of Costa Rica, obtaining valuable contributions for the Smithsonian Institution.

MUSEUMS AND SOCIETIES OF NATURAL HISTORY.

The Museum of Comparative Zoology of Harvard College.—This extensive museum, established in 1859 by Professor Louis Agassiz, has always exerted a most important influence on scientific investigations in every department of natural history. Through the liberal donations of many public-spirited men, and with occasional assistance from the State of Massachusetts, it has been enabled to accomplish far greater results than any other similar institution in the country. Its good work has not been limited to the purchase of collections, a legitimate method of fostering scientific research indulged in by most museums, but it has organized and pushed to completion many important explorations in different parts of the world, and claims a large share of the success attending the recent deep-sea dredging and trawling operations of the United States Coast Survey. Not least among its good offices has been the careful training of naturalists, and a considerable proportion of those who now stand prominent in the department of marine research received their first practical instructions from the late Professor Agassiz. The policy of the museum has ever been most liberal, and lavish sums of money have been expended wherever the prospects of good results would warrant it. Notwithstanding the fact that no department of zoology has been neglected, investigations regarding recent aquatic life have successfully competed for a lion's share of patronage, and the published results of the museum in this line are extremely flattering. Professor Louis Agassiz died in the winter of 1873–'74 and was succeeded in the directorship of the museum by his son, Professor Alexander Agassiz.

When the museum was first organized, the marine fauna of the New England coast was but imperfectly known, and Professor Agassiz and the museum assistants and students of marine zoology spent much of their time during the summer months in making collections and observations along the sea-coast. Similar operations were extended to the interior lakes and rivers, to the west coast of North America, and to foreign countries. The summer home of Professor Agassiz was at Nahant, Massachusetts, where he enjoyed superior advantages for the study of marine life, and especially of the Medusæ. His observations at this place were continued from year to year during his life, and afforded abundant results for publication. Before the establishment of the museum, however, Professor Agassiz had commenced his researches on the Atlantic coast. The summer of 1847 was spent on Nantucket Shoals, in connection with the surveys under Captain Davis, U. S. N., Mr. Desor also participating in the dredging work. Later, Professor Agassiz visited Charleston, S. C., and the coast of Florida, where he made large collections during a period of three or four years. Doctor G. Wurdemann and Mr. James E. Mills also collected extensively for Professor Agassiz at the latter place, and Dr. Weinland, on the coast of Cuba.

In 1859, Mr. A. E. Verrill began his explorations of the New England coast, which were carried on in connection with the museum until 1864, when he joined the faculty of Yale College. The summer of 1859 was spent at Eastport, Maine, and that of 1860 at Mount Desert, in company with A. Hyatt and N. S. Shaler. The same year, Mr. Alexander Agassiz, then attached to the U. S. Coast Survey, and Mr. T. G. Carey commenced their series of collectings on the West Coast of North America, which were continued for several years. Mr. Carey's contributions were mainly from the vicinity of San Francisco, but those of Mr. Agassiz were obtained at numerous places between the Gulf of Georgia and Mexico. Mr. Alpheus Hyatt, in 1860, made extensive collections of fresh-water mollusks and other invertebrates from the rivers of Kentucky, mainly for the purpose of identifying the species of *Unionidæ*, previously described from that region by Rafinesque. Mr. W. H. A. Putnam, captain of one of the large merchant ships sailing from Boston, was one of the most faithful volunteer collectors in the service of the museum, and during his many voyages, especially to the west coast of South America and the South Pacific islands, he obtained most valuable contributions to science, which were always added to the museum collections.

From 1861 to 1863, Mr. Caleb Cook, a student of the museum, was stationed at Zanzibar, on the coast of Africa, where he made a large collection of animals, both terrestrial and aquatic. In 1861, a museum party, consisting of A. E. Verrill, Alpheus Hyatt, and N. S. Shaler, spent the summer at the Island of Anticosti, in the Gulf of Saint Lawrence, and, although they were mainly interested in the land animals and plants and in geological problems, their contributions to marine zoology were very important. Dredgings were made along the coast of Nova Scotia, in the Gulf of Saint Lawrence, and along the southern coast of Labrador. Mr. A. S. Bickmore visited the island of Bermuda the same year, and explored its marine fauna, with interesting results.

During 1865–'66, the memorable Thayer expedition to Brazil took place. This expedition was rendered possible through the munificence of Mr. Nathaniel Thayer, of Boston, one of the most constant and generous contributors to the museum fund, and in every way proved a complete success. The party was in charge of Professor Agassiz, and consisted of a large corps of associates and assistants, many of whom were volunteers. In reporting upon the results of his expedition, Professor Agassiz states: "One of my principal objects during the whole journey was to secure accurate information concerning the geographical distribution of the aquatic animals throughout the regions we visited. Allowed to take with me a corps of six assistants already trained in the work of the museum, and our party being also strengthened by the addition of six volunteer assistants, I was able to lay out a scheme for a thorough exploration of large tracts of country in Brazil, parts of which had not yet been visited by zoologists." These explorations extended along the entire sea-coast, from Para to San Paulo, and included all the principal rivers and many of their tributaries. Much assistance was rendered by the Emperor of Brazil, in the way of vessels, boats, and men. The alcoholic collections received at Cambridge from the expedition filled nearly 400 kegs and barrels, and in addition there were many cases of dried specimens. In the official report of the museum for 1866 the following statement occurs regarding the extent of the collections: "An idea of the magnitude of our new stores can be formed from the fact that in the class of fishes alone no less than 50,000 specimens were counted, representing over 2,200 species, the majority of which, say 2,000, are probably new to science and to our collections. This estimate does not include the smaller specimens, less than two inches in length, which also number many thousands."

In May, 1867, began the first series of deep-sea dredgings off the coast of Florida by the United States Coast Survey, in which Count L. F. de Pourtales took charge of the dredging operations. Count Pourtales was then an assistant on the Coast Survey, but later became an assistant of the museum, and the collections he obtained were mainly worked up by himself or under his direction. From this period dates the intimate connection of the Museum of Comparative Zoology with the Coast Survey, in nearly all matters relating to deep-sea investigations of zoology on the Atlantic coast, a connection that was undoubtedly strengthened by the warm personal friendship existing between Professor Louis Agassiz and Professor Peirce, then Superintendent of the Coast Survey. The full discussion of these explorations is given in connection with the work of the Coast Survey, and we need but briefly refer to them here.

The Hassler Expedition, during 1871–'72, in which Professor Louis Agassiz participated, obtained important results. With reference to the causes which led to it, Professor Agassiz wrote, in 1872, as follows:

"About two years ago, Professor Peirce, Superintendent of the United States Coast Survey, found it necessary to build a vessel especially for the work of the survey on the Pacific Coast. When she was nearly ready for sea, it occurred to the superintendent that it was a pity to send her empty around the continent, the more so since a great part of her track would be especially interesting for scientific research. He proposed to me to join the vessel with some assistants, and to make such explorations as might not interfere with the progress of the voyage and with the regular work of the survey. At the same time he appointed Count de Pourtales, whose dredgings in the Gulf of Mexico have had such valuable results for science, to take charge of the dredging operations for the whole voyage."

The expenses of the scientific party, consisting of Professor Agassiz, Count Pourtales, Dr. Steindachner, and Mr. J. H. Blake, were entirely paid by private subscriptions from patrons of the museum. The course of the expedition was southward along the Atlantic coast and northward along the Pacific coast of America, to San Francisco, California. Dredgings were made at intervals, and numerous collections were obtained from the surface and from the shore, wherever the vessel touched.

In 1877 began the interesting series of explorations by the Coast Survey steamer Blake, under Commanders Sigsbee and Bartlett, in which Mr. Alexander Agassiz, assisted by Mr. S. W. Garman, had the direction of the natural history operations. The cost of the collecting outfit was entirely defrayed by Mr. Agassiz. During the several cruises, which terminated in 1880, the methods of deep-sea dredging were entirely revolutionized, mainly through the suggestions of Mr. Agassiz, who was the first to recommend the use of iron wire dredge rope.

During March and April, 1881, under the same auspices, Mr. A. Agassiz, assisted by Mr. J. Walter Fewkes, explored the Tortugas, Florida. It had been Mr. Agassiz's intention, by means of a small steam launch placed at his disposal, "to explore the surface fauna of the Gulf Stream, and ascertain the part taken by the innumerable surface organisms in building up the base (plateau) upon which the coral reefs of Florida have been raised." Stormy weather, unfortunately, greatly interfered with this undertaking, but many good results were obtained.

Dr. G. A. Maack, an assistant in the museum, as naturalist and geologist of the United States Darien Exploring Expedition, during 1870–'71, made large collections of shells, in addition to his other work.

In this connection may be mentioned the conchological studies of Mr. John Anthony, an assistant of the museum, which date back to before 1840. By his own dilligent labors he had amassed an exceedingly large collection of shells, mainly from the fresh waters of the United States, which are now in the possession of the museum.

In 1873, the Penikese summer school of natural history was established under the auspices of the museum, through a liberal gift of Mr. Anderson, of New York. The Island of Penikese, on which the school was located, is situated at the mouth of Buzzard's Bay, on the east side, in a region moderately rich in marine life. Although the primary object of the school was the instruction of teachers in natural history subjects, some original investigations were carried on. Soon after the death of Professor Louis Agassiz, however, the school was discontinued.

In 1875, Mr. Alexander Agassiz, accompanied by Mr. S. W. Garman, visited various portions of the west coast of South America, from Valparaiso to Lima, mainly for the purpose of making zoological collections. The principal object of the explorations was the investigation of the fauna of the high plateau, on which Lake Titicaca is located. The lake was dredged to a depth of 154 fathoms and many temperature observations were taken. The fauna of the lake was found to be very meager, but the paucity of life was to a large extent explained by the observations made.

In 1877, Mr. Alexander Agassiz built, at Newport, Rhode Island, one of the most favorable sites on the New England coast, a sea-side zoological laboratory, for his own use and that of advanced students in biology from the museum and the public schools of the State of Massachusetts. While the accommodations are sufficient for only about half a dozen students, they are very perfect and permit of the most delicate observations on living forms from the surrounding waters.

This laboratory is occupied every summer, and many valuable series of observations have already been carried on there and published. Concerning the motives which prompted Mr. Agassiz to establish this laboratory, he says: "Ever since the closing of the school at Penikese, it has been my hope to replace, at least in a somewhat different direction, the work which might have been carried on there. It was impossible for me to establish a school on so large a scale; but I hope, by giving facilities each year to a few advanced students from the museum, and teachers in our public schools, to prepare, little by little, a small number of teachers, who will have had opportunities for pursuing their studies, hitherto unattainable."

The Portland Society of Natural History, Portland, Maine.—Local collections of marine zoology made by different parties, including Dr. J. W. Mighels, from 1840 to 1844, and Mr. C. B. Fuller in more recent years.

Essex Institute and Peabody Academy of Natural Science, Salem, Massachusetts.—The Essex Institute is an establishment of long standing, and, before the organization of the Peabody Academy, paid much attention to the study of local zoology. Dr. Henry Wheatland, one of its oldest officers, was also one of the earliest dredgers on the New England coast, his operations dating back to about 1838–'40. The Peabody Academy, which later absorbed the natural history section of the Essex Institute, has been one of the most active societies in the country in matters relating to marine zoology, and soon after it was started had the support of an able corps of workers, among whom may be mentioned Professors F. Putnam, A. S. Packard, jr., A. Hyatt, and E. S. Morse, Mr. J. H. Emerton, and Mr. Caleb Cook. Its work has been mainly limited to the New England coast, but its museum contains valuable collections of zoology from many parts of the world.

Boston Society of Natural History.—This is one of the oldest institutions of its character in the country, and with the liberal support accorded it has always been able to exert a favorable influence on scientific investigations, at home and abroad, both by the fitting out of collecting expeditions and the purchase of collections. We are unable to give anything like a complete list of the work accomplished under its auspices, and will only mention the names of a few aquatic zoologists, who, as members of the society, have been engaged in important investigations. Among the earlier members were the conchologists J. P. Couthouy and A. A. Gould, the former having been most actively engaged about 1836 to 1838 (and from 1838 to 1842, as a member of the scientific corps of the Wilkes Exploring Expedition), the latter from about 1838 to 1845. Dr. Gould, however, continued at work on important conchological reports, up to the time of his death, some twenty years later. Dr. W. O. Ayers made many collections of marine invertebrates and fishes from 1851–'53. and Dr. D H. Storer, the author of an important work on the fishes of Massachusetts, continued in active service from 1838 to 1867.

In more recent times, Professor Alpheus Hyatt, custodian of the society, has made many annual collecting trips to different parts of the New England coast, having been associated with the United States Fish Commission during several summers. In 1874, Dr. Edward Palmer made for the society the largest and finest collection of the horny sponges of the Bahamas and Florida ever brought to this country. The Labrador expedition of Dr. A. S. Packard, jr., in 1860, for the purpose of studying the marine fauna of Southern Labrador, in the vicinity of Caribou Islands, may also be mentioned here, as it was conducted partly under the auspices of this society, which received a large share of the collections made. The society's museum is very large, and contains many valuable type collections of aquatic animals.

The Lyceum of Natural History of New York.—Conchological researches of Amos Binney and W. G. Binney, Thomas Bland, Sanderson Smith, William Cooper, Temple Prime, and Charles M. Wheatly, and general marine invertebrates by James E. DeKay.

American Museum of Natural History, New York.—But few explorations have been undertaken by this museum, which has, however, accumulated by purchase and donation several valuable type collections, including the famous Jay collection of shells.

The Academy of Natural Sciences of Philadelphia is another institution to which the same remarks made regarding the Boston Society of Natural History would apply, and its museum possesses many valuable types of aquatic animals. Many of its earlier members, one or two being still living, were pioneers in aquatic research in this country, and their works are now classical. Among these were Rafinesque, during the first part of the century; Thomas Say, the marine zoologist, about 1817–'22; C. A. Lesueur about 1816–'21; T. Conrad, the conchologist, from 1837–'68; Isaac Lea, the chief authority on North American *Unionidæ*, and Dr. Joseph Leidy, who has collected and published extensively on marine invertebrates and Rhizopods.

The Elliott Society of Charleston, South Carolina, has counted among its active members Dr. L. Ravenel and Professor Lewis R. Gibbes, both of whom have made many contributions on marine zoology.

The Chicago Academy of Science, prior to the disastrous fire of 1871, by which it was seriously crippled, and lost its entire collections, had taken a prominent stand in marine and fresh-water researches, mainly through the active explorations of Dr. William Stimpson, whose exploits are described in other connections. Several winters were spent on the Florida Reefs by Dr. Stimpson, about 1870, in the sole interest of the society, and the same naturalist also explored Lake Michigan. More recently Dr. Velie has given much attention to the collecting of Florida fishes under the auspices of the society.

California Academy of Sciences, San Francisco.—Conchological researches and collections of Professor R. E. C. Stearns, and miscellaneous marine collections by William Gabb, W. N. Lockington, and W. G. W. Harford.

Private Collectors.—Among independent private collectors of note have been Colonel E. Jewett, who explored the coasts of Florida, Panama, California, etc.; Mr. James Lewis, fresh-water conchologist; and Mr. J. H. Linsley and Mr. J. H. Trumbull, who collected and published on the shells of Long Island Sound, about 1845.

COLLEGES.

Among the many colleges which have carried on aquatic explorations to a greater or less extent may be mentioned the following:

Bowdoin College, Maine.—Explorations in marine zoology on the western coast of Maine.

Williams College, Massachusetts.—Expedition to Labrador and Greenland in 1860, and to Florida, and expedition of Professor James Orton to the Amazonas and west coast of South America, in 1867.

Amherst College, Massachusetts.—Conchological researches of Professor C. B. Adams in Jamaica, other West India Islands, and Panama, and in the vicinity of New Bedford, Mass.

Brown University, Rhode Island.—Collections of Mr. J. W. P. Jenks; explorations of Professor A. S. Packard, jr., in connection with Government expeditions.

Yale College, Connecticut.—The early researches of Professor James D. Dana prior to 1838, and from 1838 to 1842, as naturalist on the Wilkes United States exploring expedition. Since completing his classical reports on the crustacea and zoophytes obtained by this expedition, about 1858, Professor Dana has devoted himself entirely to geological studies. During the summers of 1864, 1868, and 1870, Professors A. E. Verrill and S. I. Smith collected for the college at Eastport, Maine, both on the shore and by dredging. Several students of the college participated in these explorations, which resulted in rich accessions to the college museum. Zoological investigations have been carried on continuously in Long Island Sound, about New Haven. One of the most important of these was by Mr. Geo. H. Perkins, who collected and published on the shells of this vicinity. Since 1870, Professors Verrill and Smith and Mr. Oscar Harger have been connected with the exploring work of the United States Fish Commission, the first named being in immediate charge of the dredging operations. Important explorations were carried on for the college by Mr. F. H. Bradley, on the west coast of Central and South America, from 1866 to 1867, and by Mr. James Peterson in the vicinity of La Paz, Lower California, from 1868 to 1870. The collections made by these two parties were enormous, and especially rich in mollusks, corals, Echinoderms, and Crustacea.

Wesleyan College, Connecticut.—Explorations of the marine fauna of Bermuda, by Mr. G. Brown Goode, in 1872 and 1877, the latter year in company with Professor W. N. Rice, and of the Saint John's River, Florida, for fresh-water fishes, by Mr. Goode, in 1874; collecting trip to the Grand Banks of Newfoundland, on behalf of the United States Fish Commission, by Mr. Henry Osborn, in 1878, and by Dr. F. V. Hamlin to Bermuda, in 1881.

Cornell University, New York.—Brazilian explorations of Professor Charles Fred. Hartt, partly under the auspices of the college, from 1867 to 1871. In 1874 Professor Hartt was appointed chief of the Geological Commission of Brazil, in recognition of his intimate knowledge of the natural features of that country, and retained that position up to the time of his death, in March, 1878. The plan of the survey included a thorough investigation of the marine and fresh-water fauna, and especially of the coral reef region, which presents many novel and interesting features. Extensive collections of marine and fresh-water animals of all kinds were made and taken to Rio de Janeiro, where they now form a part of the Brazilian National Museum. Preliminary reports have already been published regarding a portion of them. The zoological materials of Professor Hartt's private expeditions to Brazil are now at Cornell University. They have been fully described in published reports.

Union College, New York.—Studies and very extensive collections of marine annelids on the coasts of New England, New Jersey, and Virginia, by Professor H. E. Webster, from 1871 to date, assisted by Mr. J. E. Benedict, from 1878 to date. From 1871 to 1873, Professor Webster was a member of the exploring party of the United States Fish Commission.

Vassar College, New York.—Collecting trips of Professor James Orton to the Amazonas and west coast of South America.

Rochester University, New York.—Rare collection of foreign animals obtained by Pro fessor H. Ward.

Princeton College, New Jersey.—Anatomical and embryological investigations of marine animals.

Johns Hopkins University, Maryland.—Anatomical and embryological researches of W. K. Brooks, E. B. Wilson, H. J. Rice, and others, at the mouth of Chesapeake Bay, and at Beaufort, North Carolina. Many valuable embryological studies of economic marine animals, for industrial purposes, have been conducted at this young institution, especially by Professor Brooks.

University of Indiana, and Butler University, Indiana.—Ichthyological explorations of the rivers and sea-coasts of the United States and Western Mexico, by Professor D. S. Jordan and Mr. C. H. Gilbert. In 1880 and 1881, Messrs. Jordan and Gilbert explored the west coast of the United States, from Puget Sound to, and including, the northwestern part of Mexico, in the interest of the United States Fish Commission, making enormous collections of fishes, including many new species and genera. The private explorations of these two gentlemen have been mainly confined to the fresh waters of Indiana, Kentucky, Tennessee, South Carolina, and Georgia, and the coast of the Gulf of Mexico. In 1878, Professor Jordan, with Mr. A. W. Brayton, made a large collection of marine fishes in the vicinity of Beaufort, North Carolina.

The collection of fishes of Jordan and Gilbert, at the Indiana University, is one of the largest and finest in the country, and contains an exceedingly large number of types. Professor O. P. Hay, of Butler University, has recently obtained and described many species of fishes from the Mississippi River.

NOTE.—The descriptive matter contained in the following catalogue has been partly made up directly from the objects, and partly taken from published and unpublished reports. The description of the steamer Albatross was furnished by Lieutenant-Commander Tanner, United States Navy, and many of those regarding the appliances used by the Coast Survey have been supplied by Commander Sigsbee, United States Navy.

DESCRIPTIVE CATALOGUE OF THE COLLECTION ILLUSTRATING RECENT SCIENTIFIC INVESTIGATIONS OF THE SEA AND FRESH WATERS.

VESSELS EMPLOYED IN MARINE EXPLORATIONS.

Steamer Albatross, of 400 tons net measurement, built expressly for all classes of marine exploration, and intended especially for investigating the off-shore fishing grounds of the United States. Represented by a model, photographs, and plans.

United States Fish Commission.

The United States Fish Commission steamer Albatross is an iron twin-screw steamer, designed by Charles W. Copeland and built under contract with the United States Government, in 1882, by the Pusey and Jones Company, of Wilmington, Delaware.

The vessel was designed and constructed for the purpose of deep-sea exploration. The hull is so modeled as to go astern safely in a sea-way while sounding and dredging. The rudder and its attachments are of extra strength, and, in addition to the hand and steam steering gear in the pilot-house, there is a powerful screw gear attached directly to the rudder head, a heavy iron tiller on the poop-deck for relieving tackles, and the usual rudder chains. The type of machinery and the various appliances were selected with a view to the special work for which she is intended. She is rigged as a brigantine carrying sail to a foretop-gallant sail.

Her general dimensions are as follows, viz: Length over all, 234 feet; length at 12-foot water-line, 200 feet; breadth of beam, molded, 27 feet 6 inches; depth from top of floors to top of deck-beams, 16 feet 9 inches; displacement (on 12-foot draft), 1,000 tons; register tonnage (net), 400 tons.

There are six transverse iron bulkheads, and six water-tight compartments.

Of the structures which rise above the main rail, the poop-cabin extends 30 feet forward of the stern-post, is the whole width of the vessel, and 7 feet 3 inches in height from deck to deck. It contains two state-rooms, bath-room, pantry, &c.

The deck-house is 83 feet in length, 13 feet 6 inches wide, and 7 feet 3 inches high from deck to deck. It is built of iron from the funnel aft, and sheathed with wood inside and out, with iron storm-doors; but from the funnel forward, it is of wood. Beginning aft in the iron house, the following apartments have been set off, viz: 1st, entrance to ward-room stairway; 2d, upper engine-room; 3d, galley; 4th, steam drum room. In the wooden part: 1st, four state-rooms for civilian scientific staff. 2d, upper laboratory, 14 feet in length, the width of the house, and lighted in daytime by two windows and a door on each side and a skylight overhead. This room contains a central work-table, three hinged side-tables, a sink with alcohol and water tanks attached, wall-cases for books and apparatus, and the medical dispensary. 3d, chart-room, the width of the house, 8 feet 6 inches in length, containing chart-table, lockers for charts, book-shelves, berth, sofa, &c., and communicating with the pilot-house by a door in the forward bulkhead. 4th, pilot-house, 8 feet in length, the whole width of the deck-house, with elliptical front and glass windows, hung with balance weights and protected by strong wooden storm-shutters. The pilot-house projects 3 feet above the top of the deck-house, with which it communicates by two windows.

The top-gallant forecastle is 44 feet in length and 6 feet 3 inches in height, from deck to deck. The anchors, which are stowed on this deck, are handled by a single fish-davit, common to both, and a steam capstan. On the port-side, near the after end, is the Sigsbee deep-sea sounding machine.

Under the top-gallant forecastle are water-closets for officers and crew, men's bath-room, lamp-room, paint-locker, steam windlass, &c. There are two scuttles under this deck, one giving access to the store-rooms, magazine, &c., forward of the collision bulkhead, the other, to the berth deck, for use in bad weather. The forehatch also gives access to the berth-deck, which extends 40 feet fore and aft, is 7 feet 10 inches in height between decks, and comfortably fitted for the accommodation of the crew. Opening from the after end of the berth-deck is the steerage, provided with four double-berth state-rooms and a mess-room.

Abaft the steerage, but separated from it by an iron bulkhead, is the "lower" laboratory immediately below the "upper" laboratory, through which only can it be entered. This room extends quite across the ship, is 20 feet long, 7 feet 10 inches in height between decks, and is lighted in daytime by six 8-inch side lights, two 12-inch deck lights, and the hatch at the head of the stairway. Ample storage cases and lockers are provided for alcohol, jars, and specimens; long work-tables are placed on each side; in one corner is a large lead-lined sink with running water; in another, a photographic dark-room; and, across the after end, the chemical laboratory.

Below this room is the store-room, a closed iron box capable of being isolated from the rest of the ship and filled with steam at short notice, in case of fire. Here are stowed alcohol, specimens, nets, &c., for which lockers have been provided.

The vessel is propelled by twin screws, 9 feet in diameter and 14 feet 10 inches mean pitch. They are driven by two compound engines with two cylinders each, the high-pressure cylinders 18 inches and the low-pressure 34 inches diameter of bore, and 30 inches stroke of piston.

The condenser is common to both engines and forms their framing. The upper ends of the cylinders are drawn inboard over the condenser, making the engines slightly inclined.

The condenser has an aggregate of 2,150 square feet of condensing surface. There are two horizontal air-pumps, an independent circulating pump, two main feed-pumps, and two auxiliary pumps, which can be used as feed-pumps for fire purposes, or for bilge-pumps.

There are two overhead return-flue boilers, 8½ feet in diameter, 21½ feet long, with 93 square feet of grate surface, a steam chimney 7 feet 4 inches in diameter outside and 14 feet high above the shell.

The ward-room, next aft of the engine department, has eight staterooms with bath-room and pantry. The navigator's, paymaster's, and ward-room store-rooms are in the hold below these quarters. In the fore hold are the water-tanks, bread-room, sail-room, steerage and engineers' store-rooms, cold-room, and ice-house. Forward of the collision bulkhead are the boatswains' and dredging store-rooms, the magazine, &c.

The special engines of the ship are as follows, viz:

A Providence steam windlass and capstan, built by the American Ship Windlass Company, of Providence, Rhode Island.

A hoisting engine for dredging, on the spar-deck forward of the foremast; a reeling engine on the berth-deck below the former for reeling up the dredge-rope. Both were built by Copeland & Bacon of New York.

Higginson & Company's steam quartermaster, built by the Pusey and Jones Company, is placed in the pilot-house and can be used either as a hand or steam steering gear.

Wise's steam motor attached to a Sturtevant exhaust-fan for ventilating the ship.

Ash hoister, designed by Passed Assistant Engineer G. W. Baird, United States Navy.

Svedberg's marine governors attached to the main engines.

Edison's dynamo and engine for electric lighting.

Heat is provided by steam radiators in all inhabited parts of the ship.

Ventilation is secured by means of conduits leading to all parts of the ship, through which air is drawn by the exhaust fan above mentioned, which is placed on a platform in the fire-room and arranged to discharge downward in the direction of the furnaces.

Light is provided by 120 8-candle B lamps of the Edison incandescent system, and a Z dynamo driven by an Armington and Sims high-speed engine. These lamps are distributed to all parts of the ship, including holds and store-rooms, and there are twelve lamps outside for lighting the deck.

In the laboratories the lamps are especially numerous and quite sufficient for any probable needs. An arc lamp of great power, designed by Dr. O. A. Moses, to work in circuit with the Edison incandescent system, is used for illuminating the surrounding surface of the sea. A powerful submarine lamp is also provided, which can be lowered to any depth not exceeding 1,000 feet, to be used in deep-sea exploration.

Among the various appliances the following may be briefly mentioned, viz: the Sigsbee deep-sea sounding machine, sounding rods, water cups, and gravitating trap for collecting specimens at known intermediate depths, built by D. Ballauf, Washington, D. C.; Tanner's sounding machine for depths under 1,000 fathoms and for navigational purposes; the dredging boom, 36 feet in length and 10 inches in diameter, the heel pivoted to the forward part of the foremast, 7 feet 2 inches above the deck; the dredging block at the boom end, the sheave and register at the heel of the boom for indicating the length of dredge rope out, and the accumulator at the foremast head, arranged to prevent jerking strains on the rope (the accumulator used is of the form recommended by Commander Sigsbee, United States Navy); the Negretti and Zambra deep-sea thermometers, with the Bailie and Tanner improved cases; the Chester rake dredge; the well known beam trawl; the deep-sea trawl; the Chester towing net; the tangles, table sieve, seines, trawl lines, &c.,

INDEX TO THE DETAILED PLANS OF THE STEAMER ALBATROSS.

POOP-HOUSE AND FORECASTLE DECKS.

1. Forecastle.
2. Wooden bitts.
3. Fish-davit.
4. Capstan (connected with steam-winch).
5. 3-inch rifled howitzer.
6. Sigsbee deep-sea sounding machine.
7. Top of pilot-house.
8. Top of deck-house.
9. Bridge.
10. Sky-light over chart-room and laboratory.
11. Whale-boat.
12. Seine-boat.
13. Standard compass.
14. Smoke-stack.
15. Ventilator to fire-room.
16. Sky-light over drum-room and galley
17. Steam gig. (Herreshoff.)
18. Steam launch. (Herreshoff.)
19. Engine-room sky-light.
20. Dingey.
21. After-compass.
22. Mainmast.
23. Main-boom.

24. Bridge from poop to top of deck-house.
25. Poop-deck.
26. Cabin sky-light.
27. Iron bitts.
28. Screw steering-gear.

MAIN DECK.

29. Paint locker.
30. Chain cables.
31. Stopper for chain cable.
32. Compressor for steel-wire hawser.
33. Steam-winch.
34. Forecastle pump.
35. Lamp-room.
36. Bath-room for steerage officers.
37. Round-house.
38. Iron bitt.
39. Fore-hatch.
40. Hoisting-engine.
41. Dredging-boom.
42. Dredge-rope rove for use.
43. Tanner sounding-machine.
44. Foremast.
45. Ship's bell.
46. Pilot-house.
47. Steam or hand steering-gear.
48. Binnacle.
49. Signal-locker.
50. Deck-lights.
51. Chart-room.
52. Steam heater.
53. Chart table.
54. Wash-stand.
55. Chronometer chest and lounge.
56. Bunk.
57. Bunker plate and coal chute.
58. Upper laboratory.
59. Hatch to lower laboratory.
60. Work table for naturalists.
61. Dispensary case.
62. Book case.
63. Sink.
64. Steam heater.
65. Naturalists' state-rooms.
66. Bunk.
67. Wash-stand.

68. Bureau.
69. Steam drum.
70. Ash chute.
71. Ventilators for fire rooms.
72. Iron grating.
73. Galley.
74. Dresser.
75. Baird distiller.
76. Upper engine room.
77. Iron bitts.
78. Ward-room companion way.
79. Ward-room skylight.
80. Commanding officer's cabin.
81. Cabin pantry.
82. Captain's office.
83. State-room.
84. Bunk.
85. Bureau.
86. Wash-stand.
87. Lounge.
88. Sideboard.
89. Table.
90. Steam heater.
91. Bath-room.
92. Rudder-head.
93. Water-tank.
94. Silver closet.
95. Linen closet.

BERTH DECK.

96. Yeoman's store-room.
97. Fore passage.
98. Dredging store-room.
99. Brig.
100. Chain pipes leading to chain lockers.
101. Water-tight iron bulkhead.
102. Hatch to ice box.
103. Air port.
104. Bag rack.
105. Hatch to fore-hold.
106. Steam heater.
107. Reeling engine.
108. Spring accumulator and automatic stop-valve.
109. Steerage.
110. Steerage-rooms.

111. Bunk.
112. Bureau.
113. Wash-stand.
114. Table.
115. Cupboard.
116. Water-tight iron bulkhead.
117. Lower laboratory.
118. Lockers for specimen bottles.
119. Steam-heater.
120. Sink.
121. Table.
122. Photographer's dark room.
123. Coal chutes.
124. Air ports.
125. Coal bunkers.
126. Boiler.
127. Fan-blower for ventilating the vessel.
128. Iron grating.
129. Main engines.
130. Dynamo machine (Edison).
131. Ward-room companion ladder.
132. Ward-room pantry.
133. State-room.
134. Bureau.
135. Wash-stand.
136. Bunk.
137. Ward-room.
138. Table.
139. Steam-heater.
140. Lounge.
141. Iron water-tight deck.
142. Bath-room.
143. Cabin store-room.
144. Quadrant-room.
145. Ventilating-pipe.
146. Quadrant of rudder.

HOLDS.

147. Magazine.
148. Magazine passage.
149. Fore-peak.
150. Ventilating-pipe with branches.
151. Keelson.
152. Keel.
153. Chain-locker.
154. Water-tight iron bulkhead.

155. Ice-box.
156. Cold room.
157. Upper hold
158. Lower hold.
159. Steel wire hawser reel
160. Store-rooms.
161. Fresh-water tanks.
162. Water-tight iron bulkhead.
163. Laboratory store-room.
164. Ballast-room and sinkers.
165. Water-tight iron bulkhead.
166. Coal bunker.
167. Boiler leg.
168. Fire-room.
169. Lower engine-room.
170. Water-tight iron bulkhead.
171. Ward-room store-room, and shaft alleys.
172. Water-tight iron bulkhead.
173. Paymaster's store-room.
174. Equipment store-room.
175. Propeller shaft.
176. A-frames for propeller shaft.
177. Propeller.
178. Rudder.
179. Rudder-chains.

Steamer Fish Hawk, 205 tons measurement; built for fish hatching and scientific investigations near the coast. Represented by models and photographs.

United States Fish Commission.

The United States Fish Commission steamer Fish Hawk is a twin screw propeller of 205.71 tons measurement, is rigged as a fore-and-aft schooner, with pole topmasts, and was constructed for the combined purposes of fish hatching and dredging. She was designed by Mr. Charles W. Copeland, consulting engineer of the United States Light-House Board, and was completed in the spring of 1880. The Pusey and Jones Company, of Wilmington, Delaware, were the builders. The work of fish hatching necessitates her entering, at times, the shallow waters of rivers, bays, and sounds along the coast, and she has, therefore, been given a light draft, which unsuits her for long trips at sea, distant from land. "The hull below the main deck is of iron, built on Lloyd's rules for vessels of her class, and sheathed with yellow pine, from 2½ to 3 inches thick, calked and coppered. Above the main deck the structure is of wood. There is a hurricane deck extending from stem to stern, and side to side, on which are located the pilot house, captain's quarters, and laboratory." The general dimensions of the vessel are as follows:

	Feet.	Inches.
Length from rabbet to rabbet, on the seven-foot water line	146	6
Length over all	156	6
Breadth of beam molded	27	
Depth of hold amidships	10	9
Shear forward	4	4
Shear aft	1	9
Mean draft	6	$5\frac{1}{2}$

Hold.—There are five iron bulkheads, all of which, with one exception, are water-tight. In the hold, abaft the collision bulkhead, are two ice-houses, about 10 feet square. Forward and aft of these are several store-rooms, including two for natural history purposes. Next aft is the steerage, having a length of 15 feet. Under the steerage and store-rooms is the forehold, $32\frac{1}{2}$ feet long, and containing the water tanks, having a capacity of 800 gallons. The boilers, coal bunkers, fire-room, and engines are located between bulkheads Nos. 3 and 4, abaft of which is the lower cabin, 26 feet long, with seven open bunks on each side, and including the dispensary, a linen room, pantry, and store-room. Still further aft, in the stern of the ship, is a cabin store-room, entered through a scuttle in the main deck.

Main deck.—The forecastle extends 31 feet aft from the stem, and is succeeded by the main or hatching deck, which is 47 feet long. The latter has on each side a gangway port abreast of the foremast, 6 feet wide and extending from deck to deck, and four large swinging ports. The boiler hatch occupies the after part of this deck, and is raised about 9 inches above it. On the hatch are placed the donkey-pump and distributing tanks for the hatching apparatus, which is arranged around it. When engaged in dredging, the hatching apparatus, excepting the pump, is entirely removed from this deck, and it becomes the working quarters of the naturalists. The beam trawls and dredges, which are manipulated from the upper deck, are passed in at the gangway port on the starboard side, their contents emptied into sieves and washed, and then transferred to swinging tables, where they are sorted, examined, and studied. The arrangements for this class of work are very convenient, and the working space ample. With all the ports open on both sides, the deck receives an abundance of light. The donkey-pump is used for washing the materials emptied into the sieves.

Abaft the hatching deck come the donkey boiler room and galley, the engine-room and cabin pantry, and finally the cabin, followed by the small after deck in the stern, which is about 14 feet long. The cabin is abaft the engine-room, is 30 feet long, and has four rooms on a side, with one bunk in each.

Aft, on the starboard side, is the Fish Commissioner's office. The lower cabin companion-way is amidships, and a bath-room and closet on the port side.

Hurricane deck.—Forward of the foremast are the hoisting and reeling engine, and the dredging boom, the heel of which is attached to the mast. Abaft the mast, in succession, come the booby-hatch, covering the entrance to the main deck, the pilot-house, and captain's quarters. Then follow the funnel, engine-room skylight, and deck laboratory, which latter measures about 10 by 12 feet, has seven windows and one door, and is fitted up for microscopic work and study. Aft of the laboratory the deck is occupied only by the mainmast, cabin sky-light, compass, and rudder-head.

Motive power.—As before stated, the Fish Hawk is furnished with two propelling screws, right and left handed, one under each counter, which enable her to turn around almost within her own length. The double screw arrangement also greatly facilitates the handling of the vessel when dredging. Each screw is driven by one inverted cylinder surface-condensing engine, 22-inch diameter of cylinder, and 27-inch stroke of piston.

Boats.—There are four small boats, one of which is a steam cutter, of the Herreshoff pattern, with a coaling capacity for twenty-eight hours' steaming, at 6 knots per hour.

Hoisting engine.—The hoisting engine used for dredging purposes is of the trunk pattern, and was manufactured by Messrs. Copeland and Bacon, of New York. It has two cylinders, 8½ inches in diameter and 9 inches stroke of piston, with cranks at right angles. It is fitted with the common D slide valve worked by the Stephenson link. The main shaft is forward of, and parallel to, the crank shaft, the two being connected by means of gearing. Upon the main shaft is a loose drum, holding 1,000 fathoms of three-eighth inch steel wire rope, which can be thrown in and out of action by means of a friction clutch. On each end of this shaft there is a small fixed drum used for ordinary hoisting purposes. There is also a friction brake for holding the load on the main drum, and an automatic guide for coiling the wire neatly upon the drum. Steam may be used either from the main or auxiliary boiler, and exhausts into the escape pipe of main safety valve. The wire, after leaving the drum, passes over a pulley at the masthead, returning under another in the heel of the hoisting boom, through one at the outer end of the boom, and thence to the bridle of the trawl. There is attached to the pulley at the masthead an accumulator for relieving sudden strains upon the rope. One man attends the engine, hoisting and lowering the trawl or dredge without the necessity of touching the rope by hand.

Dredging boom.—"The dredging boom is 36 feet long and 10 inches in diameter; the heel is secured to the foremast by a strong gooseneck, 5 feet above the deck. The forward end, when not in use, rests in a cradle on an iron frame, in which the ship's bell is suspended. There is an iron band at the boom end for fore-and-aft guys. The topping-lift band is about 3 feet from the end, and has a strong link on the under side, to which is hooked the dredging block. The topping lift is composed of two 14-inch double blocks and a 4-inch manila rope. The upper block is shackled to an iron collar on the foremast, 3 feet below the eyes of the rigging. There is a strong sheave in the boom, inside of the lower topping-lift block, over which is rove the pendant of a a tackle, used for hoisting the bag of the trawl on board, when the weight is too great to be managed by hand. A composition sheave is inserted in the heel of the boom, two revolutions of which are equal to one fathom of dredge rope, and attached to its shaft is a register which accurately records the amount of rope out at all times." The accumulator, dredging blocks, safety hooks, wire rope, &c., belonging to the dredging gear of the Fish Hawk, are described further on.

Preparations for dredging.—"The rope being on the reel, the end is passed between the rollers of the automatic guide, carried aloft and rove through the block on the lower end of the accumulator, brought down again and rove under the registering sheave in the heel of the boom, thence through the dredging block at the boom end, and spliced into the eye of the safety hooks. The boom is then topped up, and secured over the side port by strong fore-and-aft guys, the trawl shackled to the safety hooks and swayed up clear of the rail, a man at each end to steady it, an engineer at the hoisting engine, and an officer in charge, ready at the order to lower away."

Sounding machines.—The principal sounding machine (Tanner's pattern) is supported in the rail on the port side of the forward hurricane deck, and a smaller machine of the same pattern is mounted at the stern.

The steamer Fish Hawk has been used for dredging purposes during the summer months of the past three years, and has accomplished very important results, notwithstanding the fact that it has been deemed best not to trust her more than twelve hours' sailing from land. Her principal field of exploration has been the inner edge of the Gulf Stream slope, off the southern coast of New England, down to depths of over 700 fathoms. She has been supplied with all the most improved kinds of dredging and trawling apparatus, and has made continuous series of careful temperature and density observations over the entire area of her operations.

LIST OF PHOTOGRAPHIC VIEWS, ILLUSTRATING THE DREDGING AND SOUNDING APPLIANCES OF THE STEAMER FISH HAWK.

PLATE 1. The forward part of the steamer, side view, with the dredging boom in position for use and the beam trawl ready for lowering.

PLATE 2. Forward deck, looking forward from the port side of the pilot house, showing the hoisting engine, and the dredging boom resting in the cradle.

PLATE 3. The hoisting engine on the forward deck, seen from in front, with the reel partly filled with wire dredge-rope. The register for recording the amount of rope out is seen at the base of the dredging boom, which is lowered. The pilot house occupies the background.

PLATE 4. Starboard side of the forward main deck, looking aft, as arranged for the use of the naturalists while dredging. The table sieve stands in the foreground, and the swinging work table, with bottles and dishes, is seen beyond it.

PLATE 5. The after part of the hurricane deck, with the dredging apparatus distributed over it, and the sounding machine in position at the stern.

PLATE 6. The table and cradle sieves dismantled on the after deck.

PLATE 7. The Tanner sounding machine complete, with metal and wooden cases for the Negretti and Zambra deep-sea thermometer attached; side view. Underneath the machine are a coil each of sounding wire, hand line, and deep-sea lead line, to show comparative sizes.

PLATE 8. The same, front view, in position for heaving in.

PLATE 9. The same, front view, in position for sounding, with the Bassnet atmospheric lead.

PLATE 10. The accumulator, Sigsbee's pattern; dredging block, and safety hooks.

PLATE 11. The safety hooks.

PLATE 12. The Negretti and Zambra thermometer; wooden case for same supplied by the makers; original metal case for same, with accessories, designed by Lieut. Z. L. Tanner, United States Navy.

PLATE 13. Hilgard's ocean salinometer.

PLATE 14. The wardroom of the Fish Hawk.

Steamer Blake, 350 tons measurement, built expressly for sounding and dredging purposes. Represented by photographic plates and plans.

United States Coast and Geodetic Survey.

"The United States Coast Survey steamer Blake was built for the special work on which she is employed. She is a screw steamer, of 350 tons O. M., 150 feet long on the load line, 26½ feet breadth of beam, and has a deep draught of 11 feet. Her engine is compound, of about 70 nominal and 270 actual horse-power, and her bunkers will hold sufficient coal for thirty-eight days' steaming. The rig is that of a fore-and-aft schooner. Aft on the main deck are spacious and well-ventilated quarters for the officers. Forward of the wardroom, on the same deck, is a continuous line of midship houses, reaching nearly to the foremast, and forming the engine-room, boiler-room, galley, pantry, draughting room, lamp-room, and mechanics' sleeping room. The arrangement of the main-deck houses leaves, on either side, a wide gangway, ventilated and lighted along its whole length through large square ports, which can be kept open at sea in any ordinary weather. Beneath a sufficiently large berth-deck, is a good-sized hold, with tanks for holding 2,500 gallons of fresh water; while under the cabin and wardroom, and accessible only from those apartments, are large store-rooms. The upper deck is flush, and gives ample room for the reception of all the necessary machinery and gear."

Sounding appliances.—The principal work of the Blake has been the taking of deep-sea soundings, for which purpose the Sigsbee sounding machine, elsewhere described, is now used for all depths below 100 fathoms. It was while in command of the Blake, from 1874 to 1878, that Lieutenant-Commander Sigsbee perfected his sounding apparatus on the Thomson principle. The position assigned to this sounding machine on the Blake, in its original form, was the port bow, as far forward as it could be set. For sounding, the vessel was laid head to the wind, with mainsail set, and the main boom amidships. The latest form of the machine, however, which permits of reeling in while steaming ahead, is placed just forward of the port fore-rigging. Here, nearly all the advantage of the former position is retained, and there is a straight lead aft for hauling in the wire as it trails astern, while the vessel has headway.

Dredging boom, &c.—The dredging boom is 47 feet long, and 14 inches in its greatest diameter, the metal fittings and fastenings being of wrought iron. The topping lift is of 3-inch manila, rove through iron-strapped blocks, made extra strong, and the pendant is of 4½-inch manila. The small block at the boom end is of a well-known commercial pattern, extra fastened. The pendants of the guys are of 2-inch wire rope, and the falls for the same of 2½-inch manila. Other special features of the dredging outfit of the Blake, all of which originated on that vessel, are wire dredge-rope, the accumulator of rubber buffers, the iron dredging blocks, double beam trawl, and deep-sea dredge. These are described in detail further on, and are shown in connection with the vessel in Sigsbee's series of plates of the Blake, exhibited.

Dredge reel, hoisting engine, &c.—The dredge reel of the Blake (plate 32) is capable of holding over 4,200 fathoms of wire dredge rope. The drum or barrel is of boiler iron, 3 feet 6 inches long by 2 feet in diameter, and is riveted to fillets on the two cast-iron side plates. The depth of the flanges above the drum is one foot. The side plates are made with spokes. The friction band is of wrought iron, lined with maple 1 inch thick. The standards are of cast iron, and the axle of wrought iron, 2⅞ inches in diameter, reduced to 2⅝ inches in the journal boxes. The friction lever is of the double-acting kind—that is, both ends of the friction strap or band are bolted to the lever, one on each side of the pivot.

The hoisting engine (plate 33) has two trunk-cylinders of the pattern known as Bacon's patent, each of 10½-inch bore and 10 inches stroke, firmly secured to the bed-plate at an angle of 45°, thereby avoiding a dead center, both being connected to the same crank-pin. The engine is provided with "link-motion," so that it may be run forward or backward, or stopped instantaneously, by the operation of the reversing-lever, which is fitted to lock in three positions. By its elastic flexure the lever, in locking, is thrown into jogs cut in the flange of the standard, against which it presses. The after lever, working in a vertical plane, as shown in the plate, is the reversing-lever.

The winch-head, which is 22.56 inches in its least diameter, to accommodate one fathom of the 1⅛-inch dredge-rope in a single turn, is keyed to its shaft, the latter working within the larger gear-wheel. It is provided with a powerful friction-brake, operated by a lever, and may be thrown in or out of gear with the engine by means of a lever, and overhauled independently. Below the brake-lever is the throttle, the wheel of which is made large that it may be turned easily and delicately with the left hand, when the right hand is engaged with the brake-lever. On the hub of the winch-head is a steel worm, to engage the gears of a register (plate 38), which indicates approximately the number of fathoms of dredge-rope payed out. On the after end of the crank-shaft, outside of the fly-wheel, is a small winch-head for general use. The pressure of steam is usually 60 pounds.

The winding-engine is of the same general description as the hoisting-engine, has two 6-inch cylinders, and is single-geared to the axle of the dredge-reel. It is fitted with reversing and clutch levers, arranged for locking in position. The engine and reel are under the control of one man.

Commander Sigsbee makes the following interesting general remarks regarding the dredge-reel: "For dredging in depths no greater than 500 fathoms, which would require no more than 1,000 fathoms of rope on the working reel, the latter might be made part of the hoisting-engine, and be geared to the crank-shaft. The advantage would be in compactness and simplicity. For general work, the plan adopted by the Blake is probably better. When the reel takes the full strain on the rope in hauling back, great strength is needed to resist the crushing force accumulated upon the drum, and to adapt a reel capable of holding 4,000 or 5,000 fathoms of rope to this strain would involve an increase in its weight by no means desirable, either for paying out rope or for planting on a vessel's deck."

The hoisting-engine and reel of the steamer Fish Hawk, which limits her dredging operations to moderate depths of water, are, as described elsewhere, combined in the manner recommended by Commander Sigsbee.

The positions allotted to the several dredging and sounding appliances on the Blake, are shown diagrammatically on plate 29, and graphically on numerous other plates.

LIST OF PLATES ILLUSTRATING THE DEEP-SEA SOUNDING AND DREDGING APPLIANCES OF THE STEAMER BLAKE DURING HER EXPLORATIONS OFF THE SOUTHERN AND EASTERN COAST OF THE UNITED STATES, FROM 1874 TO 1879.*

PLATE 1. The United States Coast Survey steamer G. S. Blake, 350 tons, fitted for deep-sea sounding and dredging.

PLATE 2. Fig. 1, Miller-Casella thermometer case, fitted with Sigbee's spring clamp. Above is shown a piece of the sounding-wire. Fig. 2, sounding-rod; a slight modification of Captain Belknap's sounding-cylinder No. 2, with Sigsbee's detacher. The construction is shown on plate 39.

PLATE 3. Fig. 1, Miller-Casella thermometer case fitted with Sigsbee's spring clamp. Fig. 2, sounding-rod; a slight modification of Captain Belknap's sounding-cylinder No. 2, with Sigsbee's detacher.

PLATE 4. Showing some of the causes, probable and real, of the occasional failures of sinkers to detach.

PLATE 5. Fig. 1, cans for observing currents. Fig. 2, sounding-lead, fitted with Stellwagen specimen cup.

PLATE 6. Showing the general form and working of Sir William Thomson's sounding-machine as used on board the Blake during her first season in the Gulf of Mexico; rigged for paying out.

PLATE 7. Experimental form of the Sigsbee machine for sounding with wire; used for three years on board the Blake; rigged for paying out.

PLATE 8. The latest form of the Sigsbee sounding-machine as now used on board the Blake; rigged for paying out. The construction is shown in plates 36, 37, and 38.

PLATE 9. The Sigsbee sounding-machine, rigged for paying out. (Second view.)

PLATE 10. The Sigsbee sounding-machine, rigged for paying out. (Third view.)

PLATE 11. The Sigsbee sounding-machine, rigged for reeling in, with the strain pulley brought into use.

PLATE 12. The Sigsbee sounding-machine folded for transportation.

PLATE 13. The Sigsbee sounding-machine in position on the Blake; run out for work; front view.

PLATE 14. The Sigsbee sounding-machine in position; run in, with the tubes lowered and the accommodation grating triced up.

PLATE 15. The Sigsbee sounding-machine in position, run out for work; side view.

PLATE 16. New steel reel for sounding with wire, devised by Lieut. Commander C. D. Sigsbee.

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*Extracted from "Deep-Sea Sounding and Dredging, a Description and Discussion of the Methods and Appliances used on board the Coast and Geodetic Survey Steamer Blake, by Charles D. Sigsbee, Lieutenant-Commander U. S. Navy; Assistant in the Coast and Geodetic Survey," Washington, 1880.

PLATE 17. Another view of the same.

PLATE 18. Plan of patent trunk reeling-engine for the Sigsbee sounding-machine to occupy the place on the bed board at present assigned to the strain-pulley, should the latter not be required. Designed by Mr. Earle C. Bacon.

PLATE 19. Water-specimen cup for getting a single specimen at each haul; independent poppet-valves. Used in the Coast Survey for a number of years.

PLATE 20. The Sigsbee water-specimen cup for getting specimens from various depths at a single haul, by using a separate cup for each depth from which a specimen is required. The construction is shown on plate 40.

PLATE 21. Fig. 1, case for the Negretti and Zambra deep-sea thermometer. Fig. 2, the Negretti and Zambra deep-sea thermometer without its case. Fig. 3, The Miller-Casella deep-sea thermometer, apart from its case.

PLATE 22. Same as above.

PLATE 23. The Negretti and Zambra deep sea thermometers in use.

PLATE 24. The Blake, at the Washington navy-yard. The dredging-gear ready for work.

PLATE 25. Fig. 1, style of dredge supplied for the first dredging expedition of the Blake. Figs. 2, 3, 4, dredge devised by Lieut. Commander C. D. Sigsbee, United States Navy, and Master H. M. Jacoby, United States Navy, and adopted for use.

PLATE 26. Fig. 1, plan of trawl as first used on board the Blake. Fig. 2, plan of trawl as improved by Prof. A. Agassiz, Lieut. Commander Sigsbee, and Lieutenant Ackley.

PLATE 27. The improved trawl ready for use.

PLATE 28. The improved trawl shown as having "tripped," after fouling with rough bottom.

PLATE 29. Plans of the deck and apparatus of the Blake.

PLATE 30. View of the Blake's deck, looking forward from the bow of the starboard-quarter boat, ready for paying out the dredge.

PLATE 31. View of the Blake's deck, looking aft from the starboard side of the pilot-house, ready for dredging.

PLATE 32. The forward side of the dredge-reel and its engine; the reel has 2,700 fathoms of the wire dredge-rope.

PLATE 33. View of the main hoisting engine from the starboard side.

PLATE 34. Figs. 1 and 2, iron snatch-block for dredge-rope. Fig. 3, improved accumulator for dredging.

PLATE 35. The plotting of a line of soundings.

PLATE 36. Detailed plans of an improved machine for sounding with wire, on the principle of Sir William Thomson, by Lieut. Commander C. D. Sigsbee, United States Navy.

PLATE 37. Continuation of plate 36.

PLATE 38. Continuation of plates 36 and 37.

PLATE 39. Detailed plans of Sigbee's detacher used in connection with a modification of Captain Belknap's sounding cylinder No. 2.

PLATE 40. Detailed plans of Sigsbee's water specimen cup.

PLATE 41. Sounding with wire; curve for correcting the reading of the register placed on the axle of the sounding reel, by Lieutenant-Commander Sigsbee, United States Navy; Commander Howell's method of splicing the wire; Lieut. Commander Sigsbee's method of splicing the wire into the "stray line."

PLATE 42. Sigsbee machine for sounding with wire; pattern of 1881. Fig. 1, rigged for reeling in by steam. Fig. 2, in temporary disuse.

PLATE 43. Sigsbee machine for sounding with wire; pattern of 1881. Fig. 1, rigged for paying out; clamps in use. Fig. 2, folded for transportation or stowage.

APPARATUS FOR COLLECTING ZOOLOGICAL MATERIALS.

Naturalists' Deep-Sea Dredge, for use from a large vessel or steamer.

United States Fish Commission.

The naturalists' dredge ordinarily employed on the American coast for all kinds of bottom, excepting those of soft mud and ooze, is of the old pattern, long since adopted both in Europe and the United States. For use from large vessels it is constructed of the following dimensions: The frame measures 2 feet long, and about 5½ inches broad inside, at the hinder end. The upper and lower sides, or scrapers, are 2¾ inches wide, and one-half inch thick posteriorly, but thin out to a sharp edge in front, and flare considerably, so that the width of the mouth between the scraping edges is about 7½ inches. The end pieces are of three-quarter-inch round iron, welded to the scrapers. The handles are 18 inches long, of three-quarter-inch round iron. Two different styles of nets are employed with this size of dredge frame, both woven of twine, one being closed at the hinder end, and the other open to permit of the contents being emptied without reversing the net. The latter form, which has given the greatest satisfaction, is made about 3 feet long, of webbing, having three or four meshes to the linear inch, and is securely tied at the hinder end before lowering. Either kind of net is covered with a bottomless bag of heavy canvas, about 3½ feet long, and attached directly to the frame. It is intended to protect the net against wear.

Naturalists' Boat-Dredge, for use from a small sail-boat, row-boat, or steam-launch.

United States Fish Commission.

The so-called boat-dredge differs from the deep-sea dredge merely in size. It is intended for use from a sail-boat or steam-launch. The frame is 18 inches long, 5½ inches wide inside, and 7½ inches wide between the scraping edges. The scrapers are one-half inch thick and 2½ inches wide; the handles are 16 inches long, and the net is 2½ feet long, with six or seven meshes to the linear inch; it is closed at the lower end, and has a canvas covering like the large dredge. The lower part of the net has a somewhat closer mesh than the sides.

Blake Dredge, for use on bottoms of soft mud or ooze, in deep water.

United States Fish Commission.

The Blake dredge was devised during the winter of 1877–'78 by Commander C. D. Sigsbee, United States Navy, and Master H. M. Jacoby, United States Navy, then attached to the United States Coast Survey steamer Blake, for use on the soft bottoms of mud and ooze which characterize the deeper waters off the coast. These officers were led to make this improvement over the old style of dredge, for the purpose stated, from the fact that the latter implement tends to fill and become clogged as soon as it falls upon a bottom of very soft materials, thereby preventing its proper working. The essential features of the Blake dredge are its broad, non-flaring scrapers, and square frame, which cause it to rest flat upon the bottom, and prevent its digging in beyond a suitable depth. It skims over the ground, and, as only a little mud enters at a time, it is being constantly washed from the net, to a greater or less extent, by the great volume of water passing through at the same time, leaving only the coarser portions and the specimens behind.

This dredge has been in constant use by the Coast Survey since its introduction, and has given entire satisfaction. As used by the Fish Commission it has been altered somewhat in size and proportions, but otherwise retains its original form. The dredge exhibited, which is furnished by the Fish Commission, has the frame 3½ feet long, 4 feet broad, and 8½ inches high, of one-half-inch round iron. The scrapers are 6 inches wide, three-fourths of an inch thick, and thin out to a sharp edge in front; they are placed parallel to each other, and at the sides are fastened to the ends of the side pieces of the frame. The handles are 20 inches long and similar in character to those of the common dredge, though differing from them somewhat in shape. The net is constructed of webbing, having a half-inch square mesh, opens at the hinder end, and projects slightly beyond the frame, to which it is tied to prevent reversing while being lowered. The frame is covered on the four sides by heavy canvas to protect the net. On the steamer Blake several weights and hempen tangles were attached to the end of this dredge, but this practice has not been followed by the Fish Commission.

Chester Rake Dredge, for obtaining marine invertebrates which burrow deeply into the bottom.

United States Fish Commission.

The rake dredge was designed for the special purpose of obtaining those species of marine animals which burrow deeply into muddy and sandy bottoms beyond the reach of the ordinary form of dredge. In its present shape, it was first constructed in 1881, by Capt. H. C. Chester, of the United States Fish Commission. It consists of a rectangular iron frame, 3 feet long by 9½ inches wide, the iron measuring 2¼ inches in breadth and one-half inch in thickness. The two longer sides of the frame are each furnished on the outer side with six stout, rake-like, iron teeth, 7 inches long, which curve forward toward the tips, where they are sharply pointed. At their bases they are of the same size as the iron of the frame, and their front edges are sharpened. The handles are similar in shape to those of the common dredge, but measure over 3 feet in length; they fasten into eyes at the corners of the frame. Back of the rake frame there is attached one of the ordinary Blake dredges, which measures 4 feet in width, and, therefore, projects 6 inches on each side of it. This is intended to receive the loosened materials as they are plowed up by the teeth. The rake dredge is simple in its working, but requires considerable power to drag it along, especially through compact sand and mud. Many species of animals, previously unknown, have been recently obtained by its use. The first rake frame employed by the Fish Commission was planned by Prof. A. E. Verrill, in 1871, and continued in use up to 1881. It consisted of a triangular frame of flat bar-iron, with straight teeth projecting from both sides of one of the bars, the drag rope being attached to the opposite angle. The net which followed it was fastened into a light rectangular frame of round iron. Another style of rake dredge, invented by Captain Chester in 1881, has the teeth attached directly to the scraping edges of an enlarged dredge frame of the ordinary pattern.

Benedict Rake Dredge, for collecting small forms of invertebrates in moderate depths of water.

United States Fish Commission.

This dredge consists of a double rake, and a cylinder of galvanized sheet-iron, 30 inches long by 11 inches in diameter, containing an elongate tapering strainer, and supported in an iron frame-work, having six runners of five-eighth inch round iron, about 4 inches high. These runners extend the entire length of the cylinder, and project behind it a distance of about 5 inches. They are arranged at equal distances apart around the cylinder, so that on whichever side it falls it is supported by two of them. The strainer is made of No. 40 brass wire cloth, is elongate, truncate-conical in shape, and has the same diameter in front as the cylinder, to which it is attached at the mouth. It tapers to a width of about 6 inches at the hinder end, where it rests against a coarse wire netting, forming the bottom of the cylinder. The mouth of the cylinder is furnished with a funnel-shaped collar of sheet-iron, opening inward, and with a short conical strainer, of coarse wire netting, projecting from in front. A bail of round iron, with a loop for the attachment of the dredge-rope, is fastened to the front end of the cylinder frame. The rake, which drags in front of the cylinder, is constructed of an oak bar, with two series of teeth on each side and a handle in front.

The teeth of the front series are straight, sharp, and rigid and those of the hinder series long, curved, and springy. The dredge line is attached to the front handle of the rake by means of marline only, passes to a ring at the hinder end of the rake, and thence to the cylinder bail, being securely fastened to both of the latter places. The object of this method of attaching the rope is to allow the marline at the front of the rake to part in case the latter becomes caught on the bottom, and permit of its being hauled up hind end foremost.

This form of rake dredge was designed by Mr. James E. Benedict, of the United States Fish Commission, for collecting small forms of marine life, and especially worms, which live unattached upon the bottom, on stones, shells, &c., and which are crushed or lost sight of in the ordinary dredge. It can only be used on comparatively smooth bottoms and in slight depths. The rake is intended to give the bottom materials a through stirring up so as to dislodge the animals, which together with the sediment formed are raised above the bottom and come into contact with the nose piece of the cylinder, only those below a certain size being able to pass in. The tapering shape possessed by the strainer gives it a very extended free surface for the outflow of water. The collar at the mouth of the cylinder being furnished with a light cloth veil, acts as a trap to prevent any reverse flow of water.

Beam Trawl, ordinary pattern for Zoological Collecting.

United States Fish Commission.

The beam trawls used by the United States Fish Commission are of the English fisherman's pattern, more or less modified to adapt them to the purposes of scientific investigation. They are made of different sizes, from 7½ to 17 feet in length of beam. The trawl exhibited is of the smallest size, and is intended for use in deep water, or in shallow water from a small vessel. The beam is a piece of iron gas-pipe, 7½ feet long and 2¼ inches in diameter, and it screws into brass strap bands on the tops of the runners, which measure 4 feet in length and 28 inches in height. The latter are constructed of flat bar-iron, 2¼ inches broad by five-eighths of an inch thick, and have a large screw-eye in front for the attachment of the bridle. To prevent the fish escaping through the runners, the openings which they form are closed by netting having a half-inch square mesh. This is fastened to an iron rod, which passes around the inner side of the runners and through brass screw-rings at intervals of 9 or 10 inches. The net is about 18 feet long, tapers gradually from the mouth toward the hinder end, and has a single pocket which consists of a slightly tapering cylinder of netting, about 5 feet long, fastened to the net by the larger end about 4 feet from the mouth; the inner end of the pocket is about 3 feet in diameter. The lead line is of 2¼-inch rope, and carries 42 small leads or sinkers. It is made very slack, and when in use trends back in the middle a distance of about 6 feet behind the hinder ends of the runners, to which it is attached. The net has two different sizes of mesh, each making up one-half of the net in length. In the front half the meshes are 1 inch square and in the lower half one-half inch square.

Larger trawls of the same construction as the above, with the beam from 11 to 17 feet long and the net from 20 to 40 feet long, are most commonly employed by the United States Fish Commission, even in considerable depths of water. The otter trawl has also been frequently tried with good success in shallow water. Wherever the common beam trawl can be used advantageously, it is much preferred to the double trawl next described. No difficulty has ever been experienced in lowering it right side up to depths of 600 and 700 fathoms, and when used on the same spot in connection with the double trawl has always yielded the better results. On very soft bottoms it tends to sink too deeply into the ground, and for this a remedy has been suggested, namely, to fasten broad and thin wooden shoes to the bottoms of the runners, but this feature has not yet been put to trial. The towing-net attachments to this trawl are described elsewhere.

Blake Trawl, or Double Beam Trawl, for use in deep water.

United States Fish Commission.

The difficulty of landing the ordinary beam trawl right side up on the bottom in considerable depths of water resulted, during the first dredging cruise of the steamer Blake, in the winter of 1877–'78, in the construction of a new form of trawl, which, like the dredge, can work equally well either side down. For this new and valuable invention we are indebted to Prof. Alexander Agassiz, Lieutenant-Commander Sigsbee, United States Navy, and Lieutenant Ackley, United States Navy. The construction and appearance of this trawl, in its original shape, are illustrated in the Sigsbee series of plates. Although the United States Fish Commission has hitherto confined its explorations mostly to moderate depths of water, where the ordinary beam trawl answers every purpose, it has frequently experimented with the double trawl, and has introduced slight modifications, mainly as regards the height of the runners, which has been increased, in order to afford a larger opening for the capture of fish. The trawl exhibited is an exact copy of the pattern recently adopted for the use of the steamer Albatross.

The runner frames form a very broad D-shaped figure, being equally curved above and below in front, and extending thence straight back to the upright hinder end, which they meet at right angles, and beyond which they project a short distance, being perforated for the attachment of the net. These frames are 4 feet long and $3\frac{1}{2}$ feet high, and are made of half-inch iron, 3 inches broad. The beams are two in number, and consist of pieces of gas-pipe, $10\frac{3}{4}$ feet long and $2\frac{1}{4}$ inches in diameter outside. They screw into brass collars at the middle of the runners, one on the inner side in front, one on the inner side at the back. The bridle, constructed of $3\frac{3}{4}$-inch rope, is attached to two screw eyes, which project from the front side of the runners. The net is 18 feet long, and is made of two thicknesses of webbing, having a 1-inch square mesh throughout. It has the same diameter at both ends, and to prepare for use is gathered in at the lower end and tied. The folds of the net, which are thus formed in tying, serve to close the mesh at the lower end and cause a small amount of mud, sufficient for examination, to be retained. A rope, measuring $2\frac{1}{4}$ inches in circumference, runs around the mouth of the net, and is laced along the hinder ends of the runners and fastened to the four hinder corners of the same. In common with the net, this rope is left sufficiently slack between the runners on both sides, so that on whichever side is uppermost it curves down just to the level of the beams and does not obstruct the lower half of the opening; the lower line naturally curves backward upon the ground. These slack portions of the rope form the lead line, and are each furnished with 16 leads, weighing about one-third of a pound each. The pocket for the net is made of the same webbing as the latter, is about 6 feet deep, and is fastened to the net about 3 feet from the mouth; it is somewhat smaller in diameter at the inner than at the outer end. To assist in keeping the net open while in use, four hollow glass balls or cork floats are fastened into it by means of a rope to which they are attached, and which is about one-third longer than the width of the net, and is seized to it on each side about 5 feet from the mouth. When the trawl is dragging on the bottom, these floats give greater buoyancy to the upper side of the net, and raise it above the ground. The escape of fish through the runner frames and between the beams, after they have been frightened by the lead-line, is prevented by means of netting, having a one-half inch square mesh. This is stretched tightly from beam to beam, and is fastened in the opening through the runners to a three-eighths-inch iron rod, extending around the inner side of the frame and passing through brass rings at intervals of 6 to 12 inches.

In the original double trawl, as used on the steamer Blake (see Sigsbee's plates), the framework differed from that above described only in its lesser height, which was 30 inches, and in lacking the iron rod within the runners for the attachment of the side netting. On the second dredging cruise of the Blake, instead of having the bridle tied to rings in front of the runners, it passed backwards along the sides of the runners and net to the hinder end of the latter, and was secured to the runners at the front beam by lashings passed through cut splices in the rope; to the runners at the rear beam by lashings taken around the rope; and to the seizing at the end of the net by lashings taken through thimbles which were turned into eye-splices. This form of bridle was intended to bring up the trawl rear end foremost, in the event of severe fouling on the bottom, the tripping being brought about by the parting of the lashings. On the same cruise another modification was put to trial. It consisted in enlarging the mouth of the net, carrying the roping (lead line) forward and making it fast to the runners at each end of the front beam. The roping was given a longer bight to trail on the ground, and the upper bight was prevented from falling and closing the mouth by netting stretched between the beams. When using the double trawl in deep water, it is customary to weight the runners and the hinder end of the net.

For rapid trawling in pursuit of fish and crustacea, Prof. Alexander Agassiz recommends a slight modification of the above trawl, in which the runners are 18 inches high in front and 24 inches high behind. The iron of which they are made is only 2 inches broad, but otherwise the dimensions of the entire trawl are about the same as already given.

Tangle-Frame and Swabs for collecting marine animals having a spiny or otherwise roughened exterior, or bushy growths, especially on rocky bottoms where they cannot be reached by the dredge.

United States Fish Commission.

The old style of tangles, which consisted of several hempen swabs attached to a cross-bar at the hinder end of the dredge, has never been used by the United States Fish Commission, although frequently employed by the United States Coast Survey. The tangles, as a separate instrument, were devised by Prof. A. E. Verrill for the Fish Commission, in 1871, and in the same form, somewhat modified, have been in use ever since. The original set of tangles was constructed of three flat iron bars forming a triangle, the dredge or drag-rope being fastened at one of the angles, and the opposite bar having attached to it several small iron chairs, each about 15 feet long and bearing bunches of unraveled hemp rope at intervals of about 3 feet. Since then the triangular frame-work has been dispensed with, and the cross-bar or chain-bar is supported on two immovable wheels, one at each end, as shown in the sample exhibited. "The wheels are not intended to revolve, but to serve merely as runners and supports for the iron bar, in order to keep it off the bottom and diminish the chances of its getting caught among the rocks, as well as to keep it from breaking and destroying the specimens before the tangles themselves can touch them. An oval or elliptical form for these runners would answer the same purpose, but the circular form was adopted as the simplest and, perhaps, the least liable to become caught among the rocks." Following are the dimensions of the tangles now used by the Fish Commission: The chain-bar measures about 4 feet in length, and is made of one-half inch iron, 2 inches broad. The wheels are 12 inches in diameter, 2 inches broad, and one-fourth of an inch thick. The cross-piece to the wheels is of the same size iron as the chain-bar. The chains are 15 feet long, of one-fourth-inch iron, and the tangle bunches are about 2 feet long each. It may be advisable to increase the size of the iron for use from large vessels.

Towing Nets for collecting free-swimming marine invertebrates at the surface, or at intermediate depths between the surface and the bottom.

United States Fish Commission.

The towing nets employed by the United States Fish Commission are essentially alike in size and construction, whether for use at the surface, bottom, or intermediate depths. The ring is of one-fourth-inch round brass, 12 inches in diameter, and is arranged for the attachment of three leaders at equal distances apart, at each of which places two little copper wires are soldered around the ring, with a narrow space between them, just wide enough to permit of tying the leaders. This method of fastening the leaders permits of the net being inverted and used either side out, an advantage of considerable importance when working in a dirty sea. Two kinds of cloth are preferred for the nets—silk bolting cloth and linen cheese cloth or scrim, the former, although much more expensive than the latter, serving best and being more durable. Other kinds of material sometimes employed are fine embroidery canvas, bobbinnet lace, and crinoline. The nets are made from 18 inches to 2 feet deep, of two pieces of cloth cut in the shape of an elongate semi-ellipse, and, therefore, taper gradually and terminate in a full rounded end. A small stout cord is welded around the mouth, and serves for its attachment to the ring, which is made by means of a continuous piece of sail twine winding around the ring and through the net inside of the welded cord. Larger nets, with the ring 15 to 18 inches in diameter, are occasionally employed, and also for surface work an elongate, rectangular brass frame, measuring 30 inches in length by 6 inches in width. In using the circular towing nets from the steamer for collecting at the surface or at slight depths, a long spar is run out amidships on the starboard side, thus permitting of the handling of four or five nets at a time. For intermediate depths the nets have been attached to the dredge-rope at the proper places as the rope was being paid out.

Trawl Wings used in connection with the beam-trawls, for collecting free-swimming marine invertebrates at the bottom of the sea.

United States Fish Commission.

Since 1880, it has been customary to use the towing nets at the bottom, in connection with the beam-trawls of either pattern. This practice has been productive of most excellent results, and the towing-net attachments to the trawls have come to be considered of nearly as great importance as the trawls themselves. The ordinary form of towing net is used, and, while it is impossible to tell with certainty from what depth of water its contents were derived, whether at the bottom or on the passage up, it is certain that they are far richer in quantity and quality than when the nets are simply lowered to an intermediate depth. The method of using the towing nets at the bottom, which was devised by Capt. H. C. Chester, in 1880, is as follows: A rectangular iron frame of one-half-inch round iron, 3 feet long and 8 inches wide, is swung loosely, by means of handles about 12 inches long, from a piece of iron gas-pipe, which is of the proper diameter to fit into the ends of the pipe forming the beam of the trawl, into which it reaches a distance of 1 foot or more. A large screw on the end of the beam holds it firmly in place. The frame is furnished with a coarse net, measuring from 3 to 4 feet in length and having about 3 meshes to the linear inch. The ordinary towing net, as described above, is now fastened into the coarse net by tying the ring to it, far enough from the mouth, so that the lower end of the fine net reaches nearly to the end of the larger one. Two arrangements of this kind are always used, one at each end of the beam. They are called the trawl wings, and the entire apparatus thus made up is termed the butterfly trawl.

Sigsbee's Gravitating Trap for collecting animal forms from intermediate ocean depths.

Commander Charles D. Sigsbee, United States Navy.

The old practice of dragging for animal forms at intermediate depths by means of a tow-net, which during the several operations of lowering, dragging, and hauling back remained open, not being regarded as affording sufficient evidence of the habitat of such specimens as were obtained, this apparatus was invented by Commander Sigsbee, at the request of Prof. Alexander Agassiz, who afterwards used it with success. (See Bulletin of the Museum of Comparative Zoölogy at Harvard College, vol. vi, Nos. 8 and 9, September, 1880.) The following explanation is drawn chiefly from No. 9 of the Bulletin, which was written by Commander Sigsbee.

"Our plan is to trap the specimens by giving to a cylinder, covered with gauze at the upper end and having a flap valve at the lower end, a rapid vertical descent between any two depths, as may be desired; the valve during such descent to keep open, but to remain closed during the processes of lowering and hauling back with the rope. An idea of what it is intended to effect may be stated briefly thus: Specimens are to be obtained between the intermediate depths *a* and *b*, the former being the uppermost. With the apparatus in position, there is at *a* the cylinder suspended from a friction *clamp* in such a way that the weight of the cylinder and its frame keeps the valve closed; at *b* there is a friction *buffer*. Everything being ready, a small weight or messenger is sent down, which on striking the clamp disengages the latter and also the cylinder, when messenger, clamp, and cylinder descend by their own weight to *b*, with the valve open during the passage. When the cylinder-frame strikes the buffer at *b*, the valve is thereupon closed, and it is kept closed thereafter by the weight of the messenger, clamp, and cylinder. The friction buffer, which is 4 inches long, may be regulated on board to give as many feet of cushioning as desired."

The following is a detailed description: A copper cylinder, riveted to a wrought-iron frame, has a flap or clapper valve opening inwards and fastened to the shorter arms of a set of levers. The upper end of the cylinder is covered with a removable wire sieve (60 wires to the inch), and inside the cylinder are a wire sieve (27 wires to the inch) and a wire funnel or trap (27 wires to the inch). The steel-wire rope on which the cylinder travels is placed in loops at the upper and lower extremities of the frame, and is retained therein by screw-bolts.

The friction *clamp* is composed of a solid frame, two binding chocks, a clamping screw, and an eccentric trigger or tumbler. The friction *buffer* is composed of a solid frame, two binding chocks, a clamping screw, and a compression spring with a regulating screw for regulating the binding force of the spring. The bearing faces of the binding chocks are corrugated, and the inward movement of each is limited by a stud which forms part of the frame. In clamping the buffer to the rope, the chock next the clamping screw is *always* screwed inwards until stopped by its stud; the steel rope is, therefore, always pressed between the two chocks by the elastic force of the spring, which may be regulated as desired. To regulate the buffer for any definite frictional resistance, clamp it to the rope and move the regulating screw well inwards; then suspend from the buffer a weight equal to the resistance decided upon. Move the regulating screw outwards until the buffer slides down the rope, under the influence of the suspended weight. Since the chock operated by the clamping screw is always screwed "home" in clamping to the rope, the buffer remains regulated for prolonged use, and it is probable that the regulating screw need not be touched again for a whole cruise, if the buffer be rinsed in lye-water each time after use.

A cast-iron messenger in two parts, connecting with each other by a dovetail, is an important part of the apparatus. Professor Agassiz added the funnel-shaped trap, after a preliminary trial with the apparatus.

Working the apparatus.—It is necessary to first regulate the buffer to cushion the stoppage of the falling weights, which are, cylinder and frame 38 pounds, clamp 4 pounds, messenger 8 pounds, total 50 pounds. The Blake adopted a resistance of about 80 pounds (this resistance being, of course, constant during the whole movement of the buffer), it having been found that a blow of that force resulted in no injury to the apparatus.

On the ascent the buffer must withstand not only the weight of the 50 pounds of metal, but also the resistance which the water offers to the passage through it of the several parts of the apparatus. Moreover, when the cylinder emerges from the water it is full of that liquid, and with this increased weight would overcome the stated resistance of the buffer and force the latter downwards until the lead was reached. To meet these conditions it was not thought advisable to increase the resistance of the buffer, which would involve a heavier blow against the apparatus, but a rope-yarn seizing or stop was placed on the rope, about 15 or 20 feet below the buffer, beyond which the latter could not pass.

Having secured the buffer to the rope about 5 or 6 fathoms above the lead (a very heavy lead to keep the steel rope straight) and paid out the length of rope required to span the stratum to be explored by the cylinder, the clamp and cylinder are attached, the latter being suspended from the former as follows: The rope having been placed between the two binding chocks of the clamp, the arm of the eccentric tumbler is thrown up, which moves one of the chocks inwards; then, by means of the clamping screw, the other chock is pressed against the rope, securing the clamp in position. The cylinder hangs 4 or 5 inches below the clamp and is supported by a loop of soft wire which rests on the lip of the tumbler; the ends of the wire, being rove through holes in the upper part of the frame of the cylinder, are fastened permanently to the outer arms of the lever to which the valve is screwed. It is seen that by this method of suspension the weight of the cylinder and its frame is used to keep the valve closed while paying out.* The cylinder should be filled with water poured down through the upper sieve, to maintain the valve on its seat while the cylinder is being immersed. Rope is then paid out slowly until the cylinder is at the desired depth, when the rope is stoppered and the messenger sent down.

The messenger strikes the arm of the eccentric tumbler, throwing it down and tripping the cylinder. The tumbler in falling relieves the pressure on the binding chocks, which are then free to recede from the rope. Messenger, clamp, and cylinder fall together, the valve being held open by the resistance of the water. A current is established through the cylinder, and specimens which enter are retained by the upper sieve. When the buffer is reached, the valve is closed by the pressure against the outer arms of the lever.

A very slight pressure on the clamping screw of the friction clamp, after the chocks are bearing against the rope, is enough to prevent the clamp from slipping, but by an increased pressure on the screw a greater force is required to trip the tumbler, and by this feature the arm of the tumbler is utilized to break the force of the blow which the body of the clamp receives from the falling messenger. A few rings of sheet-lead may be laid on top of the clamp and the buffer respectively.

Baird Seine for the use of naturalists in collecting along the margins of the sea, lakes, and rivers.

Boston Net and Twine Company.

These seines are made of several sizes, from 9 to 16 feet in length and from 2½ to 4 feet in height. The center consists of a large and deep pocket, about 3 feet long, with a one-eighth-inch square mesh; the sides

* It is suggested that, in lieu of the soft wire sling, the friction clamp be constructed to receive the end of a stiff wire rod, proceeding from the ends of the valve levers, and that it be done in such a way that, when the valve is closed and the rod connected with the clamp, the bottom of the latter will be in firm contact with the upper part of the cylinder frame. Such an arrangement would effectually guard against the opening of the valve with any rapidity of descent.

of the net have a one-fourth-inch square mesh. The lower edge is furnished with a lead line and the upper edge with a line of wooden floats. A pole is fastened at each end as a means of handling it. This style of seine has proved very convenient for exploring parties on account of its small size, and is in constant use in the exploring work of the United States Fish Commission. Only two persons are required to manage it. It was designed some years ago by Prof. S. F. Baird, United States Fish Commissioner, whose name it bears.

Dip Net for scraping the piles of wharves, bridges, &c.

United States Fish Commission.

This is similar in construction to an ordinary dip-net, but is made of thicker iron, and has the outer side straight and broad, with a sharp edge for scraping. It is attached to a long pole and furnished with a coarse linen net. The common styles of dip-nets are shown in the section of fishery appliances. For natural history purposes they are generally fitted with bags of fine netting or coarse cloth.

ACCESSORY APPLIANCES USED IN CONNECTION WITH DEEP-SEA DREDGING AND TRAWLING.

Steel Wire Dredge Rope, showing the methods of splicing two pieces together, of attaching the dredge, &c.

United States Coast and Geodetic Survey and United States Fish Commission.

The wire rope used by the United States Coast Survey and United States Fish Commission for dredging purposes is made at Trenton, N. J., by the John A. Roebling's Sons Company. It is one and one-eighth inches in circumference, and is composed of six strands, laid around a tarred hemp heart. Each of the six strands consists of seven galvanized-steel wires, of No. 19 American gauge (No. 20 Birmingham gauge). The ultimate strength of the rope is 8,750 pounds. It weighs 1.14 pounds to the fathom, in air, and about 1 pound to the fathom in sea-water.

Wire rope for dredging purposes was recommended by Prof. Alexander Agassiz in 1877, and was first put to trial on board the United States Coast Survey steamer Blake, in the winter of 1877–'78, during her first dredging cruise, Commander Charles D. Sigsbee, United States Navy, being in command, and Professor Agassiz in charge of the dredging operations.

Commander Sigsbee describes his experience with the wire rope as follows: "The adoption of steel-wire rope, although presenting to our minds at the outset a few difficulties which we confidently expected to overcome after a short experience, simplified matters as compared with what had previously been thought proper in a dredging outfit. Before that time dredge ropes had been made of hemp or manila, and usually for deep work a tapering rope of 3 inches, 2½ inches, and 2 inches in circumference had been employed. The size of the steel rope selected for our work was 1⅛ inches in circumference throughout its entire length.

"For the first dredging cruise it was supplied in 3,000-fathom lengths, each length wound upon a separate wooden reel. For the second cruise, the working reel already having 2,700 fathoms upon it, I had the rope supplied on wooden reels, each containing only 500 fathoms, in which shape it was easier to handle in the event of having to replace losses at sea. One wooden axle common to all these reels formed part of the outfit.

"The shortest nip that we gave the rope was over the pulleys of the leading blocks, the scores of which were 18 inches in diameter, and this did not break up the zinc enough to give trouble from rusting. We used no preservative on the rope, and had no need for it; but that recommended by the Roeblings is raw linseed-oil applied with the fleecy side of a piece of sheepskin, or to the oil may be added equal parts of Spanish brown or lamp black.

"At the works wire rope is reeled up under strong tension, and in reeling off for use it should be passed directly from one reel to the other under at least slight tension, and it never should be coiled down or faked by hand. When supplied in a coil, the coil should be rolled along like a wheel, and the rope paid off in that way to the working reel.

"The dredge, trawl, &c., should always be attached to the rope by a shackle. We at first used hooks which we moused with wire, but they always broke adrift, probably by bending. Long shackles should be selected, of a size to slip into the thimbles and into the eyes in the arms of the dredge. I would call particular attention to this matter, hoping to prevent a resort to makeshifts."

It is now customary with the Fish Commission to fasten the trawls to the dredge rope by means of the safety hooks described elsewhere.

Splicing.—"In joining two lengths of the rope, a 'long splice,' at least 20 feet in length, is made. To make an eye splice at the end of the dredge-rope, turn the end of the rope around an oblong or heart-shaped thimble, and unlay each wire from the thimble to that end. Lay these wires as an untwisted strand along the rope, and serve wires and rope together tightly with annealed-iron wire for a distance of 8 or 10 inches from the thimble. Cut off the free ends of the wires about three-quarters of an inch above the serving, and turn down each wire neatly along the serving."

The splices on exhibition are made in pieces of rope actually used by the United States Coast Survey steamer Blake, and hence the kind of rope employed by that steamer is also shown.

Sigsbee's improved Dredging Accumulator for relieving the strain on the dredge rope; devised by Commander Charles D. Sigsbee, U. S. N.

United States Fish Commission.

The construction of the accumulator used by the United States Coast Survey and Fish Commission in connection with the dredging gear is shown on Sigsbee's plate No. 34. "This apparatus consists of a number of rubber buffers A A, arranged for compression on a rod B, and separated from one another and the rod by guide-plates C C. The upper end of the accumulator being secured at D, and a strain applied to the lower end at E, the compression of the buffers will permit the cross-head F to travel along the rod B, and the rods G G to travel through the guide-plate H and the cross-head I. In this manner the accumulator elongates under strain, and when released from strain is restored to its former length by the elastic force of the buffers." In this form of accumulator, which was devised in 1878, by Commander Sigsbee, for use on the Coast Survey steamer Blake, the only new feature claimed by the inventor is the peculiar shape of the guide-plates C C, the hubs or fillets of which keep the buffers from coming in contact with the rod B when the buffers are compressed. The buffers are 4½ inches wide and 3 inches thick, and have a circular hole through the center 1¼ inches in diameter. They are made of what is known as compound No. 24, consisting of 10 pounds of fine Pará rubber, 1 pound of white lead, 1 pound of litharge, 1 pound of whiting, and 10 ounces of sulphur, the vulcanizing heat being about 260° Fah. A somewhat harder compound than this has, however, been recently employed. The long rods, nuts, cross-heads, and large guide-plate are of steel; the small guide-plates between the buffers are of brass, and all the other metal parts of wrought iron. The small guide-plates are one-eighth of an inch thick, and their hubs are made to fit loosely upon the rod and tightly within the buffers.

The accumulator recently constructed for the Fish Commission steamer Albatross is of exactly the same pattern and size as that employed on the Blake, but on the steamer Fish Hawk a slightly smaller one is in use, differing from the others, however, only in length and in the number of buffers, the size of the latter being the same. The example displayed is copied from that of the Fish Hawk.

In the Blake accumulator the central rod accommodates thirty-two buffers without compression, but seven more are pressed on, in order that the accumulator may not extend for a light strain, Commander Sigsbee explaining that "neither an accumulator nor a dynamometer is of use excepting for a severe strain." The maximum extension of this accumulator is about six feet. The Fish Hawk accumulator contains only twenty-six buffers.

In Sigsbee's series of plates, the accumulator is shown in position for use, suspended from the mast-head, in Plates 1 and 24; and lowered into view in Plates 13 and 14. In the photographic views of the Fish Hawk it is also shown in place.

Iron Dredge Block for the dredge-rope, as used on the steamer Blake. Represented by a diagram (Plate 34 of Sigsbee's series).

United States Coast and Geodetic Survey.

On the steamer Blake the dredge-rope leads through one large snatch block at the boom end, and through several similar ones placed upon the deck. In the former the side plates are free to revolve, but in the latter they are pinned to the strap, and connected by socket bolts, which are intended to prevent the dredge-rope from getting between the side plates and the strap. The pins or bolts are of steel, the sheave of cast-iron, the side plates of thin plate-iron, the flap or hook and strap of wrought iron. The pendant block has the sheave 1 inch wider than the deck blocks.

Iron Dredge Block, used on the steamer Fish Hawk.

United States Fish Commission.

Two pendant dredge blocks are used on the Fish Hawk, one suspended from the lower end of the accumulator, the other from the outer end of the dredging boom, as shown in the photographs of that steamer. These blocks are similiar to one another and to those of the Blake. The example displayed is an exact copy of the one attached to the accumulator. The side plates are 19½ inches in diameter, five-sixteenths of an inch thick, and have an intervening space of about 2 inches for the sheave. The latter is 16 inches in diameter, about 1¾ inches thick, and grooved to a depth of about 2 inches, the bottom of the groove being rounded and just wide enough to accommodate with ease a single turn of the dredge-rope. The straps are in two pieces, fastened together in the middle by the bolt or pin which passes through the sheave, and has a nut at each end. The straps are one-half inch thick, 2 inches wide above the middle, and 1¼ inches wide below. A strong swivel-hook at the upper end furnishes the means of suspending the block. The materials used are the same as described for the Blake. In addition to these blocks there is an iron sheave fastened in the heel of the boom.

Brass Dredge Block, used on the steamer Albatross.

United States Fish Commission.

The same number of dredging blocks are used on the Albatross as on the Fish Hawk, and they have the same positions, but their construction is somewhat different, and the sheave revolves on a series of friction rods, which do away with the necessity of oiling. There are no side plates. The sheave is of brass, 21½ inches in diameter, and about one-half an inch thick, excepting toward the center and rim. At the rim it expands to a thickness of about 2¼ inches, and is grooved to a depth of 2 inches, as in the previously described block. The hole through the center of the sheave is 3¾ inches across and 2½ inches through, the sheave being thickened around it to form a sort of hub. The strap is of iron, 4 inches wide by three-eighths of an inch thick, and is bent in the middle to form a right angle. At the outer end there is a small immovable ring, and at the upper end a very strong ∩-shaped eye bolted on for suspending the block. The center pin or bolt is of steel and passes through the strap at the angle, having a nut at each end. The friction rods are six in number, 2½ inches long by 1¼ inches in diameter, and are suspended in a circle between two flat rings, one at each end, by means of a pin passing loosely through each rod and fastened into the rings. The rods are therefore free to revolve, independently of one another, though they touch slightly. This friction-rod arrangement, which is entirely of brass, fits snugly into the center hole of the sheave, and in turn receives the steel pin which serves as the axis for the sheave.

Safety Hooks, for attaching the beam trawl to the wire dredge-rope and releasing it in case of undue strain from fouling on the bottom. Represented by photographs.

United States Fish Commission.

"The safety hooks are designed for the purpose of detaching the trawl when, from any cause, such as fouling a rock or wreck, the tension on the dredge-rope reaches the limit of safety. They consist of a stout steel spring inclosed in an iron cylinder and controlling the opening and closing of a pair of heavy iron hooks, which project from one end, and can be adjusted to detach at any point between 3,000 and 6,000 pounds, by the nut on the end of the central rod. As used on the steamer Fish Hawk, they were set at 4,000 pounds, the breaking strain of the dredge-rope being 8,700 pounds. The details of construction are shown in the photographs. The spring and hooks being placed in the cylinder and the cap screwed on, the instrument is ready for use. The end of the dredge-rope is spliced into the eye and the trawl shackled to the hooks, which are held in position by their shoulders pressing against the inner surface of the cylinder. The spring is compressed as the tension increases until the limit of safety being reached the shoulders are released and the hooks open freely, allowing the shackle pin to slip through, detaching the trawl and relieving the rope from strain."

APPLIANCES FOR THE EXAMINATION AND STORAGE OF ZOOLOGICAL MATERIALS.

Table or Deck Sieve, for washing the contents of the beam trawls.

United States Fish Commission.

"This piece of apparatus is the result of several successive improvements, and was given its present form in 1877. It has been the joint invention of Prof. A. E. Verrill, Capt. H. C. Chester, and Mr. James E. Smith, of the United States Fish Commission. In fundamental principle it is like the cradle sieve much enlarged and raised on legs, but the form is entirely different. Its original use was to receive the contents of the trawl instead of emptying it on deck, as had been done previously, but its advantages were soon found to be so great that it has also been used for washing the contents of the dredge whenever the quantity of mud was considerable.

"The sieve foundation consists of a large rectangular wooden frame, with wide side-pieces made of inch boards, supported on stout legs, at a convenient height, the legs being made of unequal lengths to correspond with the curvature of the deck. The bottom of the frame consists of stout galvanized iron-wire netting with one-half inch to three-fourths inch meshes. Below this is a funnel-shaped stout canvas bag which terminates in a large canvas tube. This serves to convey the waste water to the scuppers. A light frame of wood is made to fit loosely inside of the main frame, and its under surface is covered with fine wire netting of one-twelfth inch meshes. This constitutes the real bottom of the sieve, the coarse netting below serving only as a support for it. It is fastened to a movable frame so that it can be taken out and its contents emptied upon the assorting table. This also allows the wire netting to be more easily renewed when it becomes worn. The upper or coarse sieve is made with wide, flaring, or hopper-shaped wooden sides, upon which at about the middle there are cleats that rest upon the edges of the main frame. The bottom of the hopper is formed of strong galvanized iron-wire netting of three-fourths inch meshes."

The dimensions of the table sieves used by the Fish Commission are as follows: Main frame—height to upper edge, 30 inches; length, 66 inches; breadth, 38 inches; width of side pieces, 11 inches. Hopper frame—width of side pieces, 13 inches; length at bottom, 56 inches; length at top, 66 inches; breadth at bottom, 27 inches; breadth at top, 37 inches.

The model exhibited is constructed of one-third the full size as to general dimensions and the thickness of the wood, but the wire netting is the same as in the large sieves.

Cradle or Rocker Sieve, for washing the contents of the dredges.

United States Fish Commission.

"This sieve was devised, in 1872, by Prof. A. E. Verrill, for the use of the United States Fish Commission. It was so constructed as to afford the means of rapidly washing out the large quantities of mud often brought up by the dredge and rake-dredge, and at the same time to keep the mud and water off the deck as much as possible. It consists of two wooden cross-pieces, in shape rather more than half a circle, united by two narrow wooden side pieces set into the end pieces so as to leave a flush surface. The outside covering consists of two thicknesses of wire netting, the inner one with meshes of one-twelfth inch or less, the outer one of stout galvanized iron wire with one-half inch meshes. The outer netting is only to afford support and protection to the inner one. The netting is nailed to the edges of the wooden end pieces and to the side pieces, and is further secured by a strip of hoop-iron nailed over the edges all around. A strip of wood nailed across the bottom from end to end affords additional strength and protection from injury. Two stout iron straps, fastened across each end piece by wood screws and terminating above the edge in a ring, furnish the means of suspending this sieve against the side of the vessel outside the rail. The mud is then placed in it, often filling it more than half full, and a gentle stream of water from the force-pump is turned upon it. In this way several bushels of mud may be washed out in a few minutes with little trouble. Another sieve with straight wooden sides about 6 or 7 inches high—just large enough to set partially into the frame of the cradle sieve and rest upon wooden cleats provided for that purpose—has been sometimes used in connection with the cradle sieve. Its bottom is made of strong galvanized wire netting with meshes of one-half inch. It serves to separate the coarser specimens and stones from the smaller and more delicate species." In the work of the United States Fish Commission, the table sieve has to a considerable extent superseded the cradle sieve, especially where the amount of material to be handled is very great. As a rule, however, the cradle sieve is still generally used for the contents of the dredge, while the contents of a well-filled beam trawl requires the larger table pattern.

Nest of Circular Hand Sieves for washing small quantities of dredged material in a tub or bucket of water.

United States Fish Commission.

In working over small quantities of material, especially in search of the smaller organisms, circular hand sieves, in nests, have been employed by the United States Fish Commission, of the same general pattern as those described by Sir Wyville Thomson, in Depths of the Sea. These have usually been constructed with wooden frames, in nests of three to five sieves. Quite recently the wooden frames have been changed for others of galvanized sheet-iron, with good results. The old style of wooden frames, after a little use, lose their regular shape and will not nest snugly, and the beading, which runs above the wire bottom, is constantly becoming loosened and catching and concealing many small objects. The metal sieves are made in nests of three or four, one of the former and smaller nests being exhibited. In this, the lower sieve measures 10 inches in diameter in the inside, the middle sieve 9¾ inches, and the upper one 9½ inches, the difference between these diameters being equal to about the thickness of the iron. The lower sieve has a height of 3¼ inches, the middle sieve 2¾ inches, and the upper sieve 4¾ inches. In the lower sieve the netting is raised three-fourths of an inch above the bottom, but in the other two it is flush with it. The lower netting is of copper, with 38 meshes to the linear inch, and on account of its lightness is strengthened underneath by a cross frame work of moderately heavy wire; the second netting is also of copper wire, with 8 meshes to the linear inch, and the upper is of galvanized iron-wire, with 2 meshes to the linear inch. The several sieves are smooth and without angular projections on their inner surfaces, and fit snugly together. They are prevented from nesting too deeply by means of a wire bent in around the outer sides of the two upper sieves, 1½ inches above the bottom. This affords interspaces of about an inch between the nettings of the several sieves. The rims of the sieves are strengthened with wire, and the handles, which stand upright, are of such lengths that when the sieves are nested they reach to the same height, and can be grasped together. The nests of three sieves may be worked in a large bucket of water, but those of four sieves are larger, and require at least a small tub for their use.

Small Sieves for freeing minute animals from fine sand in a dish of water without motion.

United States Fish Commission.

Several different kinds of small single sieves are used by the United States Fish Commission for special purposes. One style (exhibited) is made with a copper frame, from 5 to 10 or more inches in diameter, and with a moderately fine mesh copper wire bottom, the entire sieve being nickle plated, to prevent corrosion. This sieve is gently lowered into a shallow dish of water, so as to rest against the sides of the dish a short distance above the bottom, the bottom of the sieve having been previously covered with fine dredged material, such as mud or sand, known or supposed to contain diminutive forms of life, such as small worms, copepods, amphipods, &c., which, in most instances, work quickly down through the meshes of the wire netting into the water in the dish, thereby freeing themselves in much better condition for study than could result from any other method. This style of sieve was first introduced by Prof. H. E. Webster and Mr. James E. Benedict, of Union College.

Fish Pans. Galvanized iron pans, for the examination of fish and other large objects at sea; used on the steamers Albatross and Fish Hawk.

United States Fish Commission.

These pans are made in nests, of heavy (No. 22) galvanized sheet-iron, with the edges strengthened by means of a wire bent in around them. The smallest pan measures 10 inches by 15 inches by 1¾ inches deep, and the largest 22 inches by 36 inches by 2½ inches deep.

Sorting Dishes of clear glass; nest of four sizes, used in connection with the dredging work of the United States Fish Commission. Made by the New England Glass Company, Cambridge, Massachusetts.

United States Fish Commission.

Crockery and earthenware dishes, of many sizes and shapes, are also employed in this work.

Naturalists' Forceps, in German silver, for use in salt water. Made by Codman & Shurtleff, Boston, Massachusetts.

United States Fish Commission.

These forceps are intended only for the coarser work of sorting zoological specimens, arranging them in jars, aquaria, &c., and were specially designed for use in salt water, in which steel forceps, even when nickle-plated, rapidly corrode. They are made of three sizes, 4, 6, and 12 inches long respectively.

Copper Tanks. Two four-gallon Agassiz tanks and one eight-gallon tank, improved pattern, in transportation box.

United States Fish Commission.

The tanks used by the United States Fish Commission and the Museum of Comparative Zoology, Cambridge, Massachusetts, for the storage and transportation of large alcoholic specimens, are made in four sizes of heavy tinned copper. They are rectangular in shape, and three of them constitute a series, the fourth being an odd size. They are furnished with two styles of covers. The larger tank of the series measures 19 inches long by 13 inches wide by 14 inches high, outside, and has a capacity of about 16 gallons. The mouth is round, and 10 inches broad, with a brass rim having a screw thread on the inner side. The cover is of tinned copper, and is also bounded with a brass rim having a screw thread to fit that of the mouth. The rim overlaps at the edges a sufficient distance to cover a rubber washer, by means of which the mouth is made tight by screwing down the cover. There is an arrangement on the top of the cover for the attachment of a handle or wrench.

The second and third tanks of the series have the same height as the above, but the former is only one-half and the latter one-fourth the other dimensions, and they have capacities, therefore, of 8 and 4 gallons respectively. The mouth of the 8-gallon tank measures 8 inches across, and that of the 4-gallon 4 inches across. For holding and protecting these tanks, especially during transportation, an uniform size of box is used, which measures on the outside 21½ inches long, 15½ inches wide, and 17½ inches high, and is strengthened with broad cleats. The cover is attached by means of iron hinges, and fastens with a hasp and padlock. The odd tank is of an elongate shape, and was specially designed for holding fish. It measures 23 inches long, 8 inches wide, and 14 inches high, and will hold about 12 gallons of alcohol. The mouth is about 6 inches in diameter.

The style of cover above described was devised by Professor Agassiz, after whom the tanks furnished with it have been named the "Agassiz tanks." A new style of cover has been recently constructed for the United States Fish Commission. It is of brass, tinned on the inside, and is cast in one piece. On one side it is strongly hinged to the top of the tank, and on the other has a projection with a screw hole, through which works a thumb-screw passing into a screw hole in the top of the tank. A rubber washer fits under the rim of the cover. This style of cover is more easily opened and closed than the former, and in the tanks which have been supplied with it the mouth is made as large as the top of the tank will permit.

Glass Jars with Screw Covers, for the storage and transportation of specimens. Made under Mason's patent.

United States Fish Commission.

These jars are of two styles and three sizes, pint, one quart, and two quarts. Those with the smaller mouths are intended for holding preserved fruits, and those with the broad mouths for butter. By means of the rubber washer, which fits between two surfaces of glass, these jars can be hermetically sealed. They are the most reliable jars for the storage and transportation of zoological specimens, under a certain size, which the Fish Commission has yet made use of.

Cork-stoppered Bottles of clear glass, for the storage and transportation of small specimens. Made by the Dorflinger Glass Company, White Mills, Pennsylvania.

United States Fish Commission.

These bottles are made for the Fish Commission of seven sizes, ranging in capacity from one ounce to one pint.

Homeopathic Vials, set of four sizes, contained in a storage tray. Made by Whitall, Tatum & Company, Philadelphia.

United States Fish Commission.

These vials are made especially for natural history purposes, of heavy tubing, in five sizes, from 1 drachm to 8 drachms. The mouths are carefully rounded, and of uniform diameter in each size. Rubber stopples are employed, and prevent any perceptible evaporation of alcohol. The tray accompanying the vials illustrates the method adopted by the United States Fish Commission for storing vials for convenience of reference.

Glass Exhibition Jars, for the display of alcoholic specimens of aquatic animals. Made by the Dorflinger Glass Company, White Mills, Pennsylvania.

United States National Museum.

These jars are made of fifty-six sizes, and in several series, to suit the different classes of objects. They are of clear glass, and are made extra thick, to lessen, as much as possible, the danger of breakage; the stoppers are carefully ground. The smallest jar of the series is 2½ inches high by 2 inches broad, and the largest 24 inches high by 10 inches broad. Many of the sizes are exhibited in the collections of fish and aquatic invertebrates.

APPLIANCES FOR DEEP-SEA SOUNDING.

Sigsbee's Deep-Sea Sounding Machine, for use with piano-forte wire, on the principle of Sir William Thomson. Represented by a model.

Commander Charles D. Sigsbee, United States Navy.

In deep-sea sounding with wire, the submerged weights provide a moving force for the sounding-reel containing the coil of wire. The weight of the submerged wire, and of all submerged accessories excepting the sinker, is overbalanced at discretion by means of a friction-line enwrapping a portion of the reel. Thus the motion of the reel is continued by means of the sinker and controlled by the frictional balance or brake until bottom is reached, when, the weight of the sinker ceasing to act, and the remaining submerged weights being overbalanced by the brake, the reel stops automatically. To Sir William Thomson is due the credit of having solved the problem of sounding ocean depths with wire.

To keep the wire constantly under tension is the prime essential, since a failure to maintain this condition will permit the wire to fly from the reel during the motions of the vessel in a seaway. To avoid the loss of time due to accidents or unnecessary delays is of importance in view of the expense attending the maintenance of any organization for deep-sea operations. In the Sigsbee machine every convenience and safeguard suggested by long experience has been applied, in order to economize time by rapidity of work, by lessening the probability of accident, and by making soundings practicable in any weather during which the vessel can be maneuvered. Several thousand soundings have been taken with the machine, in nearly all conditions of wind, weather, and current, much of the work having been done in moderate gales; but perhaps the most severe test was that made by Commander Bartlett in the steamer Blake. The Blake (350 tons) was hove to in a severe gale in the swift current of the Gulf Stream, in which condition she got bottom in 2,400 fathoms, and reeled in by steam without loss. Recently the Blake sounded with the same machine in 4,561 fathoms (over 5 miles), reeling in by steam and getting a specimen of the bottom deposit. The general custom in using the machine has been to employ a 35-pound lead and haul it back in depths not exceeding 1,000 fathoms, and in greater depths to use a 60-pound shot of cast-iron, detaching it on bottom. In all cases the wire has been reeled in by steam. A number of the machines are now in use by Government organizations in the United States and Europe.

A complete description of the machine and its operation is given in Sigsbee's Deep-Sea Sounding and Dredging, published by the United States Coast and Geodetic Survey in 1880, and again in 1882. The last edition contains a supplement, showing the latest improvements and the way in which the machine is folded for transportation or stowage by the hinging of the several parts. Detailed drawings of the latest improvements are also shown in the United States exhibit. The following is a general description only:

In advance of the reel, which is practically of the Thomson pattern, are two pipes parallel to each other and about 6 feet in height, each containing a spiral extension-spring fastened at the bottom, and connecting by means of ropes taken over pulleys at the top, with a cross-head moving between the two pipes, the latter serving as guides. The cross-head contains a pulley 1 yard in circumference of rim, over which the wire leads in its passage from the reel to the water. The normal position of the cross-head is at the top of the guides, and it can be borne down only against the resistance of the springs. By this means a very sensitive *accumulator* is provided to ease the jerks upon the wire while reeling in, and which also shows by a graduated scale upon the pipes the degree of strain upon the wire at each instant during the same operation; thus the accumulator is also a *dynamometer*. An odometer attached to the axle of the cross-head pulley will give at once the number of yards of wire payed out or reeled in.

The method of reeving the friction-line through the cross-head is peculiar, advantage being taken of the presence of an accumulator to obtain an arrangement which will put any desired strain upon the friction-line without the aid of the pendulous weights previously used for this purpose. This peculiar arrangement of friction-line and accumulator also operates as a *governor* on the motion of the reel when paying out in a seaway, thus: During the downward movement of the vessel, when the strain upon the wire is suddenly eased, the reaction of the accumulator increases the strain upon the friction-line, slowing down the reel, and thereby preventing the wire flying from the drum of the reel. As the decreased speed of the reel or the rising of the vessel restores the tension upon the wire, the friction-line in turn is eased by the responsive action of the accumulator, and the reel then revolves more rapidly. At the instant bottom is reached, the accumulator, being freed from whatever force is due to the weight of the sinker, reacts instantly and transfers this force to the friction-line. The effect of this operation is to provide a safeguard at a critical moment.

The method of measuring the friction upon the reel when paying out is shown in the model on exhibition. For this purpose two spring scales are placed upon the friction-line, one in front of the reel and the other behind it. The difference between the readings of the two scales gives the frictional resistance imposed upon the reel by the friction-line. It may be said here that years of experience have shown that no means of measuring the resistance upon the reel is necessary in actual work. This may seem strange, but it is nevertheless true, as a few practice soundings will show. Where there is the slightest motion of the vessel *the controlling condition is the tension upon the wire. Keep the wire constantly under tension* is the working rule. The scales are added to the outfit more as accessories for experiment than for actual use.

Beneath the reel is a lever intended to serve as an auxiliary brake in case of accident to the friction-line. It is also useful in very heavy seas, when, by reason of the momentum of the rapidly moving reel during the violence of the vessel's movement, even the action of a governor may not be quick enough to keep the wire constantly under tension. In such a case it is well to attach a spring or rubber strap to this lever brake, causing it to press against the reel with a steady force. By this means a few pounds of reserve resistance, entirely independent of the governor, is placed upon the reel, which prevents the reel from acquiring a velocity too great for the circumstances.

In the rear of the reel is a steam engine, having a V-groove pulley on its shaft. Between the reel and the engine is a tightening pulley for a belt to be taken over the V-groove pulley and the V-groove of the reel for reeling in the wire. The tightening pulley is turned to one side or the other by turning its shaft, the latter having a locking-pin at the bottom.

In front of the accumulator guide-pipes is a fairleader for the wire, and a swivel-pulley to admit of reeling in the wire while the ship is steamed ahead on her course. While paying out wire this pulley is raised on its hinge and turned to one side. For the fairleader a *lignum vitæ* clamp is provided for clamping the wire in case of accident.

The whole machine is so hinged and arranged in its several parts that, with the exception of bolts or pins to be temporarily withdrawn, only the reel and the cross-head pulley need be unshipped in order to fold it in a very small compass for stowage. The reel then stows in the tank, which contains preservative fluid for the wire. Plates 42 and 43 of the Supplement to Sigsbee's Deep-Sea Sounding and Dredging show the machine folded, also the photographic copies of special drawings on exhibition.

The times made in actual work with this machine are shown in Sigsbee's Deep-Sea Sounding and Dredging, pp. 73–76.

Experimental form of the Sigsbee Machine for sounding with piano-forte wire. Represented by a plate (No. 7 of Sigsbee's series).

United States Coast and Geodetic Survey.

This machine was used for three years on board the Blake, previous to the construction of the improved pattern described above. It is represented in the plate as rigged for paying out.

Original Service Machine for sounding with piano-forte wire, as used on the United States Coast Survey steamer Blake during her first season in the Gulf of Mexico. Represented by a diagram, showing the machine ready for paying out (Sigsbee's series of plates, No. 6).

United States Coast and Geodetic Survey.

"This machine was practically the same as those originally issued for general use, with the sanction of Sir William Thomson. A reel, having a drum one fathom in circumference (less the small allowance for the diameter of the wire), and with a V-shaped friction score at the side, is rigidly attached to its axle and mounted upon standards. On the axle is a worm which engages a counter or register to mark the revolutions of the reel. The wire, which is wound about the drum, pays out directly from the reel, through a fairleader or clamp on the forward end of the bed-board into the water. In the rear of the reel, and on the same side as the friction score, is a dynamometer pulley or wheel having two scores, which we will call the wide score and the narrow score, respectively. This is mounted in a special standard, from which it may be removed at will. For paying out wire, an endless rope belt, called the brake cord or the friction rope, is passed somewhat more than half around the friction-score of the reel, thence one whole turn around the wide score of the dynamometer pulley, and through a tail-block to the rear. The pendant of the tail-block, or, more strictly, pulley, being rove through a standing block, supports weights to tighten the friction rope. The narrow score of the dynamometer pulley is connected with a spring-scales by a tangent wire or cord in such a way that the traveling of the belt can turn the pulley on its axle only to the extent permitted by the resistance of the spring-scales. When the reel is set in motion, the retardation of the belt on the dynamometer pulley places a resistance upon the reel that can be regulated by weights at the tail-block. The scales are intended to show approximately the amount of resistance applied to the reel by means of the belt."

The Tanner Sounding Machine, for sounding in moderate depths of water with piano-forte wire, on the principle of Sir William Thomson.

United States Fish Commission.

This instrument works on the plan of Sir William Thomson, and is a simplification of the Sigsbee sounding machine, for use in moderate depths of water; the reeling in is accomplished by hand. It was devised by Lieut. Z. L. Tanner, United States Navy, in 1880, for the steamer Fish Hawk, then engaged in dredging along the cost, in all depths down to 500 or 600 fathoms. The reel is of tough composition, is fitted for holding a considerable supply of sounding wire, and is furnished on one side with a groove for the friction line by which it is controlled. It rests in a composition brass frame, cast in one piece, and surmounting a wrought iron standard which ships in the rail. Above the frame, into which it is fastened between two lugs, extends a curved arm of flat bar iron, carrying at its outer extremity a small, grooved, brass pulley, working in guides and suspended by a coiled spring which allows several inches of vertical play. A brass guard is fitted over the upper portion of the pulley to prevent the wire from flying off if suddenly slacked. The reel is worked by friction motion, by means of a handle or crank on each side. Both of the cranks have friction surfaces, which are brought into action by moving the right one half a revolution ahead, the left remaining clamped, or being held firmly in the hand. The reverse motion releases the reel and it revolves freely without moving the cranks. The register to record the amount of wire out is fastened to the frame at the left of the reel, and is operated by a worm-wheel. A small ratchet-wheel and pawl hold the reel in place when desired. The reel is unshipped by simply unscrewing one nut on the left crank, which releases the shaft, allowing it to be withdrawn, and leaving the ratchet, worm-wheel, and left crank in position. By means of a tackle designed for this purpose, one man can easily ship and unship the reel.

"The guiding pulley carries a small arm near the upper end of its shaft or spindle, which works through a slot in the casting. A small cord is attached to the arm and made fast to the free end of the friction rope, the standing part being hooked to a small metal eye in the frame over the reel. By this arrangement the friction is intended to act automatically in the following manner: The machine being ready for a cast, the small friction line is hauled taut before the lead is bent, and while the guiding pulley is up in its place. In this condition it requires a strong man to move the reel, but, the lead being bent and suspended, it compresses the spring and drags the pulley down sufficiently to slacken the friction rope and allow the reel to move with comparative freedom. The instant the lead strikes bottom, however, or the weight is removed from any cause, the pulley flies up, putting a strain on the friction rope, which stops the reel at once. It acts also as a check in paying out, the friction being governed by the weight suspended on the guide pulley, it being necessary to keep the sounding wire under constant strain, like the spring of a clock."

The original machine constructed by Lieutenant Tanner had a reel measuring only 11.43 inches in diameter, with a carrying capacity of 600 fathoms of wire. One turn around the reel was equal to half a fathom, and the entire apparatus weighed 96 pounds. Ordinary sounding leads of 12 to 20 pounds weight were used. The machine in regular use during the past two years has been considerably larger, the reel having twice the diameter, and space for 2,000 fathoms of wire. It weighs 128 pounds, and contains many improvements over the smaller machine, as described above. The example displayed is of this pattern. The smaller machine is still used at the stern of the Fish Hawk, with Basnett's patent atmospheric lead, by means of which slight depths may be measured while running at full speed. The positions assigned to the sounding machines on the steamer Fish Hawk are illustrated in the enlarged photographic views of that steamer.

Sigsbee's Correction Curve, or method of ascertaining the true depth from the reading of the register applied to the reel in sounding with wire.

Commander Charles D. Sigsbee, United States Navy.

Although this is only a method, and is represented simply by a plate, attention is called to it because of the great amount of labor saved by its use. A curve of this kind is easily made, and once obtained no further measurements of wire are needed so long as the same kind of reel and wire are continued in use. The loss of wire from the reel, or the addition of wire thereto, does not require a new curve if the curve be made long enough in the first instance. It is believed that it is now in use wherever known. For a full description, see Sigsbee's Deep-Sea Sounding and Dredging, page 37 and Plate 41.

The necessity for its use appears from the following: Reels for deep-sea sounding are made of such a size that their drums will exactly accommodate one fathom of the sounding wire at a single turn (although this is not essential). While each turn of the first layer wound about one of them is, therefore, one fathom in length, those that are above the first layer measure more, according to their distance from the drum. Each reel is rigidly attached to an axle, on which is a worm to connect with the train of a register for recording the number of revolutions of the reel. It is evident that the readings of the register show the number of *turns* of wire paid out or reeled in, but not the number of *fathoms*; and since the turns are almost constantly varying in length, it becomes necessary to have some ready means of reducing them to fathoms, in order to arrive at the depth of the sounding.

With a correction curve at hand, the number of *turns* of wire in use upon the reel and the number of *turns* paid out at any sounding are referred to the curve, whence the corresponding *fathoms* are found in a few seconds. Plate 41 of Deep-Sea Sounding and Dredging explains the construction and the method of reading the curve.

Steel Piano-forte Wire, for deep-sea sounding.

United States Fish Commission.

"The wire used by the American expeditions for sounding purposes is steel piano-forte wire, of No. 22 Birmingham (Stubb's) gauge, or about No. 21 American wire gauge, and measures 0.028 of an inch in diameter. It weighs 14½ pounds to the nautical mile (1,000 fathoms approximately) in air, and consequently about 12 pounds in water. The English-made wire has a tensile strength of from 200 to 240 pounds, is provided in lengths of 100 to 400 fathoms, and is made up in 18-inch coils, weighing about 60 pounds, and wrapped with oiled paper. The American wire, called music wire No. 13, has a tensile strength somewhat less than that of the English wire, and seems to have a higher polish. It is made up in 9 or 10-inch coils, stowed neatly within sealed tin cases, which protect it better than the English wrapping." Great care is required in the preservation of the wire to prevent corrosion. When not in use the sounding reel with its wire is kept in a tank of sperm or lard oil, free from acid impurities. One of the greatest difficulties originally encountered in the use of considerable lengths of sounding wire was the construction of suitable splices, which should be of equal strength to the wire itself. This has been overcome by the American expeditions in the manner described below.

A piece of small rope, called the stray line, and measuring from 10 to 15 fathoms in length, is spliced to the lower end of the wire for the attachment of the sinker. It is discussed farther on.

The following account of the method of protecting the wire during storage is taken from Commander Sigsbee's description: "When the wire was received in sealed tin cans, the latter were painted and stowed below in a safe place, after which only an occasional inspection or touching up of the outside of the cans was necessary. When it was supplied to us in coils, wrapped with oil paper, we would parcel each coil with soft canvas and then apply several coats of paint before stowing them below. Once when we wished to stow away a spare reel containing several thousand fathoms of wire, and had no tank available, we left the coil upon the reel, covered the upper layers with old washed flannel saturated with sperm oil, spread tallow over the flannel to a depth of half an inch, and then wrapped the whole reel in old canvas and stowed it below in a cool place. Our methods in this respect answered the purpose for which they were intended. * * * A simple method of stowage and supply of wire would be to transfer the commercial coils, as soon as they are received, to special cast-iron reels or drums, capable of holding four or five times as much as the ordinary sounding reels. In winding the wire to the supply-drums the splices might be completed at once, which would give the advantage of always having the supply in very long lengths, from which losses could be quickly replaced at sea or in port. These drums, when wound with wire, might be kept in tanks of oil or lime-water. * * * The winding of the wire from a turn-table is a slow operation and can best be done in port.

"The preservation of the wire when on the working reel is an important point, but presents no serious obstacle to the use of wire for sounding. When not on our lines the sounding-reel and its wire were kept in a cylindrical tank of galvanized sheet-iron, containing sperm oil. The tank is built up inside so that, as nearly as possible, there is but a film of oil beneath and at the sides of the reel, while on top it is covered to a depth of about one or two inches. The cover is a flat, circular piece of sheet-iron, riveted all around its edge to the under side of a wrought-iron ring, the latter being perforated to receive screws projecting at regular intervals through a second wrought-iron ring or flange, fastened around the inside of the top edge of the tank. In the center of the cover is a square hole, through which the axle of the reel is allowed to project. A sheet-iron cylindrical water-tight cap, to fit over this hole, is a desideratum. It should be about 6 inches in diameter and 4 inches high, so as to cover the stray line, which, being connected with the wire, is rove up through the central hole and coiled down upon the tank when the reel is stowed. The cover of the tank when in place is set up firm by means of thumb screws, and between the two wrought-iron rings, already mentioned, which form the joint, a washer of rubber or sennit is interposed to prevent leakage of the oil in a sea-way."

A model of this storage tank is exhibited in connection with the Sigsbee deep-sea sounding machine.

Splices in Sounding Wire. Samples showing the method of splicing the sounding wire together and to the stray line, as employed by the United States Coast and Geodetic survey.

Commander Charles D. Sigsbee, United States Navy.

The method of splicing the sounding wire employed on the steamer Blake was devised by commander J. A. Howell, United States Navy, and is as follows:

Overlap the ends of the wire at least a foot; cross them and wrap each free end tightly about the opposite wire in a close spiral twist, making the whole splice about 3 inches long. Although the spirals should begin close up to the cross, the "nip" of the latter should not be so abrupt as to weaken the wire by torsional strain. Plate 41 will serve as a model. Rub the whole splice with resin or soldering fluid, preferably the latter, and apply soft solder over all, either with a soldering iron or as follows: In a block of wood cut a groove, in which melt the solder; then draw the splice to and fro in the groove. Scrape or file off any superfluous solder, but caution must be exercised in using a file. In using a soldering iron care must be taken not to overheat the wire. At the end of each spiral the solder should be gradually tapered from the thickness of the spiral to the thickness of the single wire, to avoid a sudden change in area of cross-section, which would cause weakness. These splices are neat and compact; they are quickly made and have been used in thousands of casts, down to a depth of more than 5 miles.

The sounding wire is spliced to the stray line in the following manner, introduced by Commander Sigsbee:

"To splice the wire into the stray line, make a single wall knot in the latter, and whip the rope with twine for a half inch below the knot; tuck the end of the wire down through the middle of the single wall, and complete the knot by jamming the strands, working close down to the whipping. Beginning close up under the knot, take ten or twelve turns of the wire around the rope against the lay; then tuck it through under a strand, and make another set of turns below the first set, this time with the lay of the rope; then tuck and repeat against the lay, and expend the end of the wire. Taper and whip the ends of the strands about the wire above the knot and the splice will be complete."

These splices have been used successfully on the Blake for a number of years. It is best that they should not be as strong as the wire itself, in order to afford a chance of parting at the stray line, should the rod or lead foul irretrievably on the bottom. On the Blake the stray line was usually made 10 or 12 fathoms long, and from any small stuff less than one-quarter of an inch in diameter.

The operation of making the above splices is clearly illustrated on Plate 41 of Sigsbee's "Deep-Sea Sounding and Dredging."

Splices in Sounding Wire. Samples showing the method of splicing the sounding wire together and to the stray line, as employed on the steamers Fish Hawk and Albatross.

United States Fish Commission.

The method first adopted by the United States Fish Commission is as follows: "The ends of the wire for about 2 feet are thoroughly cleaned and laid together with about eight turns. The ends and one, two, or three intermediate points are then wound with a few turns of very fine wire and covered with solder, which is carried along the entire length of the splice and smoothed with a knife or piece of sand-paper. This form of splice is smooth, flexible, and reliable. The stray line, consisting of a piece of slack-laid cod-line, is applied to the wire in the following manner: The end of the wire is stuck twice against the lay, about 6 inches from the end of the line, then passed with the lay for 6 inches, the end stuck twice against the lay and served over with seaming twine. The wire is then passed with the lay to the end of the line, the strands trimmed down and served over with twine; a seizing is also put on over the wire first stuck against the lay. This makes a smooth and secure splice, which passes readily over the guide pulley without danger of catching under the guard."

During the summer of 1882, a simpler form of splicing the wire was introduced as follows: The two ends are overlapped for about 2 feet and twisted together with about four turns. These portions are thoroughly cleaned by means of emery paper and a weak solution of muriatic acid, tinned their entire length, and pointed at the tips. The two tips are then closely wrapped to the adjacent wire for a length of about three-fourths of an inch, with the finest steel or iron wire, and the entire splice covered with solder which is smoothed down with a piece of cloth or emery paper.

Quite recently Lieut. S. H. May, United States Navy, of the steamer Albatross, has devised another and still more simple splice, which seems to answer every requirement. The ends of the wire to be spliced are heated for a distance of about an inch and a half in the flame of a spirit lamp or candle until they become of a cherry red, and the tips filed down to sharp points. The ends are then lapped a distance of about 4 inches, and wrapped about one another with about three or four turns, after which the splice is covered or united with soft solder and finished down with sand-paper. Muriate of zinc is used as a flux.

All of the above splices are exhibited, both in the finished state and in process of construction.

Steel Wire used in taking serial temperatures.

United States Fish Commission.

When several thermometers are to be used, attached to the same sounding wire, for taking serial temperatures in the sea, their combined weight is too great to be trusted to the ordinary sounding wire of No. 21 gauge, and a heavier wire is employed. For this purpose the United States Fish Commission has made use of No. 18 wire, American gauge, which has a tensile strength in air of about 600 pounds. The Tanner sounding machine exhibited, is furnished with this size of wire.

Sounding Leads used in connection with steel sounding wire. Actual lead for recovery, and photographs.

United States Coast and Geodetic Survey and United States Fish Commission.

The sounding leads used by the United States Fish Commission in connection with the steel wire, down to depths of 800 fathoms, are of the ordinary commercial pattern for recovery, with a concave lower end to hold the tallow arming for obtaining a sample of the bottom. They weigh from 12 to 20 pounds. The lead attached to the Tanner sounding machine exhibited weighs only 10 pounds. The same style of lead is also employed by the United States Coast Survey for similar depths, but it is furnished with the Stellwagen cup (Sigsbee's Plate, No. 7) for obtaining specimens of the bottom. This cup consists of "a wrought iron spindle, sunk for a part of its length into the sounding lead, and with a detachable, conoidal cup screwed to its lower end. Sliding freely on the spindle, between the lead and the cup, is a leather washer, which is raised by the resistance of the water in the descent or by the resistance of the soil on striking bottom. On the ascent the washer falls by its own weight, or by the resistance of the water is forced down upon the cup, thus enclosing the specimen. A second washer of lead was generally used above the leather, and sometimes a piece of muslin was gathered and seized around the spindle above the washers, allowing its folds to drape down around the washers and cup, nearly to the bottom of the latter. This was intended to prevent a current of water between the spindle and the washers, and the tendency to wash out the specimen."

The sinkers for detaching, used on board the Blake in connection with sounding rods, are cast-iron shot, with a hole of sufficient size to give a clearance of one-sixteenth of an inch all around the rod, and weighing about 60 pounds each (Sigsbee's plate, No. 39).

Sigsbee-Belknap Sounding Rod.—Consisting of Commander Charles D. Sigsbee's detacher in connection with his modification of Capt. G. E. Belknap's (U. S. N.) sounding cylinder No. 2.

Commander Charles D. Sigsbee, United States Navy.

The subject of sounding rods, with especial reference to this rod, is discussed in Sigsbee's Deep-Sea Sounding and Dredging, pp. 39–51, the

Belknap cylinder No. 2 being shown in a foot-note on page 44. In that discussion the following are named as amongst the requirements of a perfect sounding rod for work with wire:

1. Certainty of not detaching the sinker during the descent.
2. Certainty of detaching on striking any character of bottom.
3. Certainty of not rehooking or of fouling with the sinker in any way after the same has once been tripped.
4. Adaptability to getting a specimen from the various kinds of bottom material.
5. Certainty of not grappling irretrievably with the bottom.
6. Certainty of retaining the specimen against the wash of water in the ascent.
7. Handiness for extracting the specimen and for cleaning the parts of the rod.
8. Freedom from changing its form under the severe pressure in deep water.
9. Strength, simplicity, cheapness, light weight, and freedom from corrosion.

In the Sigsbee-Belknap rod it has been attempted to cover these points. While the rod might be made lighter, its great strength serves a good purpose on hard rock. In his efforts to obtain a good form of sounding rod—one that would require but little watchful care in its operation—Commander Sigsbee, after much practice and experiment, decided to modify Captain Belknap's cylinder No. 2, and to apply his own detacher to this modification. The results with this rod have been most gratifying after more extended use than has probably ever been given to any other rod in sounding with wire. Commander Bartlett was the first to use it, in 1878–'79; on his first cruise he used it 250 times, and in no instance did it fail. Since that it has been used in hundreds of casts, and no complaints have been made of its operation. With the rod itself, and detailed drawings on exhibition, no special description of the rod is deemed necessary in this catalogue.

APPARATUS FOR PHYSICAL OBSERVATIONS, &c.

The Bailie-Tanner Thermometer Attachments, for serial and deep-sea temperatures, with the Negretti and Zambra deep-sea thermometers.

United States Fish Commission.

Case for use with a messenger.—The Negretti and Zambra deep-sea thermometers, which register by tripping, were adopted for use by the United States Fish Commission in 1878, and have been employed since then in all the explorations of that survey. During the first two years, the wooden case with shifting weight furnished by the makers was the only one used, but it frequently proved unreliable, especially when the vessel was rolling much. In 1880, Lieutenant Tanner, United States

Navy, constructed a metal case or cylinder for holding the thermometer tube, which could be tripped by means of a messenger sent down the wire from the steamer. More recently this same case has been perfected by Passed Assistant Engineer W. L. Bailie, United States Navy, who has added a clamp at the lower end for attaching it firmly to any part of the sounding wire.

The examples displayed are of the latest pattern. They consist of a brass tube about 11 inches long and seven-eighths of an inch in diameter inside, with slits on two opposite sides 5½ inches long by half an inch wide, through which the mercury and scale of the thermometer can be seen. The lower end of the tube, which is open, is pierced on the sides with four longitudinal rows of three holes each for the freer entrance of water, and terminates on one side in a hook for the suspension of a messenger. The clamp for the fixed attachment of the tube to the sounding wire is fastened to the upper part of the hook. It consists of a square piece of brass, raised on one side to form a flange or groove, into which a quadrant of an eccentric curve fits snugly against the sounding wire, being controlled by a stiff spring. The upper part of the case is fitted with a "messenger head," designed by Lieutenant Tanner, and consisting of a tube 2 inches long, which screws onto the main tube. It is furnished on top with a perforated screw cap, and has a slot on one side three-fourths of an inch long but of different widths, the upper one-third or slightly more being three-eighths of an inch wide and the lower two-thirds five-eighths of an inch wide, the sides of the slot curving abruptly from the lesser to the greater width. The slip hooks, for the attachment of the upper part of the case to the sounding wire during its descent through the water, pass through the slot, are 1½ inches long and project three-fourths of an inch outside. Their exposed portions are curved so that they meet only at the tips, leaving quite an open space within. They are held in place by a brass pin, which passes loosely through their inner ends, and fastens into the sides of the messenger head. A double wire spring, making three turns around the supporting pin on each side of the hooks, and passing underneath the hooks in front of the pin, forces the former up into the narrower part of the slot, in which they fit snugly and are held closely together. A strong pressure or blow from above throws them into the broader part of the slot where they readily open. The messenger is an elongate piece of round brass, 1¾ inches long by 1 inch in diameter, and is bored with a three-fourths inch hole. It is rounded at both ends and furnished with a bale above for suspending it; its weight is about 6 ounces. The entire case is of brass.

To prepare the case for use, a Negretti and Zambra deep-sea thermometer is passed into the long tube, where it is held in place by means of two rubber bushings. The sounding wire is fastened into the lower clamp and passed through the open space between the slip hooks, which are then allowed to come together at the ends. A messenger has been previously placed upon the sounding wire, and hangs suspended from a hook attached to the guiding pulley of the sounding machine. The thermometer is now lowered in the ordinary way, and after it has been down a sufficient length of time the messenger is dispatched with a quick throw. No failure to trip the thermometer by this means has been noted since the introduction of this style of case. It has been used successfully and repeatedly down to depths of 700 and 800 fathoms, but in very deep water too much time would be required for the downward passage of the messenger, and for such purposes an automatic attachment is substituted for the messenger head.

The weight of this case is such that, having once tripped, no movement of the vessel while rolling can cause it to revert to its original upright position, even for a short interval of time. For taking serial temperatures, as many of these cases as are required may be attached to the same sounding wire, and arranged at suitable distances apart. The same number of messengers are strung upon the wire, the upper one being suspended from the sounding machine and the remainder in succession from the hook of each thermometer case, excepting the lower. The tripping of the upper case frees the messenger hanging from it, which falls to the second case, and so the action continues to the end of the series. When taking serial temperatures the larger size of sounding wire, (No. 18, American gauge), elsewhere described, is necessary to sustain the extra weight of the several thermometer cases.

Automatic attachment.—The automatic attachment devised by Mr. Bailie replaces the messenger head on the above-described case, when working in such depths of water that too much valuable time would be lost in the descent of a messenger. It consists of a cylinder 3 inches long by 2 inches across outside, containing a spindle furnished about the middle with three curved propeller blades, each $1\frac{3}{8}$ inches long and three-fourths of an inch broad. The cylinder is fitted above with an open-work screw cap, having a nut in the center; below it is cut broadly away on two sides, to permit of the free entrance of water, and is joined to a smaller cylinder, about $1\frac{3}{4}$ inches long, which screws onto the tube containing the thermometer. The slip-hooks are hinged together in the center, pass out through a large square slot in the side of the smaller cylinder, and are closed at the points by being pressed together at their inner ends, the reverse action allowing them to open. The spindle, which extends vertically through the larger cylinder, is furnished with a screw thread above the blades, by means of which it screws up and down through the nut in the cap. The lower part of the spindle is 2 inches long and smooth; for the upper $1\frac{1}{2}$ inches of its length it is over one-fourth of an inch thick, but beyond that it rapidly diminishes in size to a diameter of less than one-eighth of an inch. This termination of the spindle is called the cone end. The entire lower portion of the spindle, below the blades, is free to enter the smaller cylinder through a small hole in the top, providing no obstruction is interposed. It passes between the inner extremities of the slip-hooks, and controls their opening and closing. When the spindle is screwed up so that the blades are close to the cap, the smaller or cone end of the spindle is between the hooks, and allows them to open freely. As the motion of the spindle is reversed, however, the broader part is gradually forced between the hooks, causing their outer ends to come together and bind closely. A fulcrum attachment above the hooks permits of their being raised and opened, even when they are otherwise locked by the spindle, for the purpose of inserting the sounding wire. In the water the movements of the spindle are entirely controlled by the propeller blades.

To prepare for use, the sounding wire is clamped at the lower end of the case, as before described, and passed through the opening between the slip-hooks, which are locked by screwing down the spindle. The case is now ready for lowering. As it passes down through the water, the upward current produced through the cylinder tends to keep the hooks locked by the force it exerts against the blades. As soon, however, as the reeling in begins the direction of the current is changed, the blades revolve in the opposite way, screwing the spindle up through the nut until the cone end comes between the hooks, when the latter open, release the wire, and the tripping is accomplished. Again, the relative direction of the current is altered, and when the case reaches the surface the hooks will be found locked and ready for use without the necessity of screwing down the spindle by hand, the fulcrum attachment furnishing the means of opening the hooks for the insertion of the wire. Were the blades given free play through the entire length of the cylinder, they would require to traverse about fifty fathoms before loosening the hooks. This extreme amount of play is allowed to insure against the tripping of the case by the violent pitching or rolling of the ship, and may be lessened to trip in any distance, down to one fathom, by means of a long, slender screw which enters the cylinder from below on one side. To further insure the propeller blades recovering in descent all the revolutions expended in the upward motion of the ship, in rolling or pitching, the blades are bent over at the top a distance of about one-eighth of an inch, at the same angle as the blades themselves, thus giving them more pitch with the current from the bottom than from the top, and compensating for the oblique action of the water through the broad slots at the lower end of the cylinder.

This style of thermometer case may be used as the upper one of a series for taking serial temperatures in deep water, the others being of the first described pattern and tripping in the same way.

Sigsbee's Water Specimen Cup, for obtaining specimens from a number of depths at a single haul.

Commander Charles D. Sigsbee, United States Navy.

It is believed that this is the only cup ever devised for this special purpose. A discussion of the cup and its operation is contained in Sigsbee's Deep-Sea Sounding and Dredging, published by the United States Coast and Geodetic Survey, in 1880 and in 1882, pages 90 to 98. The following description and explanation will give a general idea of the invention:

Parts of the cup.—A cylinder; a lower valve-seat which screws to the cylinder by a right-hand thread; a detachable upper valve-seat, detachable to allow the removal of the upper seat for cleaning; upper and lower poppet valves connected by an adjustable stem; a frame fastened to the cylinder with a left-hand thread, inclosing the upper valve-seat; a shaft with two sets of external screw threads; a propeller composed of two bent blades; a hub having an internal screw thread, a removable cup, and two beveled lugs; a screw cap or follower with milled head, two beveled slots, and internal screw threads; a removable sleeve and locking pin; a binding clamp, composed of a single wire lever, a pivot screw, and two contact lugs. The delicate working parts are of German silver, which does not corrode in sea water. All delicate screw threads are inclosed, as a protection against fouling by grit, &c.

Working.—The cup comes to the surface filled with water, the screw-follower down upon the upper valve, and the propeller resting upon the follower. To remove the water first screw up the propeller until it takes on the thread of the shaft; then screw up the follower until it uncouples from its thread. The valves may then be raised and the water discharged.

After the follower has been uncoupled the cup is automatic in its working, and it is only necessary to clamp it on the line with the spring binding clamp. Before paying out, the propeller may be screwed up to its fullest extent, but this is not necessary. As the cup descends the resistance of the water raises the valves, and also screws up the propeller until the lower thread in the hub clears the upper thread on the shaft, when the propeller uncouples and revolves freely on the shaft, where it is guided at top and bottom, which prevents chafe on the thread. Should a stoppage then be made to fasten on another cup, the propeller will not screw down by the rolling or pitching of the vessel.

It will be noticed that the blades are bent on their upper edges. With the blades thus bent, and the propeller made very light,* it has been found, experimentally, that by rising and falling equal distances through the water the propeller will screw up instead of down. Unless the propeller blades were bent, it is evident that the propeller would gradually screw down by a rising and falling motion, since its weight would aid in screwing down and resist in screwing up; but, even thus, experiments have shown that for an alternating motion through the water, continued for a longer time than any probable stoppage, the propeller would screw down only about a quarter of an inch, which is

* The propeller might be made of aluminum.

much within the margin of safety; and on relowering, the propeller in that case would again rise and uncouple. However, the bending of the blades overcomes any bad effects from the motion of the vessel, and the valves are free to open during the whole descent without regard to the number of stoppages made. At any stoppage each cup has within its cylinder a specimen of the water from the place where it stops.

On hauling in, the propeller of each cup screws down, by the resistance of the water, until the upper thread of the hub clears the lower thread of the corresponding screw on the shaft, when the propeller drops on the screw-follower, which until that time has been at rest, the lugs of the propeller clutch into the slots of the follower, and the latter is screwed down until it touches the upper valve, thus closing both valves. It is evident that the follower can be got out of this second position only by hand, for the lugs and slots being beveled the former can clutch the follower only in one direction. The resistance of the water, which would reverse the propeller at a stoppage on the ascent, would also lift the propeller clear of the screw-cap. If each propeller were regulated to close down the follower in passing through equal distances in water, each cup would be locked when the cup had passed through that distance after the beginning of the ascent. The follower is found screwed down so tight in coming out of the water that it can be set no tighter without endangering the thread. This favorable result is doubtless due, to some extent, to the expansion of the several metallic parts after leaving the frigid water of the lower depths.

Water Specimen Cup, for obtaining a single specimen at each haul, used by the United States Coast Survey before the invention of Sigsbee's water specimen cup. Represented by a diagram (Plate 19, of Sigsbee's series).

United States Coast and Geodetic Survey.

The structure of this cup is clearly shown on the plate. It is furnished with independent poppet valves, which are free to open and close at all times.

Hilgard's Ocean Salinometer, for determining the density of sea water by means of a glass float.

Prof. J. E. Hilgard, Superintendent United States Coast Survey.

"This instrument consists of a single float, about 9 inches in length. The scale extends from 1.020 to 1.031, in order to give sufficient range for the effect of temperature. Each unit in the third place, or thousandths of the density of fresh water, is represented by a length of 0.3 of an inch, which is subdivided into five parts, admitting of an accurate reading of a unit in the fourth place of decimals by estimation. The float is accompanied by a copper can, with a thermometer inserted within the cavity, which is glazed in front. In use, the can is nearly filled with water, so as to overflow when the float is inserted, the reading being then taken with ease at the top of the liquid. For convenience and security two such floats and the can are packed together in a suitable case, and a supply of floats and thermometers, securely packed in saw-dust, is kept on hand to replace the broken ones."

Hilgard's Optical Densimeter, for determining the density of sea water by means of a prism.

Prof. J. E. Hilgard, Superintendent United States Coast Survey.

"* * * When we get away from local conditions and inquire into the general regimen of the ocean, affected in part by the fresh water outflow from the continents, but mainly by the general thermal circulation, it becomes important to measure the differences of density with the greatest precision that can practically be obtained. * * * The method of ascertaining the density with hydrometers does not permit of great precision on shipboard, because the float partakes of the movements of the vessel, and oscillates between wide limits—wider in proportion to its sensitiveness, and generally unconformable to the oscillations of the ship. Hence it becomes very difficult to read the average position of the float with a sufficient degree of precision unless the sea be exceptionally calm. * * *

"With this view the optical densimeter has been devised, which obviates all the difficulties arising from the movement of the vessel. The basis of this instrument is the change in the refractive power of a saline solution of greater or less density. The instrument consists, substantially, of a hollow prism filled with the water under observation, transmitting from a collimating telescope a line of monochromatic light to an observing telescope, in which the refracted position of that line is read by means of a micrometer. The monochromatic light employed is a sodium flame, obtained by adding a small proportion of a solution of common salt to the alcohol of the lamp. The temperature of the liquid under observation is found by means of a thermometer inserted through the neck of the hollow prism, but which is withdrawn when the optical observation is made.

"The glass prism rests on three little knobs, so as to have a firm support. Attached to the stand carrying the telescopes are two guides, by means of which the prism is made always to occupy exactly the same position, so that all observations are made under the same angle. A small thumb-screw on the side of the prism forces it closely into the guides. It is obvious that the sensibility of this apparatus is not affected by the movements of the vessel, and that its power of measurement might be increased, by either enlarging or increasing the power of the telescopes or by introducing an additional prism. But it will be seen at once that the practical accuracy is limited to the ascertainment of the temperature at which the observation is made."

Cans for observing Ocean Currents, devised by the late Professor Henry Mitchell. Represented by a diagram (Sigsbee's series of plates, No. 5).

United States Coast and Geodetic Survey.

"The two cans are made of galvanized sheet iron, and are of the same shape and size—a cylinder, 11 inches long by 8 inches in diameter, the upper being surmounted by a cone, 3 inches in height. At the top of each is a small aperture. In use, the aperture of the lower can is kept open for the entrance of water, to facilitate the sinking of the can and prevent its being crushed under pressure, while that of the upper can is kept closed by a cork, no water being admitted. The cans are connected by a length of sounding wire (diameter .028 inches), and are so loaded with old scraps of lead or iron, or with pebbles, that when set adrift the lower can will sink to the full extent of the connecting wire, while the upper can will be submerged only to the base of its conical top, thus making the submerged surface of the two cans equal. For observing surface currents, the lower can is sunk to a depth of one or two fathoms, simply to counteract the effect of wind and surface wash on the floating can. For subsurface currents, it is lowered to the depth at which it is desired to know the current, the distance being regulated by the connecting wire. To the upper can is attached a graduated line, marked for knots and tenths, the length of each knot being 50.7 feet, to correspond to a time interval of 30 seconds. Sometimes a few fathoms of stray-line are interposed between the floating can and the initial mark, the last being a white rag. Observations are made from the boat, as a station point; those for velocity being made after the manner of observing the speed of a vessel with the log chip. The direction of the movement of the can is obtained by compass from the station point."

MARINE ZOOLOGICAL STATIONS.

The Agassiz Zoological Laboratory, at Newport, Rhode Island, for advanced students in biology. Represented by plans.

Alexander Agassiz.

In establishing this laboratory Mr. Agassiz says, "I hope, by giving facilities each year to a few advanced students from the Museum (of Comparative Zoology) and teachers in our public schools, to prepare, little by little, a small number of teachers, who will have had opportunities for their studies hitherto unattainable."

His description of the laboratory is as follows: "The new laboratory erected by me at Newport is 25 feet by 45. The six windows for work are on the north side, and extend from the ceiling to within 18 inches of the floor. In the spaces between the windows and the corners of the building are eight work tables, 3 feet by 5, covered with white tiles, 1 foot of the outer edge being covered, however, with black tiles for greater facility in detecting minute animals on a black background. Between the windows movable brackets with glass shelves are placed; while similar brackets extend across the windows and between the tables, thus providing a shelf at any desired height. The tables for microscopic work are three-legged stands of varying height, adapted to the different kinds of microscopes in use. The whole of the northern side of the floor, upon which the work tables and microscope stands are placed, is supported upon brick piers and arches, independent of the main brick walls of the building, which form at the same time the basement of the building. The rest of the floor is supported entirely upon the outside walls and upon columns with stretchers extending under the crown of the arches reaching to the northern wall. This gives to the microscope work the great advantage of complete isolation from all disturbance caused by walking over the floor. This will be duly appreciated by those who have worked in a building with a wooden floor, where every step caused a cessation of work, and was sure to disturb any object just at the most interesting moment. The floor is cemented and covered by a heavy oil-cloth. The center of the large room is occupied by a sink, on each side of which extend two long tables, 3 feet by 12. These are covered with different colored tiles, imitating mud, sand, gravel, sea-weed, black and white tiles, as well as red, yellow, blue, green, violet, to get all possible variety of background. A space at each end is covered with a glass plate, allowing the light to come from underneath, thus enabling the observer to examine larger specimens from the underside, without disturbing them when fully expanded. Two shorter and narrower tables, 18 inches by 7 feet, are placed half way between these central tables and the southern face of the building. These tables are intended for larger aquaria or dishes, and are covered with common marble slabs. There is a blank wall on the south side, the whole of which is occupied by closets and shelves for storing glass jars, reagents, bottles, dishes, &c. A space is devoted to books. The basement is used for the storage of alcoholic specimens, dredges, trawls, and other similar appliances. In the attic there is a large tank for salt water, and another for fresh. The rest of the attic will be eventually devoted to photographic rooms and room for an artist. The laboratory is supplied with salt water by a small steam pump, driven by a vertical boiler of 5 horse-power. This is kept going the whole time, day and night, the overflow of the tank being carried off by a large pipe. The water is taken some distance from the laboratory, and drawn up at a horizontal distance of 60 feet from the shore in a depth of some 4 fathoms, the end of the section pipe standing up vertically from the ground a height of 5 feet, and terminating in an elbow to prevent its becoming choked. The water is led through iron pipes coated inside with enamel. From the tanks the salt water is distributed in pipes extending in a double row over the central tables, over the long narrow tables for aquaria, and along the whole length of the glass shelves on the south wall.

Large faucets to draw off salt water are placed at each sink; and by a proper arrangement of valves it is possible to lead fresh water to a part of the pipes in case it is needed. The pipes leading over the tables and shelves are provided with globe valves and nozzles, to which rubber pipes can be attached and the water led to a vessel below. There are fifty such taps, each of which can supply water or air to at least three or four jars. The overflow runs into gutters laid alongside the tables, leading into the main drain pipe. To aerate the salt water, I use an injector invented by Professor Richards, of the Institute of Technology. This can be used to supply aerated water directly to the jar by providing it with a siphon overflow, or the aerated water can be collected in a receiver, from which air alone is then led to the jar. This latter course is the only practical one for delicate specimens, and for the bulk of the work of raising embryos. The east and west sides have large windows and doors provided with blinds. They always remain open, with the blinds closed to keep out sunlight, and serve to ventilate the laboratory thoroughly. Large tables for dissection, covered with slate, and adjoining a sink provided with fresh and salt water, are placed across the windows of these sides."

MAPS, MODELS, AND COLLECTIONS OF NATURAL HISTORY, ILLUSTRATING RESULTS OF EXPLORATIONS.

Relief Model of the western part of the North Atlantic, from Newfoundland to, and including, the Gulf of Mexico; based principally upon recent explorations by the United States Coast Survey steamer Blake and the soundings of H. M. S. Challenger, in 1873. Constructed under the direction of J. E. Hilgard, Superintendent of the United States Coast and Geodetic Survey, by A. and H. Lindenkohl, 1883.

Horizontal scale, $\frac{1}{2400000}$; vertical scale, 1,000 fathoms to one inch.

Relief Model of the Gulf of Maine, based upon the soundings of the United States Coast and Geodetic Survey, and constructed for the United States Commission of Fish and Fisheries, by A. and H. Lindenkohl, 1883.

Scale, $\frac{1}{600000}$. The signs "+" denote dredging stations of the United States Fish Commission, from 1871 to 1882.

Relief Model of the off-shore fishing-banks of Eastern North America, from New York to the eastern edge of the Grand Banks. Constructed for the United States Fish Commission by A. Lindenkohl.

Horizontal scale, $\frac{1}{1200000}$; vertical scale, $\frac{1}{72000}$; ratio of horizontal scale to vertical as 3 : 50.

Series of Charts and other Publications of the United States Coast and Geodetic Survey, showing sounding and dredging operations, &c. (For list see elsewhere in catalogue.)

Series of Charts of the Hydrographic Bureau, United States Navy, showing sounding operations. (For list see elsewhere in catalogue.)

Chart of Bering Strait, showing the surface isotherms observed in August and September, 1880, and the vertical isotherms observed September 5, 1880, by W. H. Dall, assistant, United States Coast and Geodetic Survey, in charge of the United States Coast Survey schooner Yukon. Published by the Survey.

Chart of Currents in Bering Sea and adjacent waters, 1881, compiled from various sources by William H. Dall, assistant, United States Coast and Geodetic Survey. Published by the Survey.

Twelve charts, showing the isobars in Alaska and adjoining region for every month of the year; twelve charts showing the isotherms for the same region and period; and four charts showing, for the same region, the curves of mean annual pressure, curves of mean annual temperature, distribution of plants and animals, and summer sea-surface temperatures and limits of trees, by William H. Dall, acting assistant, United States Coast and Geodetic Survey.

Published by the United States Coast and Geodetic Survey, Carlile P. Patterson, superintendent, in the Pacific Coast Pilot. Coasts and islands of Alaska. Washington, 1879.

Chart showing the dredging operations of the United States Fish Commission from 1871 to 1882, inclusive; compiled by Sanderson Smith.

The dredging stations are marked in red. Of the 1,700 hauls made during this period only about one-fourth are indicated, the remainder being in shallow water and in close proximity to others which are marked.

FISHES.

The catalogue of the marine and fresh-water fishes, showing results of investigations in that department, are given elsewhere, in a separate section, by Dr. Tarleton H. Bean.

*COLLECTION OF MARINE INVERTEBRATES FROM OFF THE EASTERN COAST OF NORTH AMERICA, ILLUSTRATING RECENT EXPLORATIONS BY THE UNITED STATES FISH COMMISSION AND UNITED STATES COAST SURVEY.**

PYCNOGONIDA.

Colossendeis colossea Wilson.

4982. Lat. 39° 59′ 45″ N.; long. 68° 54′ W.; 787 fathoms. United States Fish Commission.

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* Exhibited by the United States National Museum. As indicated in the list, many of the more interesting species were obtained by Gloucester fishing schooners, which have aided the Fish Commission greatly, since 1878, in making known the fauna of the Fishing Banks of Eastern North America.

CRUSTACEA.

Amathia Agassizii Smith.

4986. Lat. 39° 57′ N.; long. 70° 37′ W.; 192 fathoms. United States Fish Commission.

Collodes robustus Smith.

4832. Lat. 37° 26′ N.; long. 74° 19′ W.; 56 fathoms. United States Fish Commission.

Euprognatha rastellifera Stimpson.

3350. Lat. 40° 07′ 48″ N.; long. 70° 43′ 54″ W.; 67 fathoms. United States Fish Commission.

Lambrus Verrillii Smith.

4559. Lat. 39° 54′ N.; long. 69° 51′ 30″ W.; 134 fathoms. United States Fish Commission.

Geryon quinquedens Smith.

4941. Lat. 39° 34′ N.; long. 71° 56′ W.; 374 fathoms. United States Fish Commission.

Bathynectes longispina Stimp.

4987. Lat. 39° 54′ N.; long. 69° 51′ 30″ W.; 134 fathoms. United States Fish Commission.

Homola barbata White.

4988. Lat. 38° 33′ N.; long. 73° 18′ W.; 104 fathoms. United States Fish Commission.

Lithodes maia Leach.

3793. Lat. 43° 15′ N.; long. 60° 20′ W. Daniel McKennon.

Eupagurus politus Smith.

4989. Lat. 39° 54′ N.; long. 69° 44′ W.; 158 fathoms. United States Fish Commission.

Catapagurus Sharreri A. M-Edw.

3369. Lat. 39° 55′ N.; long. 70° 47′ W.; 229 fathoms. United States Fish Commission.

4985. Lat. 40° N.; long. 69° 19′ W.; 93 fathoms. United States Fish Commission.

Parapagurus pilosimanus Smith.

4619. Lat. 39° 53′ 30″ N.; long. 71° 13′ 30″ W.; 319 fathoms. United States Fish Commission.

Munida, sp.

3354. Lat. 38° 39′ N.; long. 73° 11′ W.; 130 fathoms. United States Fish Commission.

Pentacheles sculptus Smith.

4934. Lat. 33° 24′ 15″ N.; long. 76° 00′ 50″ W.; 464 fathoms. United States Coast Survey steamer Blake; A. Agassiz.

Ceraphilus Agassizii Smith.

4925. Lat. 35° 45′ 30″ N.; long. 74° 48′ W.; 263 fathoms. Steamer Blake.

Pontophilus brevirostris Smith.

3355. Lat. 40° 07′ 48″ N.; long. 70° 43′ 54″ W.; 67 fathoms. United States Fish Commission.

Sabinea princeps Smith.

4552. Lat. 39° 49′ 25″ N.; long. 69° 49′ W.; 616 fathoms. United States Fish Commission.

Pandalus borealis Kröyer.

4550. Lat. 43° 06′ N.; long. 65° 04′ 30″ W.; 90 fathoms. United States Fish Commission.

Pandalus leptocerus Smith.

4728. Lat. 40° 05′ N.; long. 68° 48′ W.; 194 fathoms. United States Fish Commission.

Pandalus Montagui Leach.

3946. Off Cape Cod, Massachusetts; 70 fathoms. United States Fish Commission.

Pandalus propinquus G. O. Sars.

4890. Lat. 38° 35′ N.; long. 73° 13′ W.; 312 fathoms. United States Fish Commission.

Eumiersia ensifera Smith.

4940. Lat. 41° 24′ 45″ N.; long. 65° 35′ 30″ W.; 1,242 fathoms. Steamer Blake.

Penœus constrictus Stimp.

4822. Lat. 37° 10′ N.; long 75° 08′ W.; 18 fathoms. United States Fish Commission.

Sergestes arcticus Kröyer.

4840. Lat. 38° 29′ N.; long. 73° 21′ W.; 435 fathoms. United States Fish Commission.

Syscenus infelix Harger.

4747. Lat. 39° 53′ N.; long. 69° 47′ W.; 317 fathoms. United States Fish Commission.

ANNELIDA.

Hyalinœcia artifex Verrill.

210. Off Martha's Vineyard, Massachusetts; 200 fathoms. United States Fish Commission.

Lœtmatonice armata Verrill.

224. Lat. 39° 48′ 30″ N.; long. 70° 54′ W.; 252 fathoms. United States Fish Commission.

MOLLUSCA.

Lestoteuthis Fabricii Verrill.

34225. Lat. 39° 52′ 30″ N.; long. 70° 17′ 30″ W.; 724 fathoms. United States Fish Commission.

Stoloteuthis leucoptera Verrill.

34221. Lat. 39° 43′ N.; long. 71° 32′ W.; 302 fathoms. United States Fish Commission.

Rossia Hyatti Verrill.

34222. Off Cape Cod, Massachusetts; 55 fathoms. United States Fish Commission.

Rossia sublevis Verrill.

34220. Lat. 40° 04′ N.; long. 68° 49′ W.; 234 fathoms. United States Fish Commission.

Argonauta argo Linné.

34224. Lat. 39° 34′ N.; long. 71° 56′ W.; surface. United States Fish Commission.

Alloposus mollis Verrill.

34218. Off Martha's Vineyard, Massachusetts; 300 fathoms. United States Fish Commission.

Octopus Bairdii Verrill.

34219. Lat. 40° 02′ N.; long. 70° 37′ 30″ W.; 101 fathoms. United States Fish Commission.

Octopus lentus Verrill.

34228. Le Have Bank. Gloucester fishing vessel.

Koonsia obesa Verrill.

34217. Lat. 39° 57′ N.; long. 70° 37′ W.; 192 fathoms. United States Fish Commission.

Salpa, sp (large species).

150. Lat. 40° N.; long. 69° 19′ W.; surface. United States Fish Commission.

ECHINODERMATA.

Lophothuria Fabricii Verrill.

5710. Off Cape Ann, Massachusetts; 25 fathoms. Schooner Young Sultan.

Pentacta frondosa Jæger.

5492. Off Cape Cod, Massachusetts; 35 fathoms. United States Fish Commission.

Schizaster fragilis L. Agassiz.

5719. Lat. 39° 55′ 28″ N.; long. 69° 47′ W.; 321 fathoms. United States Fish Commission.

Schizaster canaliferus L. Agassiz.

5563. Lat. 40° 02′ N.; long. 70° 37′ 30″ W.; 101 fathoms. United States Fish Commission.

Spatangus purpureus Leske.

5564. Lat. 39° 53′ N.; long. 69° 43′ W; 156 fathoms. United States Fish Commission.

Echinus gracilis A. Agassiz.

5732. Off Martha's Vineyard, Massachusetts; 100 fathoms. United States Fish Commission.

Goniocidaris papillata A. Agassiz.

5080. Lat. 38° 39′ N.; long. 73° 11′ W.; 130 fathoms. United States Fish Commission.

Asterias stellionura Perrier.

5011. Grand Banks; 200 fathoms. Schooner Howard.

Asterias Tanneri Verrill.

4118. Lat. 38° 39′ N.; long. 73° 11′ W.; 130 fathoms. United States Fish Commission.

Solaster endeca Forbes.

5734. Off Cape Cod, Massachusetts; 44 fathoms. United States Fish Commission.

Crossaster papposus Müll. & Tr.

4786. George's Bank. John Harrington.

Hippasteria phrygiana Agassiz.

5827. Off Cape Cod, Massachusetts; 44 fathoms. United States Fish Commission.

Diplopteraster multipes Verrill.

5694. Lat. 40° 05′ N.; long. 68° 48′ W; 194 fathoms United States Fish Commission.

Porania grandis Verrill.

5534. Lat. 39° 54′ N.; long. 69° 44′ W.; 158 fathoms. United States Fish Commission.

5733. Lat. 40° 04′ N.; long. 68° 49′ W.; 234 fathoms. United States Fish Commission.

Porania spinulosa Verrill.

5718. Off Cape Cod, Massachusetts; 90 fathoms. United States Fish Commission.

Odontaster hispidus Verrill.

5550. Lat. 40° 02′ N.; long. 70° 45′ W.; 89 fathoms. United States Fish Commission.

Archaster americanus Verrill.

5008. Off Newport, R. I.; 150 fathoms. United States Fish Commission.

Archaster Agassizii Verrill.

4701. Off Martha's Vineyard; 150 fathoms. United States Fish Commission.

Archaster Floræ Verrill.

4145. Lat. 39° 58′ N.; long. 70° 06′ W.; 146 fathoms. United States Fish Commission.

Luidia elegans Perrier.

5088. Lat. 39° 58′ N.; long. 70° 06′ W.; 146 fathoms. United States Fish Commission.

Tremaster mirabilis Verrill.

5707. Banquereau; 250 fathoms. Schooner Herbert M. Rogers.

Ophioscolex glacialis Müll. & Tr.

5585. Lat. 39° 57′ N.; long. 70° 37′ W.; 192 fathoms. United States Fish Commission.

Ophioglypha Sarsii Lyman.

5826. Off Marthas Vineyard; 100 fathoms. United States Fish Commission.

Astrochele Lymani Verrill.

5579. Lat. 40° 01′ N.; long. 68° 54′ W.; 640 fathoms. United States Fish Commission.

Astrophyton Agassizii Stimp.

5829. Off Cape Cod, Massachusetts; 25 fathoms. United States Fish Commission.

Astrophyton Lamarckii Müll. & Tr.

5706. Lat. 40° N.; long. 55° 50′ W. Schooner Alice M. Williams.

Astrophyton eucnemis Müll. & Tr.

5695. Grand Banks; 200 fathoms. Schooner Howard.

ANTHOZOA.

Pennatula aculeata Dan.

4141. Lat. 44° 17′ N.; long. 58° 10′ W.; 120 fathoms. Schooner Grace L. Fears.

5608. Lat. 39° 58′ N.; long. 69° 42′ W; 202 fathoms. United States Fish Commission.

Pennatula borealis Sars.

5725. Grand Banks; 150 fathoms. Schooner Plymouth Rock.

5726. Lat. 43° 25′ N.; long. 60° W; 250 fathoms. Schooner Plymouth Rock.

5727. Banquereau; 150 fathoms. Schooner Alice M. Williams.

Balticina Finmarchica Gray.

5728. Anticosti Island. Schooner Procter Brothers.

5729. Fishing banks. Schooner Wachusett.

5730. St. Peter's Bank; 175 fathoms. Schooner David A. Story.

5731. Banquereau; 175 fathoms. Schooner Alice M. Williams.

Anthoptilum grandiflorum Verrill.

5721, 5722. Lat. 45° 25′ N.; long. 57° 10′ W.; 170 fathoms. Schooner Howard.

5724. St. Peter's Bank. Gloucester fishing vessel.

Acanella Normani Verrill.

5696. Off Martha's Vineyard; 150 fathoms. United States Fish Commission.

Ceratoisis ornata Verrill.

4229. Banquereau; 300 fathoms. Schooner N. H. Phillips.

Primnoa reseda Verrill.

4601. Near George's Bank. Schooner Alice G. Wonson.

5828. Lat. 42° 06′ N.; long. 63° 15′ W.; 200 fathoms. Schooner Alice G. Wonson.

Acanthogorgia armata Verrill.

5697. Edge of Grand Banks. Lat. 44° 32′ N.; 170–300 fathoms. Schooner Guy Cunningham.

Paragorgia arborea Edw. & H.

4089. East of Sable Island; 280 fathoms. Schooner Magic.

4568. Lat. 43° 25′ N.; long. 60° W.; 250 fathoms. Schooner Plymouth Rock.

Anthomastus grandiflorus Verrill.

5708. Lat. 44° 02′ N.; long. 59° W.; 325 fathoms. Schooner Marion.

5709. Grand Banks; 175 fathoms. Schooner Marion.

Anthothela grandiflora Verrill.

5705. Lat. 44° 13′ N.; long. 58° 02′ W.; 175 fathoms. Schooner Bellerophon.

Actinernus nobilis Verrill.

5701. Lat. 44° 03′ N.; long. 58° 26′ W.; 250 fathoms. Schooner Procter Brothers.

5702. Lat. 43° 14′ N.; long. 61° 07′ W.; 250 fathoms. Schooner Alice G. Wonson.

5703. Lat. 43° 30′ N.; long. 60° 25′ W.; 50 fathoms. Schooner G. P. Whitman.

5704. Lat. 43° 42′ N.; long. 59° 10′ W. Gloucester fishing vessel.

Urticina nodosa Verrill.

5712. Lat. 49° 09′ N.; long. 52° 03′ W.; 180 fathoms. Schooner Alice M. Williams.

5713. (Var. *tuberculosa*.) Western Bank. Schooner Mystic.

5714. (Var. *tuberculosa*.) Off Cape Negro, Nova Scotia. Schooner Martha C.

5715. Lat. 43° 53′ N.; long. 59° 04′ W.; 150 fathoms. Gloucester fishing vessel.

5716. Grand Banks. Schooner Admiral.

5717. Lat. 44° 17′ N.; long. 58° 10′ W.; 120 fathoms. Schooner Grace L. Fears.

5823. (Var. *A*.) Lat. 43° 19′ N.; long. 60° 36′ W.; 250 fathoms. Schooner Wachusett.

5824. (Var. *A*.) Grand Banks. Schooner Plymouth Rock.

5825. (Var. *B*.) Western Bank; 300 fathoms. Schooner Nathaniel Webster.

Urticina multicornis Verrill.

5503. Off Cape Cod, Massachusetts; 44 fathoms. United States Fish Commission.

Urticina callosa Verrill.

5430. Lat. 39° 54′ N.; long. 70° 37′ W.; 225 fathoms. United States Fish Commission.

Boloeera Tuediæ Gosse.

5445. Lat. 39° 54′ N.; long. 70° 37′ W.; 225 fathoms. United States Fish Commission.

Cerianthus borealis Verrill.

5493. Lat. 40° 01′ N.; long. 71° 02′ W.; 125 fathoms. Schooner Josie Reeves.

Epizoanthus paguriphilus Verrill.

4619. Lat. 39° 53′ 30″ N.; long. 71° 13′ 30″ W.; 319 fathoms. United States Fish Commission.

Flabellum Goodei Verrill.

5700. Lat. 44° 46′ N.; long. 56° 10′ W; 265 fathoms. Schooner Augusta H. Johnson.

PORIFERA.

Cladorhiza grandis Verrill.

995. George's Bank; 150 fathoms. Schooner Alice G. Wonson.

996. Fishing Banks. Schooner Conductor.

Dorvillia echinata Verrill.

997. Lat. 43° 17′ N.; long. 51° 25′ W.; 175 fathoms. Schooner Plymouth Rock.

*COLLECTION OF FRESH-WATER CRAYFISHES (Astacidæ) FROM THE UNITED STATES, CONTAINING NEARLY ALL THE DESCRIBED SPECIES.**

Cambarus acutus Girard.

3382. Wheatland, Knox County, Indiana. R. Ridgway.

Cambarus Clarkii Girard.

3359. Mississippi River, near New Orleans. G. Dunbar's Sons.

Cambarus troglodytes Hagen.

4053. Oakley, South Carolina. F. W. Haywood.

Cambarus Blandingii Erich.

3381. Columbia, South Carolina. M. McDonald.

Cambarus fallax Hagen. (?)

4969. Saint John's River, Florida. Museum of Comparative Zoology, Cambridge, Massachusetts.

Cambarus Le Contei Hagen.

4958. Mobile, Alabama. Museum Comparative Zoology. (Type.)

Cambarus spiculifer Hagen.

4962. Athens, Georgia. Museum Comparative Zoology.

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* Exhibited by the United States National Museum. This collection has been named by Prof. Walter Faxon, of the Museum of Comparative Zoology, Cambridge, Massachusetts.

Cambarus versutus Hagen.

4963. Spring Hill, Alabama. Museum Comparative Zoology. (Type.)

Cambarus pellucidus Erich.

4970. Mammoth Cave, Kentucky. Museum Comparative Zoology.

Cambarus affinis Erich.

4904. Havre de Grace, Maryland. T. H. Bean.

4893. Potomac River, Gunston, Virginia. M. McDonald.

Cambarus virilis Hagen.

4900. Milwaukee, Wisconsin. E. G. Blackford.

Cambarus placidus Hagen.

4966. Lebanon, Tennessee. Museum Comparative Zoolcgy. (Type.)

Cambarus juvenilis Hagen.

4967. Kentucky River, Little Hickman, Kentucky. Museum Comparative Zoology.. Form 1. (Type.)

Cambarus propinquus Girard.

4851. Illinois. G. W. Milner.

Cambarus obscurus Hagen.

4971. Genesee River, Rochester, New York. Museum Comparative Zoology. (Type.)

Cambarus rusticus Girard.

4968. Cincinnati, Ohio. Museum Comparative Zoology. (Type.)

Cambarus immunis Hagen.

4866. Milwaukee, Wisconsin. E. G. Blackford. (♂, Form II.)

Cambarus extraneus Hagen.

4957. Tennessee River, near Bridge of Georgia. Museum Comparative Zoology. (Type.)

Cambarus Bartoni Erich.

3835. Carlisle, Pennsylvania. S. F. Baird.

Cambarus robustus Girard.

4961. Forestville, New York. Museum Comparative Zoology. (Type.)

Cambarus obesus Hagen.

2163. Locality unknown. 4973. Decatur, Illinois. Museum Comparative Zoology. (Form I.)

Cambarus latimanus.

3374. South Carolina (?) M. McDonald.

Cambarus advena Hagen.

4964. Georgia. Museum Comparative Zoology.

Cambarus Carolinus Erich.

4972. Mobile, Alabama. Museum Comparative Zoology. (Type of Hagen.)

Cambarus gracilis Bundy.

4960. Decatur, Illinois. Museum Comparative Zoology.

Cambarus Sloanii Bundy.

4965. New Albany, Indiana. Museum Comparative Zoology. (Form I and II.)

Cambarus spinosus Bundy.

4881. Cypress Creek, Lauderdale County, Alabama. Herrick.

Astacus Gambelii.

4855. Santa Barbara, California. Dr. Webb.

Astacus nigrescens Stimpson.

4974. San Francisco, California. Museum Comparative Zoology.

Astacus Trowbridgii Stimpson.

2080. Astoria, Columbia River, Oregon. Trowbridge. (Types.)

Astacus Klamathensis Stimpson.

3899. Walla Walla, Washington Territory. Captain Bendire, United States Army.

Astacus leniusculus Dana.

2161. Oregon (?)

COLLECTION OF AMERICAN FRESH WATER SPONGES.

Prepared by Mr. Edward Potts, of Philadelphia, and presented by him to the United States National Museum.

MICROSCOPIC PREPARATIONS.

Spongilla paupercula Bowerbank.

1. Lake Cochituate, Boston, Massachusetts. Opaque.
2. Lake Cochituate, Boston, Massachusetts. Transparent.
3. Lake Cochituate, Boston, Massachusetts. Spicules.

Spongilla aspinosa Potts.

4. Absecum, New Jersey. Opaque.
5. Absecum, New Jersey. Transparent.
6. Absecum, New Jersey. Spicules.

Spongilla lacustris Johnston.

7. European form, received from H. J. Carter.
8. (?) Ridley Creek, Media, Pennsylvania. Opaque.
9. (?) Ridley Creek, Media, Pennsylvania. Transparent.
10. (?) Ridley Creek, Media, Pennsylvania. Spicules.
11. Chester County, Pennsylvania. Transparent.
12. (?) White Haven, Pennsylvania. Transparent.
13. Var. *mutica* Potts, Lansdowne, Pennsylvania. Opaque.
14. Var. *mutica* Potts, Lansdowne, Pennsylvania. Transparent.
15. Var. *mutica* Potts, Lansdowne, Pennsylvania. Spicules.
16. Var. *Dawsoni* Bk.
19. Var. *multiforis* Carter.

Spongilla montana Potts.

17. Catskill Mountains, New York. Transparent.
18. Catskill Mountains, New York. Spicules.

Spongilla fragilis Leidy.

20. Type, from a specimen in the collection of the Academy of Natural Sciences of Philadelphia.
21. Schuylkill River, Philadelphia, Pennsylvania. Opaque.
22. Schuylkill River, Philadelphia, Pennsylvania. Transparent.
23. Schuylkill River, Philadelphia, Pennsylvania. Spicules.
24. Ridley Creek, Media, Pennsylvania. Transparent.
25. Var. *Ottawaensis* Dawson. Buffalo, New York.
26. Var. *minuta* Potts. Lehigh Gap, Pennsylvania.
27. Var. *minutissima* Potts. Lake Hopatcong, New Jersey. Opaque.
28. Var. *minutissima* Potts. Lake Hopatcong, New Jersey. Transparent.
29. Var. *minutissima* Potts. Lake Hepatcong, New Jersey. Spicules.
30. Var. *irregularis* Potts. Lake Hepatcong, New Jersey.
31. Var. *Lordii* Bk. From Bowerbank's type specimens.

Meyenia Leidii Bk.

32. Phillipsburg, New Jersey. Opaque.
33. Schuylkill River, Pennsylvania. Opaque.
34. Schuylkill River, Pennsylvania. Transparent.
35. Schuylkill River, Pennsylvania. Spicules.

Meyenia fluviatilis Johnston.

36. European form, received from H. J. Carter.
37. (?) Chester Creek, Pennsylvania. Opaque.
38. (?) Chester Creek, Pennsylvania. Transparent.
39. (?) Chester Creek, Pennsylvania. Spicules.
40. Var. *astrosperma* Potts. Lehigh Gap, Pennsylvania. Opaque.
41. Var. *astrosperma* Potts. Lehigh Gap, Pennsylvania. Transparent.
42. Var. *astrosperma* Potts. Lehigh Gap, Pennsylvania. Spicules.
43. Var. *acuminata* Potts. Lake Cochituate, Boston, Massachusetts. Opaque.
44. Var. *acuminata* Potts. Lake Cochituate, Boston, Massachusetts. Transparent.
45. Var. *acuminata* Potts. Lake Cochituate, Boston, Massachusetts. Spicules.

Meyenia robusta Potts.

46. Honey Lake Valley, California.

Meyenia crateriforma Potts.

47. Brandywine County, Pennsylvania. Opaque.
48. Brandywine County, Pennsylvania. Transparent.
49. Brandywine County, Pennsylvania. Spicules.

Meyenia Everetti Mills.

50. Berkshire County, Massachusetts. Opaque.
51. Berkshire County, Massachusetts. Transparent.
52. Berkshire County, Massachusetts. Spicules.

Heteromeyenia repens Potts.

57. Lehigh Gap, Pennsylvania. Opaque.
58. Lehigh Gap, Pennsylvania. Transparent.
59. Lehigh Gap, Pennsylvania. Spicules.

Heteromeyenia argyrosperma Potts.

60. Lehigh Gap, Pennsylvania. Opaque.
61. Lehigh Gap, Pennsylvania. Transparent.
62. Lehigh Gap, Pennsylvania. Spicules.
63. Var. *tenuis* Potts. Lake Hepatcong, New Jersey. Opaque.
64. Var. *tenuis* Potts. Lake Hepatcong, New Jersey. Transparent.
65. Var. *tenuis* Potts. Lake Hepatcong, New Jersey. Spicules.

Heteromeyenia Baleni Potts.

66. Plainfield, New Jersey. Opaque.
67. Plainfield, New Jersey. Transparent.
68. Plainfield, New Jersey. Spicules.

Heteromeyenia Ryderi Potts.

69. Indian River, Philadelphia, Pennsylvania. Opaque.
70. Indian River, Philadelphia, Pennsylvania. Transparent.
71. Indian River, Philadelphia, Pennsylvania. Spicules.
72. White Haven, Pennsylvania.
73. White Haven, Pennsylvania.

Carterius tubisperma Mills.

85. Niagara River, New York. Opaque.
86. Niagara River, New York. Transparent.
87. Niagara River, New York. Spicules.

Carterius tenosperma Potts.

88. Lansdowne, Pennsylvania. Opaque.
89. Lansdowne, Pennsylvania. Transparent.
90. Lansdowne, Pennsylvania. Spicules.

Carterius latitenta Potts.

91. Chester Creek, Pennsylvania. Opaque.
92. Chester Creek, Pennsylvania. Transparent.
93. Chester Creek, Pennsylvania. Spicules.

Tubella reticulata Bk.

94. Rio Amazonas, Brazil. Transparent.
95. Rio Amazonas, Brazil. Spicules.

Tubella Pennsylvanica Potts.

96. Lake Hepatcong, New Jersey. Opaque.
97. White Haven, Pennsylvania. Transparent.
98. Lehigh Gap, Pennsylvania. Spicules.

Tubella Fanshawei Potts.

99. Bristol, Pennsylvania.

Parmula Batesii Bk.

100. Rio Amazonas, Brazil. Opaque.
101. Rio Amazonas, Brazil. Transparent.
102. Rio Amazonas, Brazil. Spicules.

Parmula Brownii, Bk

103. British Guiana, South America. Transparent.

Uruguaya corallioides Bk.

104. Uruguay River, South America. Spicules.

DRIED PREPARATIONS, CONTAINED IN BOTTLES.

Spongilla aspinosa Potts.

998. Absecum, New Jersey.

Spongilla lacustris Johnston.

999. Chester Creek, Pennsylvania.
1000. Fairmount, Philadelphia, Pennsylvania.

Spongilla fragilis Leidy.

1001. Schuylkill River, Philadelphia, Pennsylvania.
1002. Ridley Creek, Pennsylvania.
1003. Fairmount Locks, Philadelphia, Pennsylvania.
1004. Niagara River, New York.
1005. Brandywine Creek, Philadelphia, Pennsylvania.

Meyenia Leidii Bk.

1006. Fairmount, Philadelphia, Pennsylvania.

Meyenia fluviatilis Johnston.

1007. Var. *astrosperma* Potts. Lehigh Gap, Pennsylvania.
1008. Var. *asperrima* Dawson. Buffalo, New York.

Heteromeyenia repens Potts.

1009. Lake Hepatcong, New Jersey.

Carterius tubisperma Mills.

1010. Niagara River, New York.

Carterius latitenta Potts.

1011. Chester Creek, Pennsylvania.

Tubella Pennsylvanica Potts.

1012. Lake Hepatcong, New Jersey.
1013. White Haven, Pennsylvania.

COLLECTION OF MOUNTED MARINE ALGÆ FROM THE ATLANTIC AND PACIFIC COASTS OF THE UNITED STATES, PREPARED BY PROF. WILLIAM G. FARLOW, OF HARVARD COLLEGE, CAMBRIDGE, MASSACHUSETTS.

This collection, exhibited by the United States National Museum, comprises specimens collected by Mr. F. W. Hooper and Dr. Palmer, at Key West; by Dr. Farlow, on the New England coast; by Prof. D. C. Eaton, from various sources; by A. R. Young, at New York; Mrs. A. S. Davis, at Cape Ann; Mrs. Beebe, at Gloucester, Massachusetts; Mrs. B. D. Halstead, at Swampscott; Mr. H. Averill, at New York; Dr. L. R. Gibbes, in South Carolina; Miss M. A. Booth, at Orient, Long Island; and from California and Oregon by Dr. C. L. Anderson, Capt. I. Stratton, Rev. E. Hall, Mr. H. Hemphill, Mr. D. Cleveland, and Mr. W. H. Dall.

Amansia multifida, Lmx. Key West.

Dasya Gibbesii, Harv. Key West.

Dasya elegans, Ag. Chenille. Cape Cod.
Dasya ramosissima, Harv. Key West.
Dasya Harveyi, Ashmead. Key West.
Dasya mollis, Harv. Key West.
Dasya mucronata, Harv. Key West.
Dasya Wurdemanni, Bailey. Key West.
Dasya callithamnion, Harv. San Diego.
Dasya Tumanowiczi, Gatty. Key West.
Dasya lophoclados, Mont. Key West.
Dasya plumosa, Bail. and Harv. Santa Cruz, California.
Bostrychia Montagnei, Harv. Key West.
Bostrychia calamistrata, Mont. Key West.
Bostrychia Moritziana, Mont. Florida.
Polysiphonia urceolata, Grev. Nahant, Massachusetts. Var. *formosa*, New England.
Polysiphonia Havanensis, Mont. Var. *Binneyi*, Ag. Key West.
Polysiphonia ferulacea, Ag. Key West.
Polysiphonia Olneyi, Harv. Dough-balls. Long Island Sound.
Polysiphonia Harveyi, Bail. Nigger-hair. Wood's Holl, Massachusetts.
Polysiphonia elongata, Grev. Lobster-claws. Gay Head, Massachusetts.
Polysiphonia violacea, Grev. Wood's Holl, Massachusetts.
Polysiphonia fibrillosa, Grev. Wood's Holl, Massachusetts.
Polysiphonia variegata, Ag. Wood's Holl, Massachusetts.
Polysiphonia pennata, Ag. California.
Polysiphonia parasitica, Grev. California. Var. *dendroidea*, Ag. California.
Polysiphonia Baileyi, Ag. Pacific coast.
Polysiphonia pecten-veneris, Harv. Florida.
Polysiphonia atrorubescens, Grev. Wood's Holl, Massachusetts.
Polysiphonia bipinnata, Post. and Rupr. West coast.
Polysiphonia Woodii, Harv. West coast.
Polysiphonia nigrescens, Grev.
Polysiphonia fastigiata, Grev. Nahant, Massachusetts.
Odonthalia aleutica, Ag. Oregon.
Odonthalia Lyallii, Harv. Neeah Bay, Washington Territory.
Rhodomela larix, Ag. California.
Rhodomela floccosa, Ag. Aleutian Islands.
Rhodomela subfusca, Ag. Gloucester, Massachusetts. Var. *gracilis*, same limits. Var. *Rochei*, Long Island Sound.
Digenia simplex, Ag. Key West.
Bryothamnion triangulare, Ag. Key West.
Bryothamnion Seaforthii, Ag. Florida.
Alsidium Blodgettii, Harv. Key West, Florida.
Acanthophora Thierii, Lmx. Florida to Brazil; Pacific Ocean.
Acanthophora muscoides, Ag. Florida.
Chondria dasyphylla, Ag. Cape Cod.

Chondria striolata, Ag. (*C. Baileyana*, Mont.) Cape Cod.
Chondria tenuissima, Ag. Wood's Holl, Massachusetts.
Chondria littoralis, Harv. Wood's Holl, Massachusetts.
Chondria atropurpurea, Harv. Key West, Florida.
Laurencia pinnatifida, Lmx. Pepper dulse. California.
Laurencia virgata, Ag. California.
Laurencia obtusa, Lmx. Florida.
Laurencia implicata, Ag. Key West.
Laurencia cervicornis, Harv. Key West; San Diego, California.
Laurencia gemmifera, Harv. Florida.
Laurencia papillosa, Grev. Florida.
Laurencia paniculata, Ag. San Diego, California.
Chylocladia ovalis, Hook. (*Lomentaria*, Endl.) California.
Grinnellia Americana, Harv. Wood's Holl, Massachusetts.
Delesseria sinuosa, Lmx. Gloucester, Massachusetts.
Delesseria quercifolia, Bory. California.
Delesseria alata, Lmx. Gloucester, Massachusetts.
Delesseria hypoglossum, Lmx. Charleston, South Carolina.
Delesseria tenuifolia, Harv. Key West.
Delesseria involvens, Harv. Key West.
Delesseria Leprieurii, Mont. New York.
Delesseria decipiens, Ag. West coast. Neeah Bay, Washington Territory.
Nitophyllum punctatum, var. *ocellatum*, Grev. Key West.
Nitophyllum spectabile, Eaton, MSS. California.
Nitophyllum laceratum, Grev. California.
Nitophyllum latissimum, Ag. California.
Nitophyllum areolatum, Eaton, MSS. California.
Nitophyllum (*Neuroglossum*) *Andersonii*, Ag. California.
Nitophyllum Ruprechtianum, Ag. West coast.
Calliblepharis ciliata, Kütz. Cape Ann, Massachusetts.
Gracilaria multipartita, Ag., var. *angustissima*, Harv. New York.
Gracilaria cervicornis, Ag. Key West.
Gracilaria confervoides, Grev. Florida; California.
Gracilaria armata, Ag. Key West.
Corallina officinalis, L. Cape Ann.
Corallina squamata, Ellis and Sol. San Diego, California.
Jania rubens, Lmx. San Diego, California.
Jania capillacea, Harv. Key West.
Amphiroa fragillissima, Lmx. Florida.
Amphiroa nodulosa, Kütz. Florida.
Amphiroa debilis, Kütz. Florida.
Amphiroa Californica, Decaisne. West coast.
Melobesia farinosa, Lmx. East coast.
Melobesia pustulata, Lmx. Wood's Holl, Massachusetts.
Lithothamnion polymorphum, Aresch. Eastport, Maine.

Hildenbrandtia rosea, Kütz. Eastport, Maine.
Gelidium corneum, Lmx. Florida; New Haven, Connecticut.
Gelidium cartilagineum, Grev. San Diego, California.
Gelidium Coulteri, Harv. California.
Wurdemannia setacea, Harv. Key West.
Eucheuma isiforme, Ag. Key West.
Eucheuma ? acanthocladum, Ag. (*Chrysymenia*, Harv). Key West.
Hypnea musciformis, Lmx. Wood's Holl, Massachusetts.
Hypnea cornuta, Ag. Key West.
Rhodymenia palmata, Grev. Common dulse. Swampscott, Massachusetts.
Rhodymenia palmetta, Grev. California.
Rhodymenia corallina, Grev. California.
Euthora cristata, Ag. Gloucester, Massachusetts.
Plocamium coccineum, Lyngb, var. *flezuosum*. West coast.
Stenogramma interrupta, Mont. California.
Pikea Californica, Harv. California.
Champia parvula, Harv. Noank, Connecticut.
Lomentaria Baileyana, Farlow (*Chylocladia*, Harv). New York Bay.
Lomentaria rosea, Thuret. Gay Head, Massachusetts.
Rhabdonia tenera, Ag. (*Solieria chordalis*, Harv). Wood's Holl, Massachusetts.
Rhabdonia Coulteri, Harv. California.
Cordylocladia conferta, Ag. San Diego, California.
Polyides rotundus, Ag. Cape Ann, Massachusetts.
Peyssonnelia atro-purpurea, Crouan ? Key West.
Nemalion multifidum, Ag. Watch Hill, Rhode Island.
Scinaia furcellata, Bivon. Gay Head, Massachusetts.
Liagora valida, Harv. Florida.
Liagora pinnata, Harv. Florida.
Liagora pulverulenta, Ag. Key West.
Wrangelia penicillata, Ag. Key West.
Phyllophora Brodiæi, Ag. Long Island Sound.
Phyllophora membranifolia, Ag. Long Island Sound.
Gymnogongrus Norvegicus, Ag. (including *G. Torreyi*, Ag.). Peak's Island, Maine.
Gymnogongrus tenuis, Ag. California.
Gymnogongrus Griffithsiæ, Ag. California.
Gymnogongrus linearis, Ag. California.
Ahnfeltia gigartinoides, Ag. West coast.
Ahnfeltia plicata, Fr. Cape Ann, Massachusetts.
Cystoclonium purpurascens, Kütz. Block Island, Rhode Island.
Callophyllis variegata, Ag. California.
Callophyllis obtusifolia, Ag. San Diego, California.
Callophyllis discigera, Ag. California.
Gigartina acicularis, Lmx. Florida.

Gigartina canaliculata, Harv. West coast.
Gigartina mamillosa, Ag. Portland, Maine; Santa Cruz, California.
Gigartina microphylla, Harv., and var. *horrida*. California.
Gigartina radula, Ag. West coast.
Chondrus crispus, Lyngb. Irish moss. Cape Ann, Massachusetts. Very common.
Chondrus affinis, Harv. California.
Iridæa laminarioides, Bory. (including *Iridæa minor* and *Iridæa dichotoma*). West coast.
Endocladia muricata, Ag. West coast.
Cryptonemia crenulata, Ag. Key West.
Chrysymenia halymenioides, Harv. Key West.
Chrysymenia uvaria, Ag. Key West.
Halymenia ligulata, Ag., var. *Californica;* Santa Cruz, California.
Halymenia Floresia, Ag. Key West.
Prionitis lanceolata, Harv. West coast.
Prionitis Andersonii, Eaton, MSS. Santa Cruz, California.
Schizymenia edulis, Ag. Oregon.
Schizymenia? coccinea, Harv. Santa Cruz, California.
Grateloupia Gibbesii, Harv. Charleston, South Carolina.
Grateloupia Cutleriæ, Kütz. California.
Grateloupia filicina, Ag. Florida.
Halosaccion hydrophora, Ag. West coast.
Halosaccion fucicola, Post. and Rupr. West coast.
Halosaccion ramentaceum, Ag. Eastport, Maine.
Spyridia aculeata, Kütz. Florida.
Spyridia filamentosa, Harv. Wood's Holl, Massachusetts.
Microcladia Coulteri, Harv. West coast.
Microcladia Californica, Farlow. California.
Microcladia borealis, Rupr. West coast.
Centroceras clavulatum, Ag. Key West.
Centroceras Eatonianum, Farlow. West coast.
Ceramium nitens, Ag. Key West.
Ceramium rubrum, Ag. East coast.
Ceramium Deslongchampsii, Ch. Eastport, Maine.
Ceramium diaphanum, Roth. California.
Ceramium strictum, Harv. New England.
Ceramium Youngii, Farlow, MSS. Canarsie, Long Island.
Ceramium tenuissimum, Lyngb. Key West.
Ceramium fastigiatum, Harv. Southern New England.
Ceramium ———. Key West.
Ptilota densa, Ag. California.
Ptilota hypnoides, Harv. California.
Ptilota plumosa, Ag., var. *filicina*, West coast. Var. *serrata*. Eastport, Maine, and Neeah Bay, Washington Territory.
Ptilota elegans, Bonnem. New York.

Gloiosiphonia capillaris, Carm. Cape Ann, Massachusetts.
Crouania attenuata, J. Ag. Key West.
Griffithsia Bornettiana, Farl. Wood's Holl, Massachusetts.
Callithamnion tetragonum, Ag. Orient, Long Island.
Callithamnion Baileyi, Harv. New York.
Callithamnion ptilophora, Eaton, MSS. California.
Callithamnion Borreri, Ag. New Haven, Connecticut.
Callithamnion byssoideum, Arn. Long Island Sound.
Callithamnion corymbosum, Ag. Beverly, Massachusetts.
Callithamnion versicolor, Ag., var. *seirospermum*, Harv. New York.
Callithamnion plumula, Lyngb. Gay Head, Massachusetts.
Callithamnion heteromorphum, Ag., MSS. California.
Callithamnion Americanum, Harv. New York.
Callithamnion Pylaisæi, Mont. Gloucester, Massachusetts.
Callithamnion floccosum, Ag., var. *pacificum*, Harv. Neeah Bay, Washington Territory.
Callithamnion cruciatum, Ag. New York.
Callithamnion Lejolisia, Farlow, MSS. San Diego, California.
Callithamnion Turneri, Ag. New York.
Callithamnion Rothii, Lyngb. New England Coast.
Callithamnion roseum, Lyng. New York.
Porphyra vulgaris, Ag. Laver. East coast.
Bangia fuscopurpurea, Lyngb. East coast.
Chantransia efflorescens, Thur. Gay Head, Massachusetts.
Chantransia virgatula, Thuret. Portland, Maine.
Erythrotrichia ceramicola, Aresch. Cape Ann, Massachusetts.
Padina pavonia, Lmx. Peacock's tail. Key West, Florida.
Zonaria lobata, Ag. Key West.
Zonaria flava, Ag. San Diego, California.
Taonia Schrœderi, Ag. Florida.
Dictyota fasciola, Lmx. Florida; Mediterranean Sea.
Dictyota dichotoma, D. C. Charleston.
Dictyota ciliata, Ag. Key West.
Dictyota Kunthii, Ag. San Diego, California.
Dictyota acutiloba, Ag. Key West.
Sargassum vulgare, Ag. Atlantic Ocean.
Sargassum bacciferum, Ag. Gulf-weed. Gulf Stream.
Sargassum dentifollium, Ag. Key West.
Sargassum Agardianum, Farlow, MSS. San Diego, California.
Turbinaria vulgaris, Ag. Key West.
Fucus fastigiatus, Ag. West coast.
Fucus distichus, L. (*F. filiformis*, Gm.). Swampscott, Massachusetts.
Fucus furcatus, Ag. Marblehead, Massachusetts.
Fucus vesiculosus, L. Rock-weed. Swampscott, Massachusetts.
Fucus serratus, L. Nova Scotia.

Nereocystis Lütkeana, Post. and Rupr. Great bladder-weed. Monterey, California, and northward.
Alaria esculenta, Grev. Badderlocks. Henware. Cape Cod.
Laminaria saccharhina, Lmx. Devil's apron; Kelp. New York, northward; West coast; Europe; Japan ?.
Laminaria longicruris, De la Pyl. Devil's apron; Kelp. New England.
Laminaria flexicaulis, Le Jolis. Devil's apron; Kelp. New England.
Agarum Turneri, Post. and Rupr. Sea-colander. Nahant, Massachusetts.
Stilophora rhizodes, Ag. Vineyard Sound.
Asperococcus sinuosus, Bory. Key West.
Asperococcus echinatus, Grev. New England coast.
Hydroclathrus cancellatus, Bory. Noank, Connecticut.
Ralfsia verrucosa, Aresch. Nahant, Massachusetts.
Chorda filum, Stack. New York.
Chordaria flagelliformis, Ag. Eastport, Maine.
Chordaria abietina, Rupr. Santa Cruz, California.
Chordaria divaricata, Ag. Gloucester, Massachusetts.
Castagnea virescens, Thuret. Wood's Holl, Massachusetts.
Leathesia tuberiformis, Gray. Watch Hill, Rhode Island.
Elachista fucicola, Fr. New England.
Myrionema strangulans, Grev. Wood's Holl, Massachusetts.
Myrionema Leclancherii, Harv. Gloucester, Massachusetts.
Cladostephus spongiosus, Ag. Newport, Rhode Island.
Cladostephus verticillatus, Ag. Gay Head, Massachusetts.
Sphacelaria fusca, Ag. On *Amphiroa Californica*. San Diego, California.
Sphacelaria radicans, Ag. New England.
Ectocarpus firmus, Ag. (*E. littoralis*, Harv.) New England.
Ectocarpus Farlowii, Thuret. Peak's Island, Maine.
Ectocarpus siliculosus, Lyngb. Charleston, South Carolina.
Ectocarpus viridis, Harv. Orient, Long Island.
Ectocarpus fasciculatus, Harv. New England coast.
Ectocarpus granulosus, Ag. Santa Cruz, California.
Ectocarpus Hooperi, Harv. Greenport, Long Island.
Desmarestia aculeata, Lmx. Eastport, Maine.
Desmarestia viridis, Lmx. New York.
Desmarestia ligulata, Lmx. Monterey, California.
Punctaria latifolia, Grev., and var. *zosteræ*, Le Jolis. Eastport, Maine.
Punctaria plantaginea, Grev. New England.
Phyllitis fascia, Ktz. Eastport, Maine.
Scytosiphon lomentarius, Ag. Eastport, Maine.
Caulerpa prolifera, Lmx. Florida.
Caulerpa crassifolia, Ag., var. *Mexicana*. Florida.
Caulerpa plumaris, Ag. Florida.
Caulerpa Ashmeadii, Harv. Key West.
Caulerpa ericifolia, Ag. Florida.

Caulerpa cupressoides, Ag. Key West.
Caulerpa lanuginosa, Ag. Key West.
Caulerpa paspaloides, Bory. Florida.
Caulerpa clavifera, Ag. Florida.
Halimeda opuntia, Lmx. Florida.
Halimeda tuna, Lmx. Florida.
Halimeda tridens, Lmx. Key West.
Udotea flabellata, Lmx. Key West.
Udotea conglutinata, Lmx. Key West.
Codium tomentosum, Stack. Florida; var. *damæcornis*. West coast.
Chlorodesmis ? Key West.
Bryopsis plumosa, Lmx. Eastern coast.
Bryopsis hypnoides, Lmx. Key West.
Vaucheria piloboloides, Thuret. Wood's Holl, Massachusetts.
Dasycladus occidentalis, Harv. Florida.
Dasycladus clavæformis, Ag. Key West.
Acetabularia crenulata, Lmx. Florida.
Cymopolia barbata, Lmx. Key West.
Chamædoris annulata, Mont. Key West.
Penicillus dumetosus, Dne. Florida; West Indies.
Penicillus capitatus, Lmx. Mermaid's shaving-brush. Florida.
Blodgettia? confervoides, Harv. Key West.
Anadyomene flabellata, Lmx. Key West.
Dictyosphæria favulosa, Dne. Key West.
Ascothamnion intricatum, Kütz. Key West.
Enteromorpha intestinalis, Link. New England.
Enteromorpha compressa, Grev. New England.
Enteromorpha clathrata, Grev. New England coast.
Ulva latissima, Linn. Sea-lettuce. New England coast.
Ulva fasciata, Delile. California.
Cladophora membranacea, Ag. Key West.
Cladophora rupestris, L. Cape Ann, Massachusetts.
Cladophora arcta, Dillw. Cape Ann, Massachusetts.
Cladophora lanosa, Roth. Orient, Long Island.
Cladophora uncialis, Fl. Dan. New England coast.
Cladophora lætevirens, Dillw. Key West, Florida.
Cladophora fracta, Fl. Dan. Eastern coast.
Chætomorpha Picquotiana, Mont. Cape Ann, Massachusetts.
Chætomorpha melagonium, Web. and Mohr. Cape Ann, Massachusetts.
Chætomorpha sutoria, Berk. Stonington, Connecticut.
Chætomorpha brachygona, Harv. Key West.
Chætomorpha tortuosa, Dillw. Eastport, Maine.
Hormotrichum Younganum, Dillw. New England coast.
Lyngbya majuscula, Harv. Cape Cod.
Lyngbya ferruginea, Ag. New England coast.
Lyngbya Kützungiana, Thur. Eastern coast.

Calothrix confervicola, Ag. East coast.
Calothrix scopulorum, Ag. East coast.
Sphærozyga Carmichaelii, Harv. Wood's Holl, Massachusetts.
Petrocelis cruenta, Ag. Eastport, Maine.
Spirulina tenuissima, Kütz. Eastport, Maine.
Chnoöspora fastigiata, Ag. San Diego, California.
Hormactis Farlowi, Bornet. East coast.

HERBARIUM OF NORTH AMERICAN ALGÆ.

Prepared by W. G. Farlow, C. L. Anderson, and D. C. Eaton.

SPECIMENS OF ROCK FORMATION FROM DEEP WATER OFF THE NEW ENGLAND COAST.

These specimens were derived as follows: one from Station 1124, United States Fish Commision, lat. 40° 01′ N., long. 68° 54′ W., depth 340 fathoms; one from George's Bank, depth 70-200 fathoms, collected by a Gloucester fishing schooner, and presented by J. D. Lloyd, Gloucester; and one from George's Bank, depth not recorded, collected by a Gloucester fishing schooner.

Prof A. E. Verrill wrote as follows, in 1878, and again in 1882, regarding the discovery of these rock specimens:

"One of the most important results of the investigations by the United States Fish Commission, in 1878, was the discovery of a hitherto unknown geological formation, apparently of great extent, belonging probably to the Miocene or later Tertiary. The evidence consists of numerous large fragments of eroded, but hard, compact, calcareous sandstone and arenaceous limestone, usually perforated by the burrows of *Saxicava rugosa*, and containing in more or less abundance fossil shells, fragments of lignite, and in one case a spatangoid sea-urchin. Probably nearly one-half of the species are northern forms, still living on the New England coast, while many others are unknown upon our coasts, and are apparently, for the most part, extinct. From George's Bank about a dozen fossiliferous fragments have been obtained, containing more than twenty-five distinct species of shells. These fragments came from various parts of the bank, including the central part, in depths varying from 35 to 70 fathoms, or more. From Banquereau we received one specimen of similar rock, and from the Grand Banks two similar specimens. At present, it appears probable that these fragments have been detached from a very extensive submerged Tertiary formation, at least several hundreds of miles in length, extending along the outer banks, from off Newfoundland nearly to Cape Cod, and perhaps constituting, in large part, the solid foundations of these remarkable submarine elevations."

"At several localities off the southern coast of New England, during the summer of 1882, the United States Fish Commission steamer Fish-hawk dredged up at several stations, but especially in depths of 234, 351, and 640 fathoms, fragments and nodular masses, or concretions, of a peculiar calcareous rock, evidently of deep-sea origin, and doubtless formed at or near the places where it was obtained. These specimens varied in size from a few inches in diameter up to one irregular nodular mass, taken at station 1124, in 640 fathoms, which was 29 inches long, 14 broad, and 6 thick, with all parts well rounded. This probably weighed 60 pounds or more. The masses differ much in appearance, color, texture, and fineness of grain, but they are all composed of grains of siliceous sand, often very fine, cemented by more or less abundant calcareous matter. The sand consists mainly of rounded grains of quartz, with some feldspar, mica, garnet, and magnetite. It is like the loose sand dredged from the bottom in the same region. The calcareous cementing material seems to have been derived mainly from the shells of foraminifera in the same region. In some cases I was able to identify distinct casts of foraminifera, and in some pieces of rock distinct fossil shells were found, apparently of recent species. It is probable that these rocks belong to a part of the same formation as has been previously recorded from the fishing banks farther east. No rocks of this kind are found on the dry land of this coast."