

## THE UNITED STATES FISH COMMISSION.

### SOME OF ITS WORK.



THE discovery of America was quickly followed by marvelous stories of its fishery wealth, which attracted the covetous eyes of Europe, and made the Grand Bank a favorite resort for fishing-vessels nearly a century before the Pilgrims landed. Proving a veritable El Dorado during the strife and speculation then prevailing, it was mainly that source of industry which directed the early tide of immigration toward the rugged coasts now comprised within New England and the British provinces. Settlements were established to assist in the preparation of the catch, and those who sought political and religious freedom in the untried land were confident of at least this means of gaining sustenance. The industry developed rapidly under foreign hands, but its management has gradually shifted from the Old World to the New, leaving only the French in active competition at the present time.

From its favorable location, New England readily became the leader in this movement as regards the United States, but the fishery interests of this country have long since spread beyond those narrow limits. Important grounds stretch southward into the Gulf of Mexico, and northward, on the Pacific side, from San Diego to the icy belt. The large inland lakes and river systems constitute, moreover, a vast storehouse of resources from which is drawn a good percentage of the food-supply. No other country in the world has such varied and productive fisheries, and nowhere else has the fishing business been more actively carried on or more systematically promoted. It has kept pace with the rapid increase of population, and no pains have been spared to bring it to its present standing.

The phenomenal progress thus exhibited has been due, however, entirely to private enterprise, through which the industry has prospered after its own fashion and without restraint. It was, therefore, only natural that the insidious decay which threatens every enterprise in proportion as its growth is uncontrolled, should finally attack the fishing-grounds and spread to all localities where persistent efforts had prevailed. These grounds became depleted to a

greater or less extent in different places, the amount of injury done not being measurable by any precise standards. The reasons assigned were mainly avaricious or injudicious fishing, but other causes have tended toward the same result, and sometimes in a marked degree. For the first, however, it is scarcely just to lay the weight of blame upon the fishermen themselves. The conditions which surround their calling are peculiar, and they are gifted with at least the average ambition of the human race. With few exceptions, their fields of work are public grounds, which they can neither fence nor plant, nor can they give to them the benefits of individual protection. Why, therefore, should not each strive for the greatest gain, regardless of his neighbor or of his own distant future?

While the farmer makes provision for successive crops, the fisherman is almost wholly limited to those supplies which nature has contributed. A moderate amount of fishing may have no appreciable effect upon the grounds, or may even prove beneficial to them; but harm results as soon as the balance of life has been disturbed, or some constraint has been placed upon the habits of the fishes. Such occurrences have been common in the later history of this country, and have been the cause of wide-spread suffering.

How to protect and maintain the fisheries is, therefore, an important problem, deeply affecting the welfare of every civilized nation, but its solution has been long delayed through the imperfect means taken to consider it. It remained for the United States to introduce the first extensive measures for relief, founded upon a thoroughly rational and comprehensive basis, and thenceforward to take the lead in all such matters. This innovation required that the causes of the trouble be first determined by careful observations, in order that the remedies applied might be entirely appropriate and successful. At the beginning of the inquiry there was nothing to suggest the broad proportions which the present Fish Commission afterward assumed. A specific survey was proposed, which might have terminated within a year or two, had not the time been propitious for greater efforts, and the future welfare of the fisheries been confided to a master mind. Circumstances favored an expansion of the work, and led finally to the establishment of a new

branch of government, the benefits of which extend to every part of the country.

The inception of the commission resulted from certain depleted fisheries along the southern New England coast, with which the adjoining States found themselves incompetent to deal. Upon the assumption that the damage had occurred in navigable waters, the matter was taken in hand by Congress during the winter of 1870-71, and a bill was passed providing for a scientific study of the subject. It authorized the appointment, from among the civilian officers of the Government, of a commissioner of fish and fisheries, who should possess the requisite attainments and should serve without additional pay. His duties were to investigate the alleged decrease of fishes both on the sea-coast and in the great lakes, and to report the results to Congress, with such recommendations for relief as seemed advisable.

Professor Spencer F. Baird, then the assistant secretary of the Smithsonian Institution, was selected for this important post, and his administration of the same, continued for more than sixteen years upon a wise and liberal policy, has not only given to the many fishing interests greater unity and strength, but has assured them such prosperity for the future as lies within the power of human efforts. To accomplish so great a task required, however, that the scope and purpose of the commission be rapidly enlarged, with a corresponding increase in the personnel and in the duties of its director. The cause of decrease having been determined, it became essential to devise effective measures for preventing further loss, and for repairing, so far as possible, the damage already done. This led the commission into fish-culture and to a consideration of the ways and means of fishing, by which its scheme of work was rounded out, and thoroughly practical results were attained.

Professor Baird's strong personality was manifested in every branch of the commission, and his later years were almost wholly occupied in the promotion of its interests. But scientific investigations, for which he was best suited by training and inclination, received, however, the greater share of his attention, and bear most strongly the impress of his untiring energy and genius. The remarks which follow have reference chiefly to his favorite subject.

The greatest decrease among food-fishes had been reported from southern Massachusetts and Rhode Island, where, therefore, it was most appropriate that the explorations should begin. One of the most extensive sheets of water in this region is Vineyard Sound, the favorite resort for many fishes, and the common thoroughfare for all vessels passing

up and down the coast. On the east it reaches Monomoy, and on the west communicates directly with Buzzard's Bay and the waters off Rhode Island. Upon the mainland at its upper western end is a little fishing-village called Wood's Holl, a vantage-point for the entire area whose fisheries were in immediate distress. Here it was that, in June, 1871, Professor Baird began his investigations, aided by a small party of scientific men specially qualified to take up the different problems which the inquiry had suggested. Among its members were some of the most distinguished naturalists of the country, acting as volunteer assistants, and accepting the splendid opportunities for study as compensation for their services, a practice which has continued to the present time.

A small building on the lighthouse wharf in the little harbor was converted into a rude laboratory, and a floating establishment, comprising a sloop-yacht, a steam-launch, and several rowboats, was quickly brought together. This simple equipment furnished the means for a careful and comprehensive exploration, which was carried seaward as far as the stability of the little fleet permitted. It was a season of hard work and of important and enduring results. The fishermen and the dealers in fish were closely questioned regarding the methods and statistics of their trade; the gill-nets and fish-traps near at hand were visited every day; seines, dredges, and surface-nets were in constant use to gather materials bearing upon the aquatic life of the region; and observations were made upon the physical and chemical conditions of the sea, as to its temperature, density, and composition.

It had previously been the custom, both in this and in other countries, to consider the matter of decreasing fisheries through the conflicting testimony of interested persons. Professor Baird, however, was not satisfied to follow this example. The scientific methods of research which had insured the stability of his zoological work were, in his opinion, just as applicable to the present subject, even though the results desired were of a practical nature. The decrease, if one had actually occurred, might have been produced by injudicious practices, or it might have been the outcome of natural conditions, or, possibly, of both combined. In any case there were many facts requiring investigation. Had man been the agent of destruction? Was it due to his fishing through the spawning-season, to the use of large nets of fine texture, or to his lining the shores and passageways with fixed appliances of capture? If nature itself were responsible, was it caused by changes in physical conditions affecting the habitats of certain fishes,



DRAWN BY J. C. BEARD.

THE BAT-FISH.

ENGRAVED BY F. S. KING.

had the food upon the grounds become exhausted, or were new predaceous species exterminating the older and better-known kinds?

In carrying out this new policy, it was necessary to examine directly the different fishing-grounds and to determine their characteristics and the nature and relations of their inhabitants, as well as their conditions past and present; to study the growth and the habits of fishes, with special reference to their migrations, schooling, and spawning; to observe the influence of temperature, salinity, and other physical conditions upon their general welfare and upon their movements from place to place. It was also essential to consider with equal thoroughness all artificial constructions having a pernicious influence upon natural laws, such as the more destructive forms of fishing-apparatus and the barriers erected in watercourses.

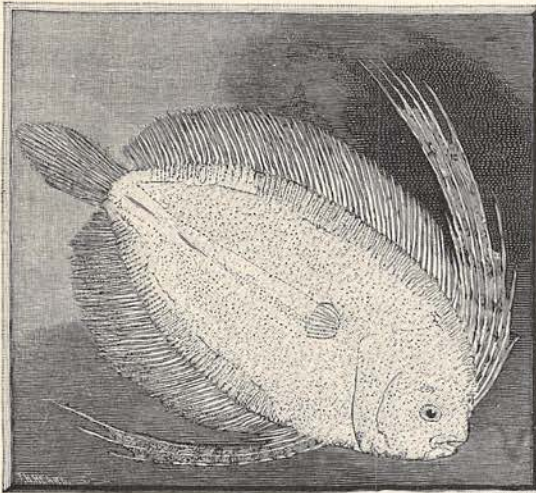
During the second and third summers the  
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work was carried to the coast of Maine, with headquarters at Eastport and Portland. Thence the party returned southward to Noank, Connecticut, and to Wood's Holl for a second time. Salem and Halifax were visited in 1877, and Gloucester, Provincetown, and Newport during the three succeeding years. While the vessels of the commission were still unsuited for making long cruises, these annual changes were required in order to reach the different fishing-regions. The working-quarters were never elaborate affairs, but some convenient building near the water was hastily adapted to the purpose and furnished with only the simplest character of outfit. Pine tables were placed in front of each of the windows for the separate accommodation of the assistants, and the intervening walls were covered with open shelving for the books and specimens. The center of the room was occupied by

larger tables, and the aquariums were sand-wiched in wherever the space permitted. Such was the customary arrangement of the laboratory proper, but the coarser work was usually provided for in a basement room or in a separate structure.

The daily occupations varied with the weather and with the tastes and qualifications of each assistant. Severe storms might keep them indoors, but it rarely happened that some field-work was not in progress. The party was practically divided into squads, changing more or less in composition from time to time, one charged with seining and other modes of fishing, another with the general collecting along the shore and in shallow water, while the more

During the first two years the Fish Commission dredging was done entirely by hand, and generally from a sail-boat or steam-launch. The outfit consisted of a small dredge with its coil of rope, and many accessories in the way of sieves and surface-nets, thermometers and other instruments, and the bottles and tanks of alcohol. The dredge was usually lowered from the bow, where the rope was also fastened if the tide was running strong. In a gentler current a broadside was presented to the stream by carrying the rope around a thole-pin amidships, but in still water the sails would be resorted to. During the intermission which then followed, attention was paid to surface-collecting and to testing the temperature and density of the water. The hauling of the dredge devolved upon the entire ship's company, and was tiresome in the extreme. The dead weight at the lower end had none of the qualities of a gamy fish, and yielded only to the methodical pulling of the trained sailor. The excitement began with the dump-



DRAWN BY J. C. BEARD.

ENGRAVED BY T. H. HEARD.

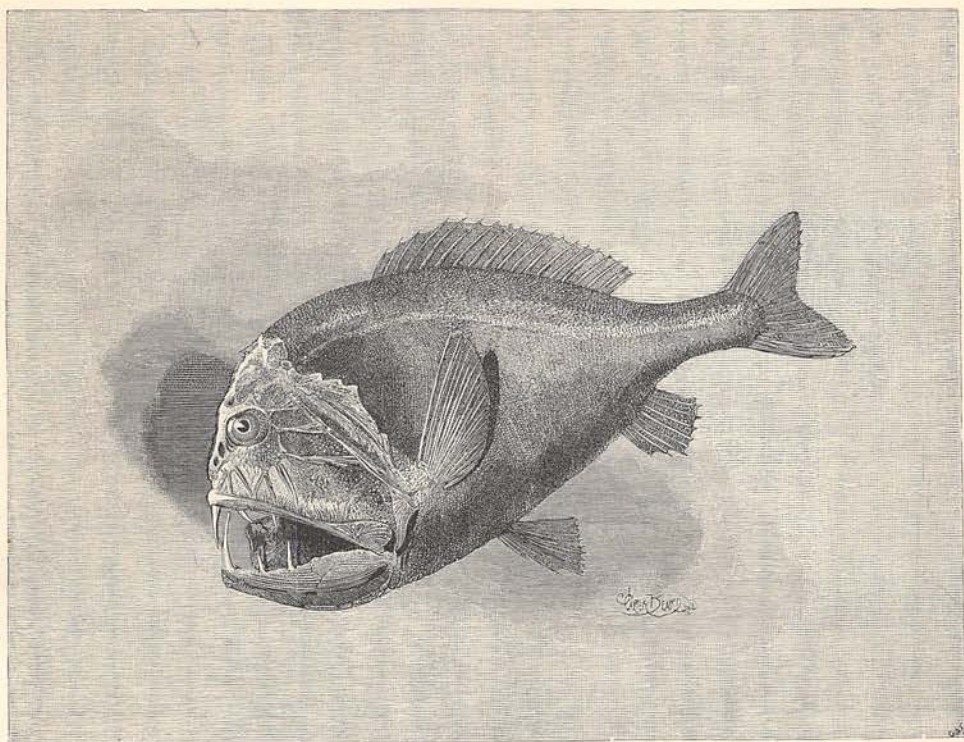
CRESTED SOLE AND BEARDED FLYING-FISH.

daring ones were usually assigned to vessel service. The seiners' duties are most arduous. Trained to an amphibious existence, tugging incessantly at the heavily loaded net which catches now and then upon a rough spot, handling many thousand captives every day, and tramping sometimes for miles along the beaches, their outdoor labors are excessive, and yet the vigorous exercise conduces to sound health and hardened muscles. There have, however, been no easy places in any part of this exploring work. Whether with the dip-net along the shores, the towing-net dragged at the surface by rowing, or the dredging-apparatus from the larger boats, the earnest student has ample opportunities to test his physical endurance, as a prelude to his actual observations. Improved and more expeditious methods are fast relieving the so-called drudgery, but, while they add to the conveniences of the seaside laboratory and increase the facilities for turning out results, they are certainly not so beneficial to the general welfare of the naturalist.



ing of the contents of the net into the long, shallow box athwartships, where the overhauling and washing could be done without scattering the sand and mud about the deck. One man was made recorder, while the others carefully examined the material and noted its characteristics and condition. A certain number of specimens were saved in alcohol or by drying, and the balance was cleared away to make ready for the next haul.

This manual dredging was continued rapidly, and as many casts were made each season as with the modern methods; but nothing larger than a hand-dredge could readily be employed from the small boats, and the work was mainly limited to comparatively shallow water. With the acquisition of a small steamer,



DRAWN BY J. C. BEARD.

THE FANG-FISH.

ENGRAVED BY O. NAYLOR.

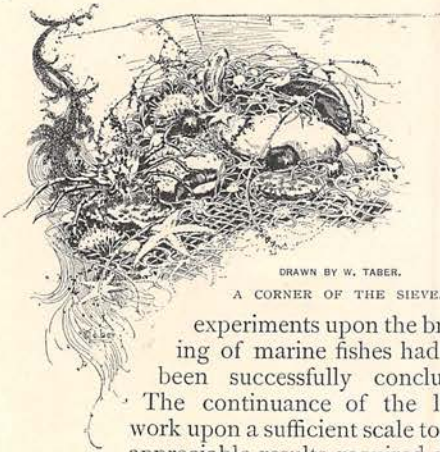
contributed from 1873 to 1879 by the navy, came improved facilities, especially in the way of steam-power, which permitted the examination of deeper water and the convenient use of larger dredges, tangle-bars, beam-trawls, and other useful implements. The beam-trawl of the English fishermen was first employed for scientific purposes by the Fish Commission in 1872, and has since been widely adopted by explorers.

After dark the laboratory became the rendezvous of all the members of the party, and the duration of their night's labor was measured by the day's success. It was the rule to close up current observations before retiring, to leave as little as possible for the morrow, except in the case of special studies requiring greater deliberation. The proper time to visit this building was, therefore, in the evening, when every table had its occupant and every one was busily employed. The cross-shadows resulting from the scattered lamps added to the general confusion of the scene, and lent an air of mystery to the many objects covering the floor and tables. The day's catch was, for the most part, still in the large receptacles, as it had been brought in from the field, and each worker was occupied in trying to produce order out of chaos. Transferring the specimens to smaller dishes, he assorted them into groups or species,

making such observations as the time permitted, and then finally disposed of them in alcohol or placed them in an aquarium for future life-studies. It was frequently after midnight when the task was finished, as notes had to be compared and the results discussed before planning further operations.

It rarely happens that so many branches of research are represented at a single field-station as was the case in those above described. The assemblage was composed of both scientific and practical investigators, jointly interested in securing the same ends, but separately engaged on different topics—the general naturalist, with his knowledge of habits and distribution, the embryologist, who could explain the origin and growth of fishes, the hydrographer, whose specialty is the physics of the sea and of the ocean-bottom, and the professional fisherman, expert in the handling of apparatus and acquainted with their effects upon the several species. While the results obtained in each of these subjects had a particular significance apart, to subserve the purposes of the fisheries required that all should be combined and carefully correlated, a task which fell upon the few leaders who alone were qualified to make deductions.

The migratory habits of the summer party terminated in 1881, the year following the building of the steamer *Fish Hawk*, and when the first



DRAWN BY W. TABER.  
A CORNER OF THE SIEVE.

experiments upon the breeding of marine fishes had also been successfully concluded. The continuance of the latter work upon a sufficient scale to give appreciable results required more extensive and complicated machinery than could readily be brought together in the temporary structures previously provided. It was, therefore, necessary to determine upon a proper site and to construct new buildings specially adapted to the purpose. The claims of several localities to such distinction were considered, but the choice was finally given to Wood's Holl, as meeting the combined requirements of the service more fully than any other place. The fishes to be propagated, like the cod, mackerel, and lobsters, were entirely oceanic, and demanded pure sea-water for the development of their eggs and embryos. The biological studies had reference also to the same class of fishes, and a convenient station was desired for the vessels of the commission. No fresh-water streams enter Vineyard Sound or Buzzard's Bay within a considerable distance of Wood's Holl, and its surroundings are essentially marine in all particulars. The little harbor in which the first building had been placed was inadequate to the increased operations, and recourse was therefore had to the larger one near by. A narrow strip of land along the center of this

harbor, having a shore frontage of about a quarter of a mile, was obtained for this purpose in 1882, partly by subscriptions and partly by direct gift from the owner.

While the planning and building of the new station were in progress, the summer party retained possession of its old laboratory, where it was destined to remain until 1885. The new quarters add a prominent and attractive feature to the little village, as much taste and skill have been displayed in their grouping and construction. They cover a small point of land, which has been extended outward in the form of a stone pier, affording greater protection to the inner roadstead and serving as a mooring-place for Government vessels. This pier is rectangular in shape, inclosing an area of water about 250 by 150 feet square. It is capped by a wooden wharf, which divides it near the middle into two basins, the outer one intended exclusively for living fishes taken for their spawn or for study, the inner one serving also as a landing-place for small boats and steam-launches. The buildings, five in number, comprise a hatchery and laboratory combined, a quarters building, a water-tower, a coal-shed, and a storehouse.

On account of the scanty accommodations afforded by the town, the commission has furnished shelter for its assistants in what is called the quarters building, the one nearest to the railroad station, and most noticeable from an architectural point of view. Next beyond it is the water-tower, smaller yet somewhat taller than any of the adjacent buildings, and important as controlling the entire supply of fresh and salt water used about the premises. The third building is deserving of more minute attention, as here it is that the proper functions of the station are carried out. The facilities for fish-culture and for scientific purposes are provided in a single large structure, 120 feet long by 40 feet wide, and three stories high. Al-

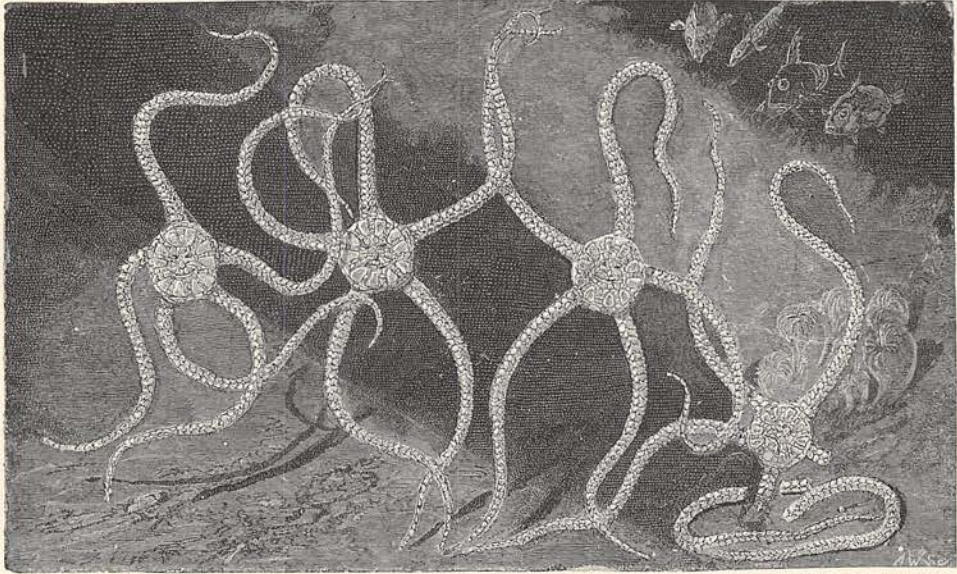


DRAWN BY W. TABER.

THE MARINE STATION AT WOOD'S HOLL, MASSACHUSETTS.

though extremely plain in all its details, nothing has been omitted that is essential to the proper conduct of operations, and it ranks as one of the most complete establishments of its kind. The lower floor is divided into two nearly equal rooms, devoted to propagation and to the aquarian exhibit. The southern room opens directly upon the wharf adjoining the inner basin, and contains a complete outfit for the hatching of cod and lobsters, devised and first made use

buckets from the wharf, can nearly everywhere be drawn from faucets at intervals of only a few feet, and the oil-lamps have been replaced by electric lights. The scientific staff has also increased in size, and the inquiry has been so differentiated that each one has his particular duty to perform, and the hours have become more regular in consequence. Summer continues to be the principal season for these scientific studies, as it is only then that the vol-



DRAWN BY J. C. BEARD.

DANCE OF THE SERPENT-STARS.

ENGRAVED BY A. WALDEYER.

of at this station. Many aquariums, arranged in double rows, are utilized for the embryos during the hatching period, but at other times serve for the preservation of living animals, in connection with the scientific work. On the second floor there is a large general laboratory at the northern end, and many small apartments for biological investigations. The physical laboratory, and the photographic and other small workrooms, are located on the floor above, which also furnishes several dormitories to accommodate the overflow from the quarters building. Salt and fresh water are distributed to all the rooms where they could possibly be needed, and in this, as in many other respects, the advantages for study are unexcelled. Each student has a separate supply of salt water at his disposal, and a little aquarian stand beside his ordinary work-table. If these are not sufficient for his demands, he has recourse to larger aquariums in the middle of the laboratory, and to those in the hatching-room below.

There is little about this building to remind one of the older laboratories. The cramped quarters, rickety floors, and worn-out tables have disappeared. The water, formerly brought in

unwater assistants can be obtained; but some branches of the inquiry are in progress through the entire year, and the building is always open on account of the hatching work.

During the past four years the marine inquiries of the Fish Commission have been extended to all the sea-coasts of the country, and Wood's Holl has ceased to be the only rendezvous for its vessels, the latter also having convenient laboratories on board, where special researches can readily be carried on. Many problems, moreover, require to be investigated in particular localities, where the conditions are especially favorable, and for that reason the study of the habits and development of the oyster, the shad, the salmon, the Spanish mackerel, and many other species has been conducted elsewhere. The headquarters of the scientific branch are in Washington, where suitable workrooms have been established, and where the collections are brought together.

While seaside laboratories are indispensable to the study of fishery problems, they cannot, unless supplemented by convenient means for reaching distant points, have more than a local value and significance. It was the lack of such



SHARKING.

facilities during the first ten years of the commission that made it necessary to move its summer station from place to place. The construction of the steamer *Fish Hawk* in 1880 rendered this habit less obligatory, while the addition of the *Albatross* soon afterward made a permanent station very desirable in connection with the North Atlantic work.

The *Fish Hawk* was the first large vessel built by any nation expressly for the promotion of the fisheries. The steamers previously employed for this character of investigation had been adapted to the work by only such few additions and alterations as were deemed essential. They were inconvenient at the best, but were made to answer the requirements with the crude appliances then available. A new era as regards the

methods of exploration and of fish-culture was, however, rapidly approaching, and the building of the *Fish Hawk* happened opportunely with respect to the improvements made in both. The clumsy, old-fashioned sounding-line gave place to a slender wire, and the hempen dredging-cable to a small iron rope. The physical and collecting apparatus was also greatly modified, and the hatching meth-

ods were materially perfected in many ways. The *Fish Hawk* was designed to assist in both these branches. Her services were demanded for the propagation of shad in the shallow bays and river-mouths, and she was also needed in connection with the sea-coast work described above. It was, therefore, necessary that her draft should not exceed seven or eight feet when loaded; but, being high above the water, this renders her unwieldy in a rough sea, and her behavior is sometimes disagreeable during heavy weather.

During 1880 the summer party was established at Newport, Rhode Island, in the old abandoned lead-works, whose adjacent shot-tower formed an excellent lookout from which the coming of the new ship was first announced. The previous year a Gloucester fishing-smack, trawling for cod and hake some eighty miles off No Man's Land, had encountered a peculiar fish, which proved, upon examination, to be an entirely new species. A large quantity was captured, and, being of good flavor, several specimens were sent to Fulton Market, New York, where they were well received. Its many golden-yellow spots and stripes had gained for it the name of "leopard-fish" among the sailors, but, being objectionable from a gastronomic standpoint, this term was soon discarded for "tile-fish," having reference to the final syllables of its scientific designation, *Lopholatilus*. Although without significance, this name was thought to grate less harshly on the palate, and to favor the introduction of the fish as an article of food. The discovery of this product within a few hours' sailing of the great metropolis suggested the development of a new and important fishery, and it therefore became advisable to determine, for the benefit of the public, the range and abundance of the species. In assigning the *Fish Hawk* to this undertaking, the commissioner initiated the aggressive offshore operations which have



DRAWN BY W. TADER.

AROUND THE SIEVE BY THE ELECTRIC LIGHT.

ENGRAVED BY W. MOLLIER.

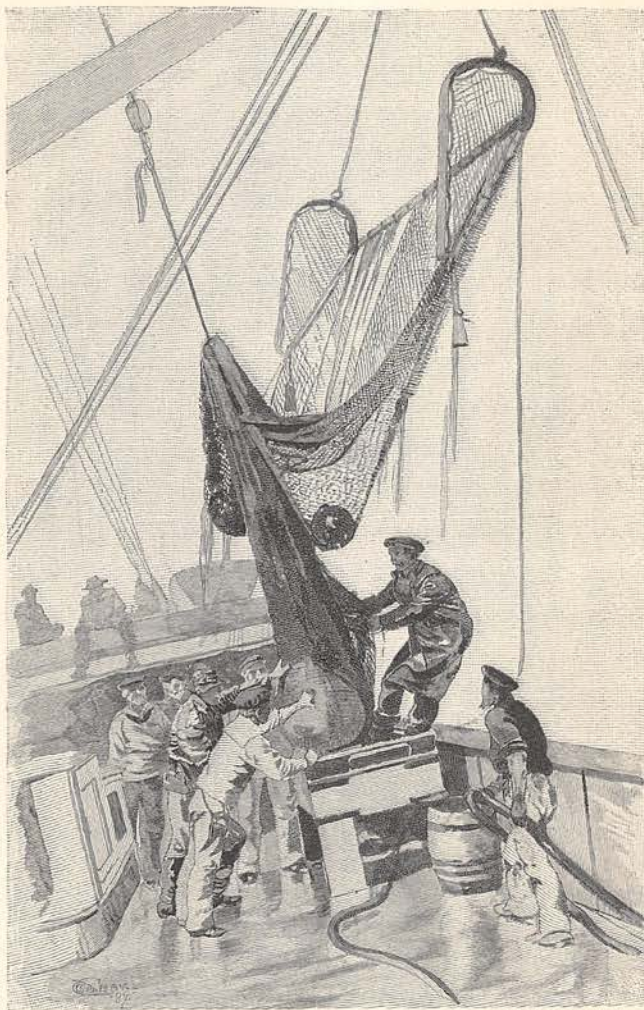


since then been conducted upon so large a scale and with so much success. The tile-fish investigation was prosecuted with great vigor during two summers, and some of the incidents connected with the first cruise are worthy of recording, as illustrating, in a measure, the general methods of the work.

The tile-fish taken in 1879 had been found in about one hundred fathoms. To reach the same place would require a night's steaming, and by spending only a single day upon the grounds, the entire trip could be accomplished within a period of thirty-six hours, as long a cruise as it was considered expedient to make at that distance from the shore. A time was finally selected, upon advices from the Signal Office that no storms were coming up the coast, and with that assurance little difficulty was experienced in obtaining from the shore laboratory the volunteers required for this interesting search. The start was made at sundown, and by daylight on the following morning the steamer had passed within the influence of the Gulf Stream. The air was softened by the tropical current, and the deep blue water, smooth and glassy at the surface, was thickly strewn with many delicate and transparent forms. The first sensation was more conducive to indolent pleasure than to vigorous efforts, but the hours were far too precious for idleness of any kind, and the workers were summoned from their bunks before the sun was fairly up.

The instruments were taken from their places, and the sounding work was at once begun. For the fishing trial a trawl-line of the pattern used on the northern banks for cod and halibut had been selected, measuring several hundred fathoms long, and with hooks at intervals of three or four feet. This had been baited with fresh menhaden the previous evening, and was now coiled in the regulation tub. A brief examination having disclosed the proper depth of water, and the indications being otherwise propitious, the heavy tub was lifted into a small boat which had been lowered from the davits, and was manned by the champion fisherman and

two experienced sailors. Pulling away to give the steamer a clear berth, they began their work by throwing over the upper end of the trawl, an anchor carrying it to the bottom, and a keg-buoy marking its position at the surface. The entire line was then paid out, its further end being secured and indicated in the same manner as the first. Several hundred hooks were thus distributed along the bottom, each with its tempting morsel to attract the fish.

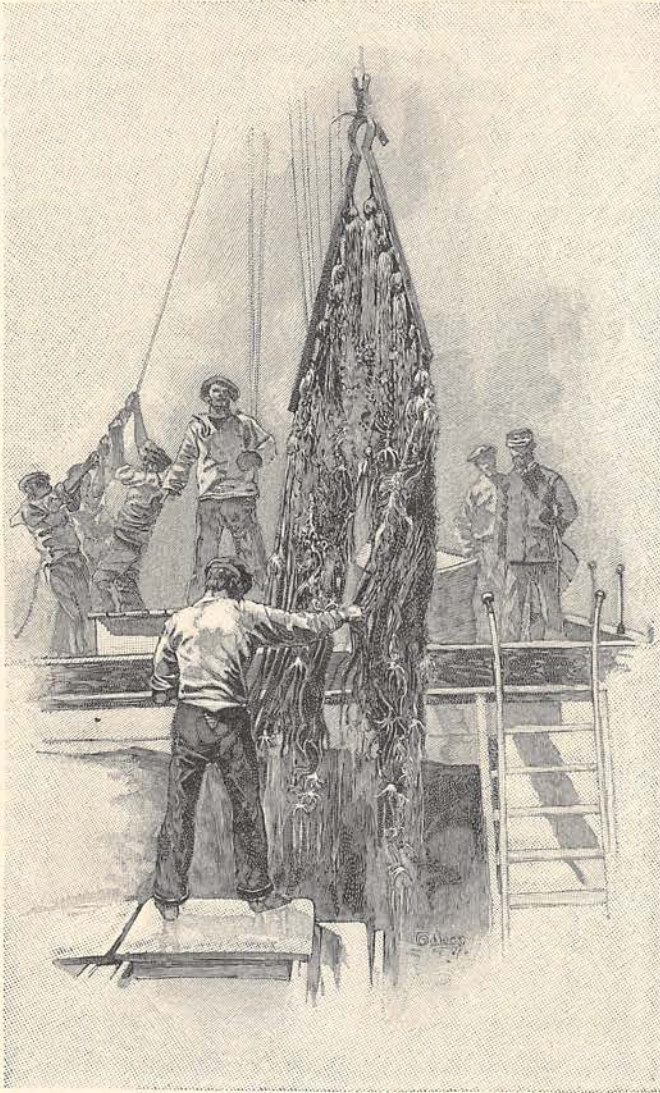


DRAWN BY W. TABER.

LANDING THE BEAM-TRAWL ON DECK.

ENGRAVED BY P. AITAIN.

Time was now given to insure a full catch, and, leaving the little boat fastened to the trawl-buoy, the steamer took up its regular course of work in determining, by other methods, the character of the bottom and its inhabitants. A few successful hauls with the collecting-apparatus showed what animals are peculiar to the region, while the sounding-wire, with thermometer and water-bottle attached,



DRAWN BY W. TABER.

ENGRAVED BY K. C. ATWOOD.

TANGLES FROM THE SEA-LILY GROUNDS, GULF OF MEXICO.

developed its physical features. It was decided to run a line of dredgings directly seaward. The ground was smooth and well suited to the beam-trawl, the big conical net of which had a much greater scope than either the dredge or the tangles, and secured much larger and more active prey. Held widely open at the mouth by a long beam and sled-shaped runners, and supplemented by a free towing-net on each side, this has become the most formidable instrument in the outfit of the deep-sea naturalist, and has led the way to many wonderful discoveries. The dredge is better fitted for digging in the bottom, and may be used in rather rough places, but on the latter always at the risk of being lost. The tangles are composed of tough hempen

fibers, arranged in swabs, or bunches, which catch upon all spiny objects and hold them fast. Their range is somewhat limited, but on bottoms where the dredge and the trawl would soon be torn to pieces their utility is recognized.

The *Fish Hawk* is thoroughly adapted to the handling of all appliances of this character. The dredging- and sounding-apparatus are on the upper deck, and are managed by the officers and crew. That part of the main deck directly underneath forms a single large room, having a row of continuous square ports, or windows, on each side, two of which are open to the floor and placed conveniently to receive the dredge or trawl as it is hoisted from the water. This apartment, removed from the annoying features of the heavier operations, constitutes the working-quarters of the naturalists. All the necessary equipment for their study is here provided, and here their time is chiefly spent.

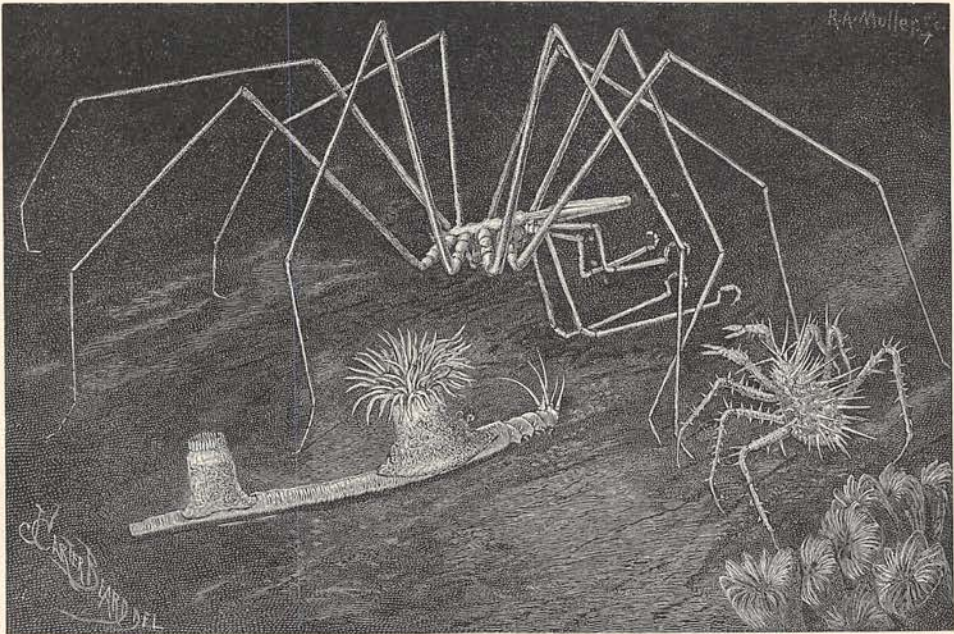
A sounding is made to determine the depth of water, and its temperature and density at the bottom. Then the beam-trawl is bent to the iron rope projecting from the boom-end over the starboard bow, and rapidly lowered, being held for a few moments at the surface to insure the floating of the

net. Anticipating a fair catch, the large sieve is pushed in front of the outer doorway, a number of pails and tubs are filled with water, and the swinging tables are covered with dishes of many sorts and sizes. The naturalists are a study in themselves. Discarding the spotless linen which distinguishes the naval officer from the ordinary seaman, they have attired themselves in flannel shirts and other garments no longer suited to polite usage. The work is hard, and the material which they handle is decidedly uncleanly in its crude state. Rank is indicated by the application and intelligence of the student, and his garb, however elegant and refined, would bring him no distinction among his colleagues.

The time allotted for the haul varies from twenty minutes to an hour or more, according to the circumstances, and the sound of the reeling-engine overhead is a signal to prepare for action. First the bridle appears, then the beam and runners cut the surface, and the dark-brown net is lifted high in air, giving out a heavy shower of mud and water. Many curious creatures, partly discernible through the meshes, show that the drag has been successful and the bottom is rich in life. A bight of rope is thrown around the bulging net to draw it inboard, when the lower end is opened, and the contents slide rapidly into the hopper-frame forming the upper part of the table-sieve. A soft, oozy mud is the chief constituent of the mass,

also evident among the different members of the staff, each striving to discover the most important features of the catch. Fishes, crabs, shell-fish, serpent-stars, corals, sponges, and hosts of other forms are mingled in confusion, and each specialist has the wherewithal to please his fancy; but in the first scramble he is apt to take whatever is nearest to him, regardless of its final destination. In this manner the principal contents of the sieve are soon transferred to clear water, but some portions demand more patient and deliberate sorting. After a second examination, the specimens are placed in alcohol to preserve them for future study, and to prepare for the next batch of treasures.

The trip may furnish rich results or be only



DRAWN BY J. C. BEARD.

ENGRAVED BY R. A. MULLER.

ON THE GULF STREAM SLOPE, FROM ONE TO TWO MILES BELOW THE SURFACE.

covering and concealing for the time its many distinctive objects. This mud forms the deep-ocean bottom, and is composed of the shells of the *Foraminifera* and of other minute animals, some still fresh and living, but the majority more or less disintegrated and fast changing to a powder. Several minutes' diligent washing with the hose is necessary to force this yielding matrix through the meshes of the sieve and to bring its larger occupants to light. During this operation the naturalists give strict attention that the stream of water shall not harm the delicate specimens, which, one by one, are hastily examined and then dropped into a clean receptacle. It is a time of great excitement, which, however, only the initiated can thoroughly appreciate and enjoy. Much pleasant rivalry is

moderately successful, according to the character of the region; but on the day in question the rewards were greater than they had ever been before. The steamer went quickly from one station to another, securing at each cast much more material than could conveniently be cared for. The water deepened rapidly to one hundred, two hundred, and even more fathoms. The descent was gradual from the shore to the point of beginning work, and there the true continental edge was found, the commencement of the real ocean, the depths of which in this vicinity reach nearly three thousand fathoms.

Each specimen was carefully scrutinized as it was taken up, but the usual questions, What is it? and, What is its significance? were diffi-



DRAWN BY J. C. BEARD.

THE MARBLED ANGLER ON ITS GULFWEEED RAFT.

ENGRAVED BY H. WOLF.

cult to answer on this particular day. The complexion of the fauna was different from any that previously had been discovered by the Fish Commission. The region was a new one, and not a member of the party was prepared to find so rich and varied an assemblage in the deeper waters of this northern latitude. A number of the species had been taken in other places, some in the far south and others toward the north, but a large percentage was wholly new. The record greatly exceeded that of any former dredging expedition, and was the equivalent of many an entire season's work. According to subsequent investigations, the conditions here displayed extend a considerable distance up and down the coast, bordering the inner margin of the Gulf Stream and tempered by its presence. Here also, in depths of from 85 to 150 fathoms, the tile-fish

was nourished by the rich diet, and through the influence of the warmer waters retained the tropical brilliancy of its markings.

Notwithstanding the attractive nature of the dredging work, the little boat which had been left to watch the fishing-gear was never for a moment lost sight of, and after a few hours the steamer again came up to it. While it is customary among the fishermen to tend their lines entirely from the small boats, it was determined in the present case to do the overhauling directly from the steamer's deck, in order that any specimens obtained might be handled carefully and every opportunity afforded for making observations. Taking the buoy-line through the port gangway, the anchor was raised on board, immediately followed by the main line, which required the united strength of several sailors to keep it go-

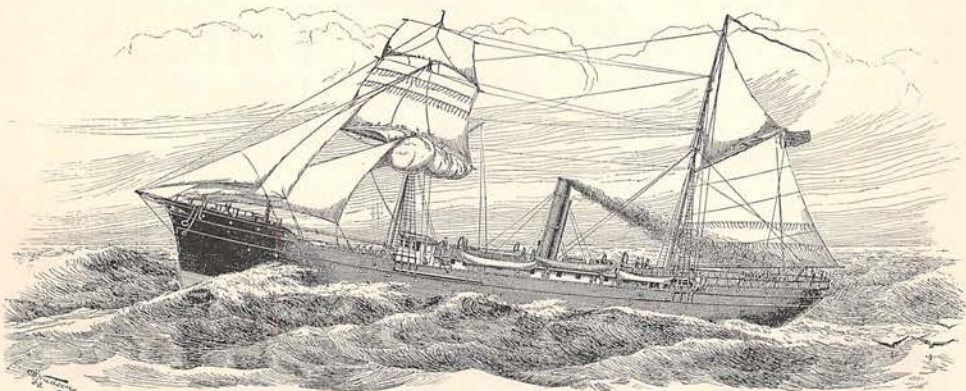
ing. A moment of suspense ensued, and then a noble specimen of the tile-fish lay struggling on the deck. Many more were soon added, and several other species, of no less interest to the naturalists, were also captured. The success of the expedition had been assured, and the report of the fishing-schooner fully verified. No previous cruise had given such positive results and promised immediate returns of so much practical value. It now remained to determine the range and abundance of the species, an investigation which was continued with much profit during the same and the following summer, the largest single catch amounting to 73 tile-fish, weighing from 3 to 32 pounds apiece, and aggregating 550 pounds. During this period, however, the *Fish Hawk* was also employed in many other kinds of work, both in the line of exploration and of fish-culture.

During March and April, 1882, a number of vessels arriving at New York and other ports reported large shoals of dead and dying fishes at the surface, through which they sometimes sailed for many miles. They were first described as cod, but, after specimens had been properly identified, they proved to be none other than the tile-fish, together with occasional examples of some of the rarer species associated with them on the same bottoms. Some calamity had overtaken them, but its character and causes have never positively been determined. There were no marks of violence or disease on any of the specimens, and many still seemed to have a spark of life remaining when lifted from the surface. The period of their destruction was immediately preceded by severe storms, which may possibly have agitated the inshore waters sufficiently to force a colder stratum from the arctic current over and upon their grounds. A sudden change of temperature, however it may have been produced, offers the most plausible theory for the accident, and is the one now generally accepted. The extent of the destruc-

tion may be appreciated from careful estimates, which placed the number of dead fish at several hundred millions, and their total weight at over a billion pounds. During 1883 it was impossible to take any tile-fish upon the old grounds, and several other fishes and invertebrates formerly living with them had also disappeared. Repeated search during subsequent years has proved equally unavailing, and if any survived to repopulate the region, the fact remains to be determined.

The exploration of the tile-fish grounds broke the barrier which had previously confined the work along the coast, and showed that, even with so frail a vessel as the *Fish Hawk*, valuable results could be accomplished at some distance from the shore. No one doubted the utility of an examination of the deep-water grounds, but it needed a practical demonstration to give it the necessary impetus and support. Direct observations had never been undertaken to determine if the varying abundance of such important fishes as the mackerel and menhaden was due to natural causes or resulted from man's interference. The cod and halibut banks resorted to were chiefly accidental discoveries, and no systematic researches had been made to ascertain their full resources or to develop new regions. South of New England the offshore waters were scarcely known, and those of the Pacific coast were still a mystery, even to the fishermen. The *Fish Hawk* was evidently unsuited to the study of this class of problems, which required a more continuous sea service, regardless of the conditions of the weather. A larger and stronger vessel of a totally different type was urgently demanded, and was soon provided.

The *Albatross* was built in 1883, making her trial trip on December 30 of that year. She is entirely novel in construction as well as in the character of her work, having no counterpart among the other nations of the world. Her



DRAWN BY C. B. HUDSON.

THE FISH-COMMISSION STEAMER "ALBATROSS."



DRAWN BY W. TABER.

ENGRAVED BY J. W. EVANS.

SOUNDING THE ABYSS WITH PIANO-WIRE.

plans were based upon the experience of the Fish Commission, and also of the coast survey and naval service, adapting her to every kind of exploration from which the ocean fisheries could derive a benefit. As the name implies, her home is on the open waters, whether upon the shallow banks or over the most profound depths, and her conduct under trying circumstances has been extremely gratifying. It was only natural, however, that great difficulty should have been experienced in bringing so many new features within the narrow compass of a single craft. The addition of a civilian scientific staff, of laboratory quarters on a large scale, and of coal facilities for long cruises, were among the matters which it was necessary to consider and adjust; but all perplexities were finally settled in a satisfactory manner.

The *Albatross* bears no resemblance to the *Fish Hawk*, either externally or in her interior arrangements. Her lines are graceful, and her depth is proportioned to her height above the water. The total length is 234 feet, and the displacement 1074 tons. Besides the steam-power, acting through twin screws, she is rigged like a brig, and is provided with high bow and stern, the latter being modeled with special reference to her backing against sea and wind when dredging. The main deck is partly

covered by the topgallant-forecastle, the main house amidships, and the poop-cabin, but the space required for the working-apparatus is ample and conveniently arranged. These appliances are chiefly forward of the pilot-house, among the more conspicuous being two machines for sounding with piano-wire, and the heavy dredging-engine with its accumulator and long boom. The iron rope is stored below upon a large reel capable of holding over five miles of this tenacious cable. The methods of operating the apparatus are essentially the same as on the *Fish Hawk*, but, having no large openings at the sides, the dredge and trawl must be lifted over the rail, and the washing of their contents is conducted on the upper deck.

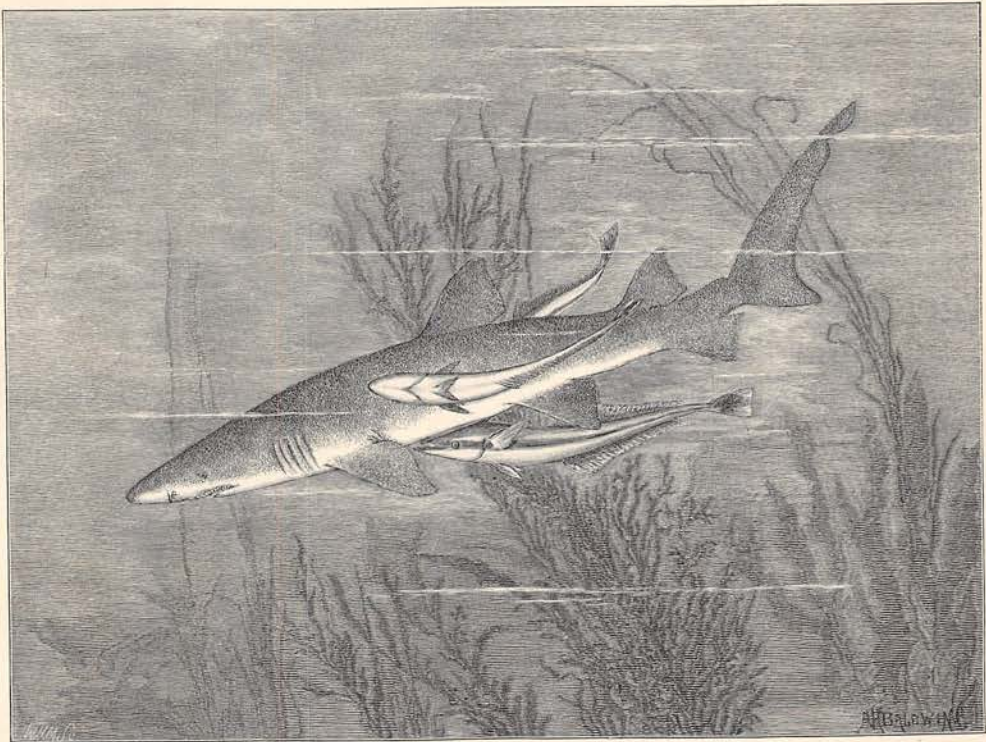
The scientific quarters have been placed together amidships, where the motion is least perceptible. The upper laboratory occupies the middle portion of the deck-house, and is lighted by means of windows instead of ports, and by a skylight overhead. Although only about fourteen feet square, it is well equipped for certain branches of investigation, and contains the library and medical dispensary. A stairway leads directly to the main laboratory on the lower deck, and this, in turn, communicates with the scientific store-room in the hold. The former extends entirely across the ship, and includes facilities for detailed physical and biological inquiries, a photographic dark room, and large series of drawers and sliding-trays for specimens and instruments. The steamer is lighted throughout by means of the Edison incandescent electric system, in connection with which there is a powerful arc-

lamp for illuminating the deck at night, and several search-lights for submarine use.

The *Albatross* represents the final stage in the development of exploring methods applicable to the study of the sea, and, having suitable means for elaborating the results on board, she is, moreover, a perfect floating workshop. Every appropriate device for collecting and for scientific observation has been provided, not omitting even the simplest forms of fishing-gear. Officered from the navy, as is the *Fish Hawk* also, experts in hydrography and seamanship have been enlisted in her service, and many young civilians and naval men have received from her most efficient and useful training.

The explorations of the *Albatross* and of her more humble predecessors have afforded a golden harvest for the naturalists, apart from their results of economic value. While the dredges, nets, and tangles are searching for

pearance are unusually common, and among invertebrates extravagant shapes and odd structures are just as frequently encountered. The surface waters contribute also a great wealth of life, especially in the pathway of the Gulf Stream or along its borders, where countless tropical forms, like the physalia, paper-nautilus, and marbled angler, are slowly drifted northward. The surface-nets and gigs furnish an enjoyable occupation from the vessel's rail, and at night, with the electric lights submerged a few inches, the catch is much increased. Then it is that the swift-darting squid appears in schools, and, dazzled by the glare, impales his long arms upon the cluster of sharp hooks, moved gently up and down to attract his notice. Fully as active, and far more difficult to capture, is the surly shark, bent on large prey, the sworn enemy of the sailor, and duly made to suffer for his supposed crimes when in the latter's power.



DRAWN BY A. H. BALDWIN.

SHARK WITH PARASITIC REMORAS.

ENGRAVED BY W. H. MORSE.

the food species, and determining the essential features of their environment, they must necessarily disclose the curious forms as well. Nowhere have the zoölogical discoveries of recent times been richer, both in number and in variety, than in the deep sea, a province which successfully defied intrusion until within a comparatively few years. Fishes of remarkable ap-

More recently a third addition has been made to the little fleet of Fish Commission vessels, a schooner of eighty-three tons, having a deep draft and good speed. Combining the best features of the American and English fishing-vessels, she was specially designed for the offshore banks, but that has not prevented her employment in both the ex-

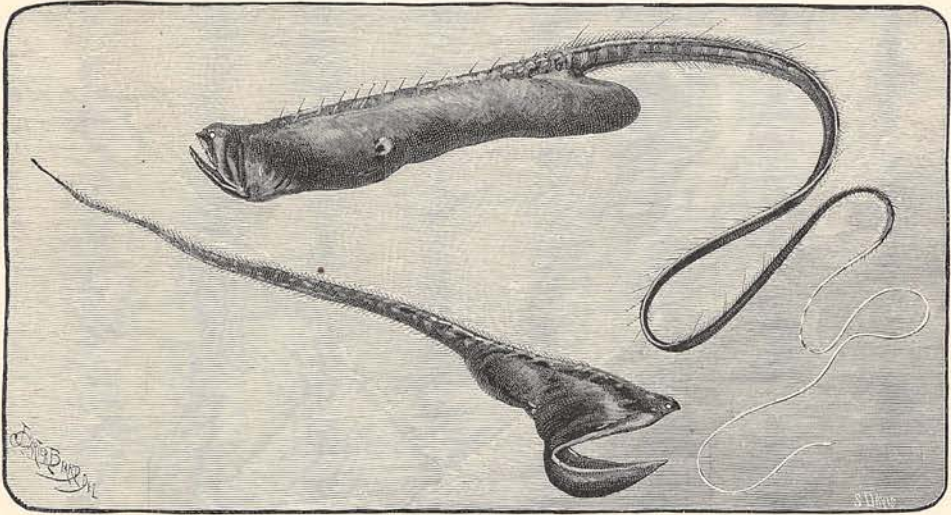
ploring and fish-cultural branches of the work, for which she is well adapted. The *Grampus*, as she is called, has already attracted much attention, and her lines are frequently copied in the modern smack.

Having described the methods suited to the scientific study of the fisheries, it remains to explain the manner in which they may be utilized for the public good, and the extent of their application up to the present time.

It has been the principal office of the steamer *Albatross* to develop the resources naturally existing along the sea-coasts, the fishing-grounds which are little known or have never been

habitants of the favored spot. The soundings are brought closer together until its area and contour have been defined, and its limits accurately plotted upon the chart. The temperatures and currents are observed, the dredge or the trawl vigorously employed, and frequent trials made with the fishing-gear best adapted to the circumstances.

The value of the information thus obtained is direct and pertinent. It gives the fisherman the precise position of a fishing-ground of the very existence of which he may formerly have been ignorant. The outlines are printed on a map, from which he learns its bearings from



DRAWN BY J.C. BEARD.

THE BOTTLE-FISH AND THE PELICAN-FISH.

ENGRAVED BY S. DAVIS.

discovered by the fishermen. To achieve this object in a thoroughly comprehensive manner requires a detailed examination of the bottom over extensive regions. Lines of soundings, run near together, determine its character and the depth of water. The beam-trawl or the dredge makes known the richness of the life, and the food on which the fishes subsist; oftentimes the fishes themselves are taken by the same means. With hooks and lines, with the more effective cod-trawls, and with various forms of nets, a better knowledge is obtained of the presence and abundance of those fishes, and of the means to be suggested for their capture upon a commercial scale. As a matter of fact, the sounding-lead in the hands of an experienced sailor is, in many places, a comparatively good criterion of the value of the bottom, and by its constant use a large area may rapidly be eliminated from the field, as consisting of barren sand or soft, sticky mud, or as having too great a depth. As soon as a change for the better is perceived, efforts are at once redoubled to ascertain the peculiarities and in-

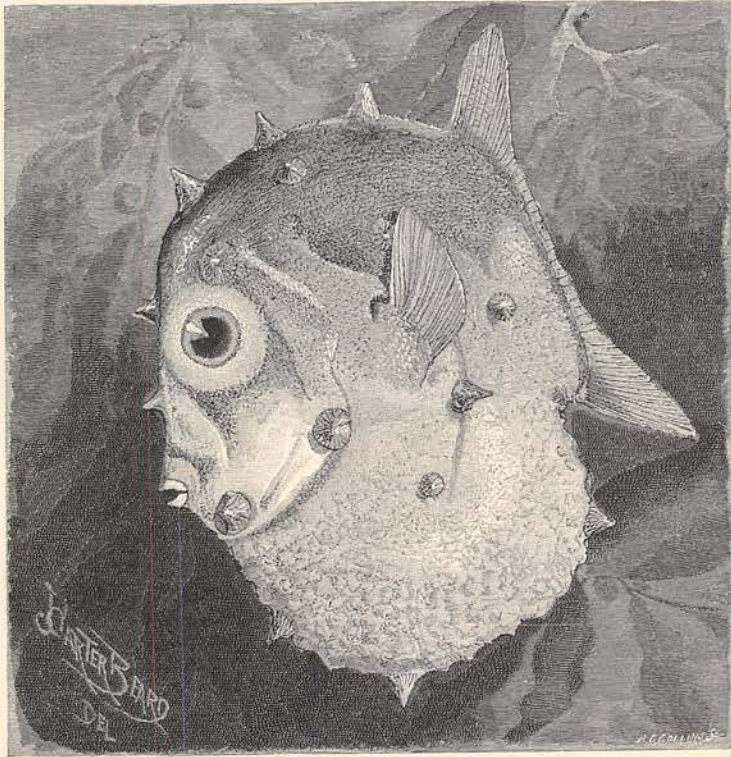
any given point, or its latitude and longitude. Instructed as to the species which resort to it, and their abundance, he has the means of determining for himself whether it warrants his attention, and, if the habitat of a rich growth of animals, he has the additional assurance that the ground is permanent, being frequented for feeding purposes. Many grounds, however, are at the surface, where the conditions are generally less uniform and the problems presented more difficult of solution, the fishes concerned being chiefly migratory in the widest sense. The study of these grounds has scarcely passed the experimental stage, and yet some good results have already been accomplished in respect to them.

The *Albatross* began her first work in April, 1883, and several months were spent in tracing the movements of the mackerel and menhaden, and in developing the tile-fish region south of Martha's Vineyard. During the three succeeding years she was almost continuously at sea, and her operations were extended from Newfoundland to South America. Two cruises were



made across the great eastern banks, the Bahama region was examined in a vain search for the winter home of certain pelagic food-fishes, and a hydrographic survey of the Caribbean Sea was successfully conducted in the interest of the navy. An appreciation of the value of these researches soon led to a demand for simi-

ing an extent of nearly forty degrees of latitude, the western coast-line presents a great diversity of climate, which is favorable to prolonged operations, and, notwithstanding that its hydrography was little known, the survey has been pushed ahead with great rapidity, and yet with greater thoroughness than any previous ex-



DRAWN BY J. C. BEARD.

JUVENILE SUNFISH.

ENGRAVED BY R. C. COLLINS.

lar investigations on the Pacific side, and the importance of the latter was justly recognized. Certain changes in the machinery of the steamer, deemed necessary before sending her upon so long a voyage, delayed her transfer, however, until the autumn of 1887, a short time subsequent to Professor Baird's death.

It was May, 1888, when the *Albatross* reached San Francisco, and in the mean time the office of Commissioner of Fisheries had been conferred on Colonel Marshall McDonald, a distinguished assistant in the service. Although resolved to carry out the policy established by Professor Baird, it seemed to him expedient to institute some changes in the conduct of the scientific work, with the view of securing more immediate benefits for the practical fisheries. The plans drawn up for the future guidance of the *Albatross* accordingly restricted her inquiries almost entirely to the submerged continental platform, the seat of nearly all the "ground" fisheries, as above explained. Hav-

ploration of a similar kind. The area covered up to the present time amounts to over one hundred thousand square geographical miles, and includes the coast from San Diego to Vancouver Island, the submerged border south of the Alaskan peninsula, and the southeastern part of Bering Sea.

Investigations of the same character are illustrated by much of the early work of the commission, particularly on the New England coast. Of more recent date have been the explorations of the *Fish Hawk* on the tile-fish grounds and oyster-beds, and of the *Grampus* on the red-snapper banks of the Gulf of Mexico and in the mackerel region. The inquiry last mentioned has been one of the most interesting as well as difficult and puzzling studies that have yet been taken up. The mackerel and menhaden, together with other pelagic species, and the anadromous fishes, like the shad and salmon, are regulated in their movements by changes in the temperature of the water. The condi-



DRAWN BY J. C. BEARD.

SQUID AND DEVIL-FISH.

ENGRAVED BY H. WOLF.

tions which control the latter species in the rivers have been comparatively well determined, but such is not the case with the pelagic forms, whose distance from the shores generally prevents convenient access to their haunts. During nearly every season since her building the *Grampus* has followed the mackerel northward from their point of appearance on the coast, her cruise extending on one occasion as far as Labrador. Although making all the customary observations, as did the *Albatross* in the same field, they were naturally too remote from one another, too disconnected, to furnish a basis for deductions. In order, therefore, to ascertain with more exactness the laws of temperature in the body of water which these fishes traverse, the *Grampus* has spent three summers in studying this single problem, with every suitable appliance known to science, having the assistance also, during one season, of the coast-survey steamer *Blake*. Through a wide section of the sea, extending 150 miles off Martha's Vineyard and Block Island, parallel lines of stations have been run at intervals of ten miles in both directions. At each of these points the temperature and density were observed at many intermediate depths between the surface and the bottom, and the same was repeated as often as the season would allow. The results give numerous vertical sections through the water, which indicate the thickness and distribution of the different bands of temperature and currents, and show their variations from time to time. It now remains to determine their relations to the atmosphere

and to the bodies of moving fishes, and to ascertain if the migrations of the latter may thereby be predicted.

The deterioration of fishing-grounds, as previously described, is the subject which led primarily to the organization of the Fish Commission. The occurrence of a decrease is established by statistics, its causes and remedies are determined by scientific investigations, and its replenishment is accomplished by fish-culture or legislation. The first few volumes devoted to the annual operations of this service show how thoroughly the matter has been treated, and how applicable are the modern methods of research to problems of this kind. The causes may be due to natural or to human agencies, often readily observed; the remedies are more perplexing, and require the judicious consideration of many questions which the survey proper does not reveal. The manner of conducting the inquiries does not differ essentially from the study of new grounds, but necessitates a greater attention to details, including the fishery methods of the region, and has been limited chiefly to coastal waters and to the lakes and rivers.

Subsidiary to this problem is the study of the life-history of fishes from their earliest stages to mature age, and of their habits under all conditions. These studies are necessary, in order that efficient steps may be taken for the formation of new fishing-areas, and for the protection and improvement of those already known. Aside from their development, with which the embryologist has to deal, carrying

on his work at one of the stations of the commission, or at some other convenient point, there are many grave questions for consideration. It is well known that shad and salmon return with astonishing regularity to the rivers where they spawn. Many other useful fishes are landlocked or inhabit small streams; but how is it with those marine species which never leave the salt water? Within a few years it has been decided to attempt the restoration of the inshore fisheries for cod, once affording a profitable occupation, but now depleted nearly everywhere. Is it practicable to reestablish fishing-grounds where no defined boundaries exist, where the entire ocean is before them? The case varies with the species, and must be determined separately for each. All have their special habits, some favorable to human influences and others equally opposed to them. Certain bodies of the cod, spending their summers in the open sea, return each autumn to their chosen spawning- and feeding-grounds in shallow water, while others prefer the rocky shores at all seasons. To increase the numbers of either kind is to enlarge the schools which assemble periodically within the reach of the smaller fishing-boats, or live continuously at their mercy. This fact, first proved by observations of the adult fish, has been confirmed by the hatching work of five years past, the young, in countless multitudes, now filling every favored spot from Narragansett Bay to Maine. What is possible with the cod may be repeated with many other species, and has been done with some; but until their habits had been studied, it would have been a waste of time and money to undertake their breeding. It is still an open question as to whether the artificial propagation of either the mackerel or the menhaden could be carried on with profit, but the lobster is even more restricted in its movements than the cod, and the oyster may be brought entirely within control. Both of these species are good subjects for careful nursing, and both are receiving much attention.

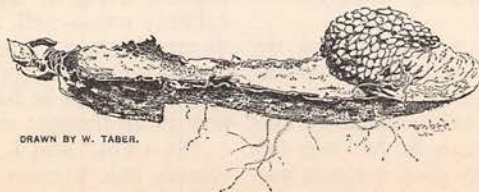
Fishery legislation, whether applied to ex-

hausted or to prosperous grounds, should be based upon the principles which this inquiry has demonstrated, and fishery methods should be guided by its teachings. The older system, still generally prevailing, makes no provision for the future, and to its workings is chiefly due the present need of cultivation.

Another promising field in which a remarkable progress may be recorded is the transplanting of useful species, the formation of new fisheries. By this means a food-supply has been created in many regions, and its variety and abundance have been increased in others. To accomplish this successfully requires a knowledge of all the conditions natural to the fishes, and a thorough study of the waters where their planting is proposed. In the interest of this division, as of that relating to depletion, a systematic survey of the inland waters is now in progress. Every river-basin is made the subject of an exhaustive investigation, which discloses its physical characteristics, the different kinds of fishes—useful, predaceous, or otherwise—concerned in its economy, and the lower forms of life constituting the basis of the food-supply.

Science stands, therefore, between nature and the fisheries as a willing and helpful agent, powerful in its influence to promote the general good. From the experimental stage its progress has been gradual but decisive to the higher plane, where its benefits are no longer problematical. Whether in the discovery of new wealths or in the reparation of former industries, its services are acknowledged to be essential. It teaches the principles of fish-culture, and leads the way to proper legislation and judicious fishery methods. The policy so liberally supported in this country has no stronger advocates at present than the selfsame people who first taught Americans how to fish, but who are now content to follow in their footsteps. The warm indorsement of Berlin, in 1880, and of London in 1883, was a tribute fairly earned and well deserved by the honored founder of this service.

*Richard Rathbun.*



A SLIPPER WITH SEA-ANEMONE.