

Figure 21.--Deck of the Fish Hawk showing hoisting and reeling engine and winch used by Baird and Verrill in the exploration of New England Coast. About 1885.

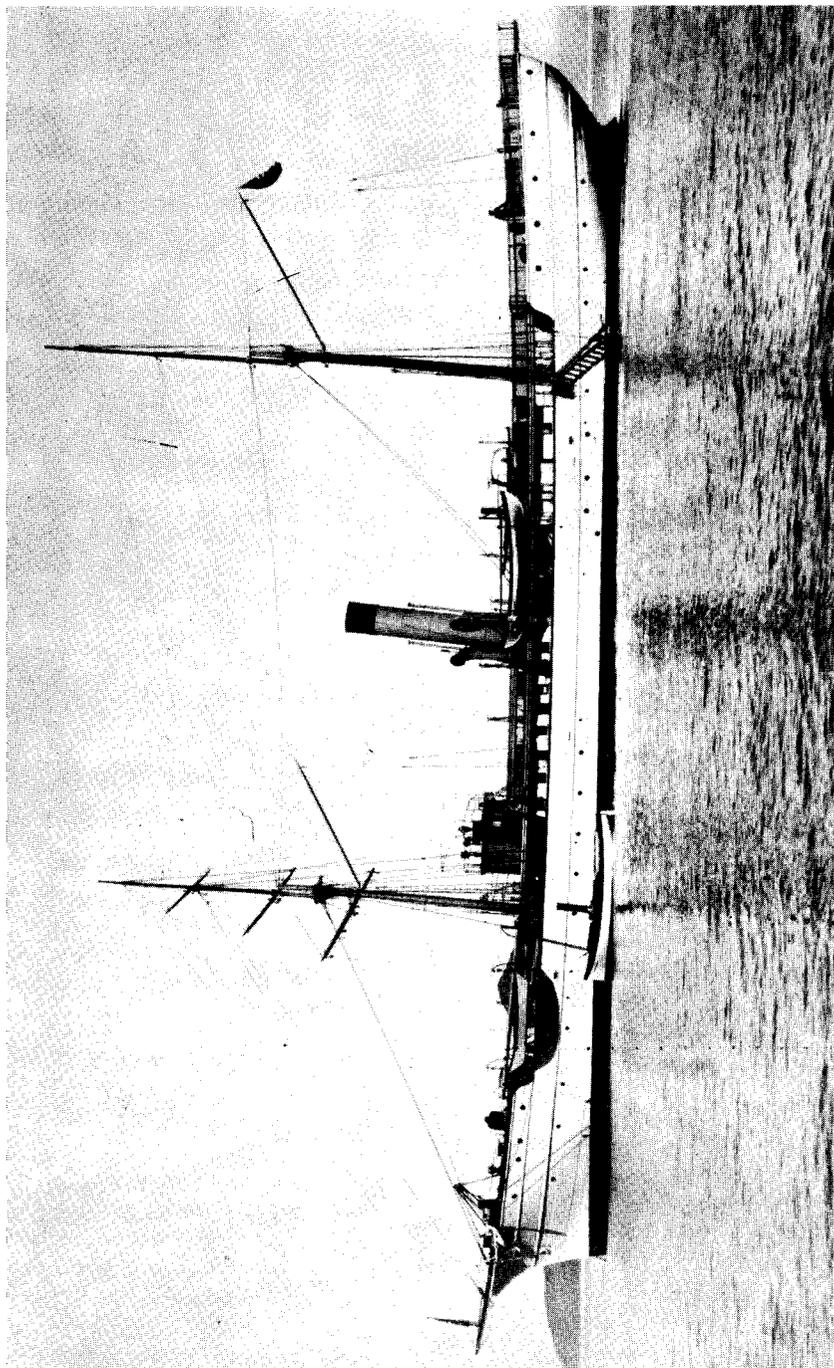


Figure 22.--J. S. S. Albatross. Photograph from the National Archives.

photographic dark room and chemical laboratory. There was plenty of storage cases and lockers for jars, bottles, and various collecting gear. A supply of alcohol was stored under the laboratory in an iron-walled room which could be isolated from the rest of the ship. In case of fire, this room could be quickly filled with steam.

The dredging engine was provided with additional "gypsy heads" for hoisting boats, and was equipped with a friction brake to regulate the paying out of the rope. The dredging wire was 3/8-inch diameter galvanized steel. It was composed of six strands wound around a tarred hemp heart; each strand consisted of seven wires. The wire weight was 1.32 pounds per fathom in air, and 1.2 pounds in water. The ship carried 4,000 fathoms in one length and later on received additional reels in 500-fathom lengths. A newly designed sounding reel, various trawls, dredges, nets, and recording thermometers were on board the Albatross for conducting oceanographic research. Every technical detail of the laboratory arrangement and equipment indicated good planning and understanding of technical research problems by Baird and his principal collaborators. Tanner incorporated many original ideas into the design, construction, and operation of the ship and its naval equipment; Verrill was primarily concerned with the laboratories and their equipment.

In 1883 the Albatross was prepared to undertake oceanographic investigations in any part of the world. Her explorations made a glorious chapter of U.S. marine research, and the name Albatross became famous in all civilized parts of the world. It is interesting to read the comments about this ship written by the famous American explorer, Alexander Agassiz, who in 1890 was asked by Marshall McDonald, at that time the U. S. Commissioner of Fish and Fisheries, to take charge of deep-sea exploration off Panama. The Albatross was offered under the conditions that Agassiz should supply the coal, thoroughly re-equip the ship, and pay part of the running expenses. In return, he was to get first choice of the collections that were of special interest to him. Upon reaching Panama late in February 1891, Agassiz boarded the Albatross, and in his letter home described the ship in the following words: "The working accommodations are fine, an upper room 20 feet x 20 feet for rough work and general laboratory, and a second floor below for storing the collection in racks. We ought to do well. . . . My cabin opens out into a good-sized dining room and sitting room of about 12 feet by the width of the ship, where Tanner and I sit and take our meals. It has large portholes, a fine skylight, and is very airy and comfortable." Upon completing a preliminary trip and returning to Panama after an absence of 20 days, Agassiz wrote: "The Albatross is an excellent sea boat and she rides the sea wonderfully well, and really much better than many

large ocean steamers I have been on. . . . You can have no idea how comfortable the trip has been. . . . The accommodations for work and for taking care of the collections are excellent. . . . The laboratory, with its ingenious arrangements and its excellent accommodations for work by day and night, was to me a revelation." (Agassiz, 1913). Agassiz usually made three or four deepwater dredging or trawling hauls every day, and at the same time the surface net was towed.

The seaworthy qualities of the Albatross and the comfort of its laboratory facilities and living quarters were admired by a number of other scientists who, in following years, took part in her deep-sea explorations.

Occasionally the Albatross was detailed to Woods Hole, but she never became an integral part of the station. Her life ended here. The ship was decommissioned in October 1921, and laid up at the Bureau's dock at Woods Hole. On June 5, 1924, she was sold at public auction. When the old and friendly ship was being towed away a few older members of the Bureau of Fisheries, who in previous years had been associated with her, watched her final departure with their hearts filled with sadness.

In issuing orders to the commanding officers of the Commission's ships, it was Baird's policy to outline a precise program of the proposed operations and explain their purpose. The following document issued on April 10, 1883, to the commanding officer of the Albatross is a good example of the thoroughness of his planning (Tanner, 1885, p. 119-20).

"Sir: As soon as you can be ready for the service (of which you will give me a week's notice), you will go to sea for the purpose of investigating the conditions which govern the movements of the mackerel, menhaden, bluefish, and other migratory species along the coast of the United States in the spring, commencing your investigations off Hatteras, or in the region where these fish usually make their first appearance, and following up the schools in their movements.

"The special work to be performed will be to determine the rate of progress of the fish along the coast, their comparative abundance and condition, the places where they first show themselves, the physical condition of their surroundings as to temperature and currents of the water, its chemical and biological peculiarities, etc.

"You will endeavor to ascertain whether the appearance of the fish at or near the surface depends upon the condition of temperature, wind or sky, and also, by the use of the apparatus at your command, what character of food in the water seems to determine their movements. You will cause examination to be made of the stomachs of such of these fish as you can capture and carefully preserve a portion at least of the contents of the stomach for immediate or future examination.

"Should you deem it expedient you will cruise off the coast a sufficient distance to determine the outward line of motion of the fish, and you will communicate to such fishing vessels as you may meet any information that may enable them the more successfully to prosecute their labors. The time of this work is left to your discretion. You will whenever you touch at any port of the United States send a telegram to me and await instructions as to further operations, if there be nothing to detain you.

"You will give to the naturalist of the expedition all possible facilities for collecting and preserving such specimens as you may meet during the cruise.

Very respectfully,

Spencer F. Baird, Commissioner

P. S. --The operations of dredging and trawling should be carried on as frequently as opportunity offers; and if no suitable bait can be had, the trawling line should be used for the purpose of determining the currents of desirable fishing grounds. "

Baird considered that explorations in the sea should be conducted simultaneously with the laboratory studies on reproduction, development, behavior, and growth of commercially important marine species. He was proud to explain the significance of such research and to demonstrate its methods to other scientists, government officials, and laymen. Being well known and highly respected both in the Congressional and administrative circles of Washington, he was in a position to invite the highest officials to visit Woods Hole. The report of the commanding officer of the Fish Hawk for 1882 (Tanner, 1884b, p. 9-10) contains the following interesting references: "At 9:00 on the morning of the 28th (of June, 1882) the U. S. Steamer Tallapoosa arrived, having on board the Hon. W. E. Chandler, Secretary of the Navy, and chiefs of bureaus. At meridian we left the harbor with Prof. Baird, the Secretary, and the chiefs of bureaus, for a short trip to show the manner of working the various apparatus used on board. Three casts of the dredge and trawl were made in Vineyard Sound, and at 4:30 p. m. we returned to Woods Hole. The Tallapoosa left the harbor at 9:15 the next morning. "

On September 6 of the same year, Woods Hole was visited by the President of the United States, Chester A. Arthur. The official report of the Commanding Officer records this event in the following words: "At 9:30 a. m. , September 6, The United States Steamer Despatch, having on board the President of the United States, and accompanied by the Fish Commission steamer Lookout, arrived in the harbor. At meridian we left the harbor with the President, Professor Baird, and others on board. To show the former the manner of working the various apparatus, three hauls of the trawl and dredge were made in Menemsha Bight. We reached port at 5:55 p. m. , when the President returned to

the Despatch. At 5:00 the next morning the Despatch, with the President on board, got under way and left the harbor." Edwin Linton (1927), at that time a beginner-biologist employed by the Fish Commission, described this event in his reminiscences of the Fish Commission: "I remember, on one occasion, the President of the United States was there over night, was given an exhibition trip on the Fish Hawk, and the process of operating the beam trawl was shown him. Now we young assistants, coming as we did from inland, knew nothing at first hand about Presidents and their ways, or of the ways of those who were accustomed to be about them. When we were told that there was to be a collecting trip in the morning we reported for duty in our usual unconventional attire. By the time the Fish Hawk was steaming out into Vineyard Sound we made the discovery that officers and crew, and everybody else on board, were each and all dressed in honor of the Chief Executive, all bravely clad, and easy in their minds, except three young men who were having all the disagreeable sensation peculiar to those who dream of like unpleasant experience. I remember yet quite vividly, the appraising look which the Professor gave us just before, as it seemed to us, he decided not to present us to President Arthur."

The work of the Fisheries Laboratory and the operations of the Fish Hawk continued to arouse public curiosity excited by the visits of high officials. Local papers faithfully reported the sailing and returning of the ships and the successes of the collecting as well as the arrivals and departures of Baird. Thus the Cape Cod Item of July 15, 1881, contains the following note: "Our streets present a very animated and business-like appearance with the arrival of the U. S. Fish Commission under the supervision of Prof. Spencer F. Baird of the Smithsonian Institute, Washington, D. C., who with his family and corps of attendants is quartered in the Webster House, among which are the following: Dr. Tarlton H. Bean, J. Paul Wilson, Herbert Gill, Prof. C. Deering, Capt. Herbert Chester of U. S. F. C., Prof. J. Emerton, Prof. A. E. Verrill, Sydney L. Smith, New Haven. The Commission have at their command two steamers, one the Fish Hawk, Z. L. Tanner U. S. N., Commander, for the purpose of going to various points to dredge for specimens, and the Lookout, a fine steam yacht for the purpose of accommodating distinguished visitors. Various lines of telephone will connect the depot, post office, hotel, wharves, and buildings used by the Commission."

In the following days of summer the paper reported (August 19, 1881) that "among important specimens obtained by the U. S. Steamer 'Fish Hawk' on the last trip to Gulf Stream, was a fine octopus or devil-fish, a number of tile fish weighing about 35 pounds each, was also secured, the same being a very rare specimen." From miscellaneous news items in the paper we learn that Assistant U. S. Fish Commissioner T. B. Ferguson arrived in port

on board the U. S. S. Lookout and brought "a large sunfish weighing 300 pounds which was dissected by Dr. Bean who also found many parasites attached to gills." On the 14th of July, we read that the steamer Fish Hawk went to No Mans Island securing four ground fishes. During the trip a trawl net was used collecting many fish, mollusks, crabs, etc. The large number of specimens collected by biologists apparently incited the imagination of the local reporter who on July 29 wrote (Cape Cod Item) that "on last dredging expedition of the U. S. F. C. Steamer Fish Hawk 172 barrels of alcohol were used in preserving specimens." In the next issue of this weekly paper a correction was printed which said "our correspondent wrote 1-1/2 but types read it 172-- quite a difference."

News items appearing in the local press are indicative of public interest in the new laboratory, which offered new opportunities for employment and trade, attracted tourists, and in this way became an important factor in the economy of the small village. At the same time the press emphasized the importance of the tourist trade and encouraged the owners of "farm houses to make them attractive to summer visitors." The number of tourists was rapidly increasing as can be judged, for instance, from the following lines in an August 19, 1881, issue of the Cape Cod Item: "Last week Saturday the 4:10 train started from Boston with 18 cars loaded with passengers and about every train since has been filled. Undoubtedly many of them took advantage of the opportunity to visit the marine laboratory of the Fish Commission."

Probably the most significant achievements of marine exploration in the vicinity of Cape Cod were the studies of the invertebrate fauna conducted by Verrill, and described by him in a large number of papers. He strongly believed it to be a duty of a scientist to publish the results of his investigation for the benefit of other scientists. Following this conviction, he produced nearly a hundred scientific articles based on the collections accumulated during his association with the U. S. Fish Commission. The majority of the papers appeared in reports attached to the annual reports of the Commissioner of Fish and Fisheries; others were published in the American Journal of Science, the Transactions of the Connecticut Academy of Arts and Sciences, and other journals. The collection of invertebrates made by the Fish Commission from 1871 to 1887 at over 3,000 localities within New England waters comprised several hundred thousands of specimens of more than 2,000 species (Verrill, 1958). The huge collection was taken by Verrill to Yale University in New Haven where he continued to work on it during the winters. As a partial compensation for his work he received the duplicates after the first set of specimens

containing all the type specimens and any unique forms had been deposited with the National Museum in Washington, D. C. The second set of duplicates was given to the Museum of Comparative Zoology of Harvard University. Verrill completed the study of the Fish Commission collection only in 1908 and, according to the information given in his biography, he sold his set of duplicates to the Peabody Museum of Yale University.

Verrill's work provided a basis for our knowledge of bottom invertebrates in the immediate vicinity of Woods Hole and the adjacent areas extending to the 100-fathom line or farther offshore to some extent. His report upon the invertebrate animals of Vineyard Sound and the adjacent waters with an account of the physical characters of the region, published in 1871, has not lost its scientific value to the present day, and remains a major source of information about bottom communities of this area. Likewise, are his "Report on the Cephalopoda of the Northeastern Coast of America" (Verrill, 1882), "Results of the Explorations made by the Steamer 'Albatross' off the Northern Coast of the United States" (Verrill, 1885), and "Notice of a Remarkable Marine Fauna Occupying the Outer Banks off the Southern Coast of New England, and of some Additions to the Fauna of Vineyard Sound" (Verrill, 1884). In the latter paper he describes the rich fauna in the region about 105 miles along the 100 fathom line between latitudes $35^{\circ}40'$ and $40^{\circ}22'$ N. and longitudes $69^{\circ}15'$ and $71^{\circ}32'$ W. According to his conclusion, the number of species and the abundance of individuals in this area "is due very largely to the annual uniformity of the temperature enjoyed at all seasons of the year, at all those depths that are below the immediate effects of the atmospheric changes. The region . . . is subject to the combined effects of the Gulf Stream on one side and the cold northern current of the other, together with the gradual decrease in temperature in proportion to the depth."

He describes also the effects of the Gulf Stream in bringing "vast quantities of free-swimming animals which furnish an inexhaustable supply of food for many bottom animals". After Verrill's time, the study of bottom invertebrate communities on the offshore areas along the New England Coast was discontinued and was resumed only in 1954, in connection with recent investigations of groundfishes of Georges Bank. Verrill's conclusion about the condition responsible for the abundance of life along the 100-fathom line in an area south of Woods Hole shows a highly developed power of observation and the ability of the author to visualize a general ecological picture from the multitude of detached observations. Verrill never lost sight of the forest because of the trees.

His work on cephalopods contains the descriptions of gigantic squids, Architeuthis and their allies. Their existence

in the waters not far from Woods Hole is rarely suspected by summer tourists and boatmen. The efficiency of Verrill's field explorations was facilitated by his skill in devising or modifying collecting instruments and perfecting methods of dredging and trawling. He remarks (Verrill, 1883, p. 65) that the adoption of steel-wire rope for dredging from the Fish Hawk greatly expedited the work. He was fully acquainted with the latest improvements, in sounding, dredging, and trawling techniques made in Europe. He immediately adopted the new methods for the operations of the Fish Hawk. He must be credited for designing new forms of traps for capturing bottom animals, the "trawl wings" for catching free-swimming forms close to the bottom, and many other devices. The mop-tangles that Verrill devised for catching spiny animals were later adopted by the oyster growers in Long Island Sound for removing starfish; this device is still used at the present time.

Other important contributions of the Woods Hole Laboratory made during the first years of its existence are the three papers by Edwin Linton (1889, 1891, 1892) on entozoa of marine fishes. These publications were the first in a long series of papers on parasitic worms which Linton produced during more than 50 years as a voluntary collaborator at the laboratory.

The works of Harger (1880) on marine Isopoda and of Farlow (1873, 1882) on marine algae were the result of careful taxonomic studies of the material collected by the station's vessels.

The work on fishes dealt primarily with the occurrence, distribution, and development of the more important species. Among the valuable contributions originated at the Woods Hole Laboratory between the years 1871-87 were: "List of Fishes Collected at Wood's Hole" (Baird, 1873), "The Scup, The Blue-Fish" (Baird, 1873), "The Sea Fisheries of Eastern North America" (Baird 1889); "Catalogue of the Fishes of the East Coast of North America" (Gill, 1873); "The Natural and Economical History of the American Menhaden" (Goode, 1879), "Materials for a History of the Sword-Fish" (Goode, 1883); "Materials for a History of the Mackerel Fishery" (Goode, Collins, Earll, and Clark, 1884); "Embryography of Osseous Fisheries, with Special Reference to the Development of the Cod" (Ryder, 1884). The principal question regarding the causes of the decline in commercial fish catches and fluctuations in their abundance, could not be answered by these investigations and with the methods available at Baird's time. Even at the present time, in spite of the outstanding progress made in fishery biology and the development of statistical methods of studying fish populations, the causes responsible for the wide fluctuations in the abundance of fish remain undiscovered.

The experience of many European biologists in artificial propagation of fresh-water fish showed that the populations of fish in streams and ponds could be maintained by restocking with artificially raised young fish. Various organizations in the United States and state officials urged the U. S. Commissioner of Fisheries to initiate artificial cultivation of marine species and to introduce foreign species of fish into American waters. The construction of a marine hatchery at Woods Hole was made in response to these requests. The problem of maintaining a fish population at a desired level of abundance appeared to be a simple one. In general, the fecundity of oceanic food fishes is very high, the adult female (depending on species) producing every year from several hundred thousand to several million eggs. Inference was made that by means of artificial propagation it would be possible to increase the supply of such fish as cod, flounder, shad, mackerel, halibut, and other species, and also to transport them to other localities where they were not present. Baird, in accord with the opinion of other biologists of his time, believed that artificial propagation might be effective, and put his full energy in establishing new hatcheries along the coast and over the mainland of the United States. Technical progress in the design of various hatching jars, boxes, and other equipment made in the United States was so rapid that as early as 1881 the U. S. Fish Commission participated with great success in the Berlin Fishery Exhibition, showing the progress of fish culture in the United States. A considerable part of this exhibit was prepared at Woods Hole.

D. Haack (1882, p. 57) summarizes a German appraisal of the American section in the Exhibition in the following words: "Everything which America had sent was on a magnificent scale. The American exhibit was distinguished by the neat workmanship of all the objects. But best in astonishment we stand before the large model of the Fish Hawk, a large steamship especially constructed by the American Government for the purpose of pisciculture. The steamship contains, both in its interior and its sides, hundreds of large pieces of apparatus for hatching fish eggs. The steam engine partly serves for pumping of water and partly for moving to and fro in the water the apparatus attached to the sides of the vessel, thus vivifying the germs of the eggs. . . . With all our piscicultural efforts we must confess that we felt very small when viewing this grand American exhibit; and the magnificent results obtained in America are sufficient guarantee that this is no American humbug. For the present we can certainly do no better than to strain every nerve and imitate the example set us by the Americans." In recognition of his achievements at the Berlin Exhibition, Baird received from the Emperor of Germany the "Erster Ehrenpreis" of the International Fisherei-Ausstellung at Berlin. Previously he had received the silver medal