UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART XIII.

REPORT

OF

THE COMMISSIONER

FOR

1885.

A.—INQUIRY INTO THE DECREASE OF FOOD-FISHES.
B.—THE PROPAGATION OF FOOD-FISHES IN THE WATERS OF THE UNITED STATES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1887.

Resolved by the Senate (the House of Representatives concurring), That the report of the Commissioner of Fish and Fisheries for the year 1885 be printed, and that there be printed 11,000 extra copies, of which 3,000 shall be for the use of the Senate, 6,000 for the use of the House of Representatives, 1,500 for the use of the Commissioner of Fish and Fisheries, and 500 for sale by the Public Printer, under such regulations as the Joint Committee on Printing may prescribe, at a price equal to the additional cost of publication and 10 per cent thereto thereon added, the illustrations to be obtained by the Public Printer, under the direction of the Joint Committee on Printing.

Agreed to by the Senate February 24, 1885.

Agreed to by the House March 2, 1885.

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REPORT OF THE COMMISSIONER.

A.—GENERAL CONSIDERATIONS.

1.—INTRODUCTORY REMARKS.

The duties assigned to the United States Commissioner of Fish and Fisheries, as indicated in the law authorizing his appointment, consist, first, in the investigation of the causes of decrease in the supply of useful food-fishes of the United States, and of the various factors entering into the problem; and, second, the determination and employment of such active measures as may seem best calculated to stock or restock the waters of the rivers, lakes, and the sea.

Twelve annual reports, containing in all upwards of 12,800 octavo pages, as well as several hundred plates, have heretofore been issued. This, the thirteenth, swells the total number of pages to upwards of 14,000. It covers the operations of the Commission during the calendar year 1885 and in part for 1886, being the fifteenth year of its history.

Year by year a more or less rapid and continual expansion of the Commission has been chronicled, increased appropriations have been made, indicative of the appreciation by Congress of the efforts put forth, and a growing demand from the people of the country for assistance in maintaining and increasing the food supply of the nation has been developed. As heretofore, the work of the Commission has been aided and supplemented by that of the various State commissioners acting under appointment from the governors of the different States and Territories. Relations with all these have been cordial and harmonious, and each, in varying methods, has done what was possible with the means placed at his disposal. The State commissioners are in no sense responsible to the United States Commissioner, and whatever co-operation has taken place has been of a purely voluntary nature. The following States and

Territories have been represented during the present year by the number of commissioners indicated:

State.	No.	State.	No.	State.	No.
Alabama	2	Maine	3	Pennsylvania	6
Arizona	3	Maryland	2	Rhode Island	3
Arkansas	2	Massachusetts	3	South Carolina	1
California	3	Michigan	3	Tennessee	3
Colorado	1	Minnesota	3	Vermont	2
Connecticut	3	Missouri	3	Virginia	1
Delaware	1	Nebraska	3	Washington	1
Georgia	1	Nevada	1	West Virginia	3
Illinois	3	New Hampshire	3	Wisconsin	7
Indiana	1	New Jersey	3	Wyoming	3
Iowa	1	New York	4		
Kansas	1	North Carolina	1	Total	97
Kentucky	10	Ohio	3		

There has also been hearty co-operation with the work of investigation by various men of science, notably by those connected with Government bureaus of this and other countries, and with many of the leading colleges and educational organizations of the country. To the latter it has been possible for the Commission to supply, in return, collections of marine forms and other material of great value for class-room instruction, and for museum purposes. These collections involve no expense to the recipients beyond the cost of freight, of alcohol, and of suitable receptacles for exhibition and storage, and are assigned to schools and colleges upon recommendation of the member of Congress from the district in which the institutions are located.

In addition to the usual routine operations of the Commission during the year, in the way of general administration, of inquiry, and of propagation of food-fishes, the following specially noteworthy points may be indicated as having engaged its attention. These will be referred to more fully hereafter:

1. The completion of the suite of buildings at Wood's Holl, and their occupancy, for the purposes of investigation and fish production.

2. The exploration of the fishing-grounds of the Gulf of Mexico by the steamer Albatross, and the investigation of the red snapper and other fisheries.

3. The appropriation of $14,000 for building the schooner Grampus, the construction of plans, and the award of the contract for building to Messrs. Robert Palmer & Sons, of Noank, Conn.

4. Participation in the New Orleans Cotton Centennial Exposition, at which were exhibited the steamer Albatross, with her appliances for research and practical work, and a hatching car fully equipped with eggs and live fish.

5. The taking of a census of the fisheries of the Great Lakes for purposes of comparison with that of five years ago.

6. The co-operation of the Treasury Department in obtaining statistics of the sea fisheries of the Atlantic Ocean.

7. The examination of the oyster-beds of Long Island Sound by the steamer Lookout under the direction of Mr. E. G. Blackford.

8. The importation of several installments of live soles from England, and of the eggs of Loch Leven trout and *Coregonus albula*.

9. The hatching of cod at Wood's Holl, of grayling at Northville, and of shad at a new station on the Delaware.

10. The building of a shad hatchery at Fort Washington on the Potomac River.

11. The discovery of a rational system of oyster culture, including the collection of spat by a new process proposed by John A. Ryder.

12. The transportation of clams from Tacoma, Wash., on the Pacific coast, to Wood's Holl Station upon a car of the Commission.

13. The successful confinement of young shad in a pond from June to November.

14. The extensive distribution of carp to private ponds and numerous plants made in public rivers.

15. The continued efforts and increased results in taking and hatching the eggs of shad, whitefish, trout, salmon, and other species of food-fish at previously established stations of the Commission.

16. The exportation of live catfish to Holland, France, Germany, and England; and of large shipments of whitefish eggs to Germany, Switzerland, and Australia.

17. The introduction to commerce of smoked kingfish.

18. The record of the establishment of the Iceland halibut fishery as a profitable undertaking for American fishermen.

19. The meeting in Washington of the American Fisheries Society.

20. The publication of Section I of the quarto fishery report in two large volumes, one of text and one of plates.

The work connected with the administration of the office has probably been greater during the present year than in any preceding year. The number of letters received, registered, and indexed during the fiscal year ending June 30, was 14,174, and the number written during the same period, 10,549, or a total of 24,723. In addition, there were received 3,994 applications for fish and several thousand statistical returns relating to the lake fisheries, the sea fisheries, and the culture of carp.

This increase in the office work of the Commission has necessitated additional room, and on the 1st of October the house immediately north of the Fish Commission office, known as 1448 N street, N. W., was leased and has since been occupied as offices of the disbursing agent and his clerks.

It gives me much pleasure to record that during the year no casualties have occurred to the immediate *personnel* of the Commission, and no serious interruption of work in consequence of death or prolonged sickness of any of its members. The death of Prof. Henry J. Rice, which occurred at his home in Brooklyn, N. Y., on December 14, however, involved a serious loss on account of the interruption of the valuable embryological work, which he conducted for the most part at the private laboratory of Mr. E. G. Blackford, Fulton Market, New York City, and in which the Commission was much interested. The general cause of fish-culture has also suffered in the death of Mr. George Henry Jerome, which occurred August 15, at Niles, Mich. He was for a time a member of the State Board of Fish Commissioners of Michigan, and was the first State superintendent of Michigan fisheries. Many years of his life were devoted to the cause of fish-culture, and his influence was often potent with the legislature of his adopted State when questions arose with reference to the fisheries.

2.—STATIONS OF THE UNITED STATES FISH COMMISSION.

During the present year all of the stations which were occupied during 1884 have been in use, and there have been added thereto temporary stations on the Delaware River for the purpose of hatching shad.

A.—INVESTIGATION AND RESEARCH.

(1) *Gloucester, Mass.*—This station was first occupied in 1878, and has been maintained ever since on account of the opportunities furnished for securing information with reference to the sea fisheries. In February of the present year the office was placed in charge of Mr. W. A. Wilcox, secretary of the American Fish Bureau. With the assistance of Capt. S. J. Martin, statistics of the fisheries have been collected, from which monthly reports have been compiled and published in the Fish Commission Bulletin. Mr. Wilcox has also assisted in obtaining extended information relative to the sea fisheries.

(2) *Wood's Holl, Mass.*—This station, which has been occupied since 1881, is the largest and perhaps the most important of all occupied by the Commission. It furnishes a harbor and wharfage for the steamers of the Commission which are engaged in research along the North Atlantic coast each summer. It is fitted up especially for the propagation of marine forms, such as the cod, the lobster, and the oyster. It is in charge of Capt. H. C. Chester, and is occupied by the Commissioner in person during three or four of the summer months.

(3) *Saint Jerome, Md.*—This station, established in 1881, is used for experimental work in connection with oyster culture, and is in charge of W. de C. Ravenel. Five ponds have now been constructed, and during the year extended observations have been made upon the densities of sea-water in various typical localities.

B.—PROPAGATION OF SALMONIDÆ.

(4) *Grand Lake Stream, Me.*—This station since 1875 has been operated jointly in the interest of Maine, New Hampshire, and Massachusetts, and of the United States, and is under the direction of Mr.

Charles G. Atkins. Work is confined to propagating landlocked or Schoodic salmon, of which 641,000 eggs were taken the present year.

(5) *Bucksport, Me.*—This is one of the oldest stations of the Commission, having been established in 1872, and is also under the direction of Mr. Atkins. It is devoted to the production of eggs of the Penobscot salmon, of which 2,315,000 were secured during the present year. An installment of eggs of *Coregonus albula* from Germany was hatched and deposited in Heart Pond, Orland, Me., and Lake Hebron, Monson, Me.

(6) *Northville, Mich.*—This station, established in 1872, was one of the first occupied by the Commission and has been in continuous operation. It was first established for the propagation of whitefish, but at present its operations extend to the cultivation of brook trout, rainbow trout, lake trout, landlocked salmon, and brown trout. It has been in charge of Mr. F. W. Clark for a number of years and has produced several hundred millions of eggs of the whitefish.

(7) *Alpena, Mich.*—This station was organized in 1882 as an auxiliary to the Northville Station. Whitefish eggs are taken at Alpena and forwarded to Northville for development. This is also under direction of Mr. Clark.

(8) *Baird, Cal.*—This station was opened in 1873 for the purpose of securing eggs of the California salmon. It was operated for this purpose for about ten years, but during the year 1884 and the present year no eggs have been taken, although a keeper has been in charge. Mr. Livingston Stone has superintended it from its inception.

(9) *Trout ponds near Baird, Cal.*—This, as well as the preceding station, is situated on the McCloud River, and is also under direction of Mr. Stone, although more immediately carried on by Mr. L. W. Green. It has been operated since its establishment in 1879 for securing eggs of California or rainbow trout, of which 246,000 were obtained in 1885. During the present year a disease developed among the trout which caused some alarm, and which was investigated by Prof. S. A. Forbes, with the result of ascertaining that it was identical with that which swept off such large quantities of fish in the Wisconsin lakes in 1884.

(10) *Wytheville, Va.*—This station, the property of the State of Virginia, has been used by the United States Commission since 1883, through the courtesy of Colonel McDonald, the State commissioner. Its superintendent is Mr. George A. Seagle. It is used for the propagation of Penobscot salmon, California trout, brook trout, Rangeley trout, lake trout, black bass, red-eye perch, carp, and grayling. During the present summer a new hatchery was erected with a capacity of 500,000 eggs. Several small ponds were also constructed and the distribution of the water supply completed.

(11) *Cold Spring Harbor, N. Y.*—This station is the property of the New York State Fish Commission, and is in charge of Mr. Fred Mather, since 1883. Through the courtesy of Mr. E. G. Blackford, one of the State commissioners, work has been performed in behalf of the United

States Commission in connection with the propagation of whitefish, brook trout, rainbow trout, brown trout, Penobscot salmon, and land-locked salmon.

C.—PROPAGATION OF SHAD.

(12) *Battery Station, Md.*—This station has been operated since 1876 for the purpose of hatching shad, the young of which have either been returned to the waters of Chesapeake Bay or transported to other portions of the country for introduction to new waters. During a portion of the season the steamer Lookout, Mate James A. Smith, was in attendance to co-operate with the work. In the present season over 10,000,000 young fish were hatched, of which about one-half were deposited in the immediate vicinity.

(13) *Central Station, Washington, D. C.*—In 1881 the old Armory building was assigned to the Commission for the purpose for which it is now used. It receives at different times of the year eggs of shad, herring, salmon, whitefish, and various kinds of trout, to be hatched and distributed by cars to various portions of the country. The station is in charge of Colonel McDonald.

(14) *Fort Washington, Md.*—Stations in this vicinity have been occupied by the Commission since the year 1874 for the purpose of collecting shad eggs. The immediate locality was first occupied in 1883 by permission of the War Department. During the present year a building was constructed near the wharf, to be used as a hatchery and for the storage of eggs, of which over 22,000,000 were taken. It is in charge of Col. M. McDonald, and practically is an outpost of the Central Station.

(15) *Gloucester City, N. J.*—This station, situated on the Delaware River, was first occupied the present year. The steamer Fish Hawk was stationed at this point from May 23 to June 10, and succeeded in securing over 10,000,000 eggs. This work was under charge of Lieut. L. W. Piepmeyer, U. S. N., commanding the vessel.

The steamer Lookout, Mate James A. Smith commanding, made two trips to the Delaware for the purpose of collecting shad eggs, most of which were transferred to Battery Station.

(16) *Lambertville, N. J.*—A temporary station was organized at this place during the present year, for the first time, for the purpose of hatching shad eggs. Car No. 3, in charge of Mr. J. F. Ellis, fully equipped with shad-hatching apparatus, was moved to this point early in June, where it remained until the middle of July and met with fair success.

D.—PROPAGATION OF CARP.

(17) *Monument Reservation, Washington, D. C.*—The carp ponds were established at this point in 1878, since which time large numbers of scale, mirror, and leather carp have been produced. There have also been grown in limited numbers goldfish, golden ides, and tench. During the present year the experiment was made of confining shad in one

of the ponds throughout the summer, which proved successful. Mr. Rudolph Hessel is in charge.

(18) *Arsenal Grounds, Washington, D. C.*—This station is supplementary to the Monument Reservation Station, and has been used since 1878 for the cultivation of scale carp. It is in charge of Mr. Richard Lynch.

For information with reference to the actual work accomplished with different species of fish and eggs at these various stations, the reader is referred to a later portion of this report, where there will be found a full list of species cultivated by the Commission and a statement of the success attained with each variety.

3.—NEW HATCHING STATION PROPOSED.

In Colorado and elsewhere in the Rocky Mountain region there occurs in considerable numbers the Rocky Mountain trout* (*Salmo purpuratus*), which is deemed by ichthyologists much more worthy of propagation in Eastern lakes and streams than *Salmo irideus*, as attaining a larger size, being more active, and inhabiting a wider variety of waters. Mr. Pierce, the Colorado Fish Commissioner, describes it as occurring at the Twin Lakes, in Lake County of that State, of good size, and in abundance sufficient to warrant artificial propagation. (The Twin Lakes are 5 miles from Twin Lake Station, on the Denver and Rio Grande Railroad, and 18 miles from Leadville.) He says: "It is rarely caught at less than 2 pounds weight, and runs from that to 10 pounds. The specimens I saw were 4, 5, 7, and 10 pounds, respectively." During June of the present year he sent an agent to Twin Lakes, who put up a hatchery at the foot of the lower lake with a capacity of 1,000,000 eggs. He had no difficulty in procuring plenty of fish with a seine or in trapping them between the lakes in large quantities. Only a few eggs were secured during June, which led to the conclusion that the work should have commenced earlier, perhaps in April. What eggs were obtained were hatched, and about 1,000 of fry were removed to a pond at the State hatchery at Denver. At the upper end of the smaller of

* Prof. D. S. Jordan says: I feel very sure that this trout is the most valuable one we have, and I would like to see it have a chance.

My preference for *Salmo purpuratus* over *Salmo irideus* lies in this: It reaches a larger size, and from the extent of its distribution (every river and lake from Southeast New Mexico, Colorado, Dakota to Oregon and Kamchatka) it seems more adaptable to a variety of circumstances and waters. It is a handsomer, more active species. It is unquestionably different from *S. irideus*, having a larger mouth, teeth on the hyoid bone, and especially much smaller scales.

From two red blotches under the chin, always present in life, I have suggested that it be called the red-throated trout. It thrives in lakes. Utah Lake is full of them, and they run up the Provo River in such numbers that the irrigating ditches scatter them all over the meadows. The finest specimens I have seen are those from Lake Tahoe, where they reach 26 pounds weight. There is a little hatchery now at Tahoe City, Nevada. This locality is the best I know. Next I would place Provo, Utah.

the lakes there is an abundance of spring water suitable for hatching. The State of Colorado having made no appropriation for 1885-'86, the use of the State hatchery was tendered to the United States Commission by Mr. Pierce, with the approval of Governor Eaton. Senator Teller also manifested his interest and approval of the proposed work. In addition to the State hatchery Mr. Pierce owns a private hatchery of 300,000 eggs capacity, at which he raises trout for market.

Mr. Pierce was informed that the establishment of a trout-breeding station in Colorado would be considered a very important auxiliary to the work of this Commission, and that as early as practicable a reconnaissance of the lakes, their location and surroundings, would be made with a view to active operations. The actual equipment of the station when once erected would be inexpensive, as the necessary apparatus is now on hand. The matter remains in abeyance for future consideration.

4.—VESSELS OF THE U. S. FISH COMMISSION.

A.—The Steamer Albatross.

The Albatross, under the command of Lieut.-Commander Z. L. Tanner, U. S. N., continued during the year to do valuable work in connection with the investigations and researches required of the Commission by the Government.

At the beginning of the year all preparations for sea had been completed, and on January 3 the vessel left the navy-yard at Washington and proceeded to sea under instructions to make a full and careful investigation of the food-fishes and fisheries of the Gulf of Mexico, including a trip to the island of Cozumel off the coast of Yucatan, and a visit to the New Orleans Exposition as a part of the display of the Fish Commission. While in the Gulf Stream off and to the southward of Cape Hatteras the weather was too rough to admit of much deep-sea research or a satisfactory attempt to search for tile-fish, and the vessel was finally run out of the stream and headed for Key West, where she arrived on the 9th. After lying there a few days the Albatross steamed over to Havana, where the usual courtesies were extended by the officials of the port, and in the vicinity of which some valuable scientific work was done.

Leaving Havana the vessel proceeded across the Gulf to the island of Cozumel, making soundings and dredgings on the way, reaching the island on the 22d of January, where she remained until the 29th, during which time an investigation was made of parts of the island, especially of the village of San Miguel, and numbers of birds and marine specimens were obtained. Soundings were next made on the Campeche Banks, but the examination of this region was cut short by sickness on board, and the vessel proceeded to Pensacola, where a typhoid patient was transferred to the hospital. Some investigations were made on the fishing-banks off Cape San Blas in regard to the character of the bottom and the marine fauna, after which the vessel proceeded to New Orleans, reaching there on February 13. Here from February 20 to March 1 the Albatross was on exhibition at the exposition wharf, during which time many thousands of people from all parts of the country visited her and expressed great interest in what they saw.

On the 1st of March the steamer left New Orleans for Pensacola, making soundings and dredgings on the way. From the 6th to the 19th the time was occupied in an examination of the fishing-grounds and fisheries off the west coast of Florida, especial attention being given to the red-snapper banks off Cape San Blas, which were visited under the guidance of Mr. Silas Stearns, of Pensacola. Capt. Joseph W. Collins was also on board, and a full account of the investigation will be found in his report in the appendix. On March 20 the vessel arrived at Key West, where coal was taken on and some necessary repairs were made.

On the 30th the return passage to Washington was begun, and unsuccessful attempts were made to take tile-fish. From the middle of the Gulf Stream to the coast and for some distance up Chesapeake Bay a line of soundings and a set of serial temperatures were taken, which are likely to prove of great value in connection with the study of the movements of migratory fish at this season. On the 6th of April the vessel was again at the Washington navy-yard, having made the entire cruise without any notable accident or loss.

The next trip was made from June 2 to the 7th, being chiefly in search for tile-fish off the mouth of the Chesapeake Bay and along the coast towards Cape Hatteras. None were taken, but much trawling and dredging was done, and the naturalists obtained a considerable variety of deep-water and surface forms of life.

The summer cruise of the Albatross was begun June 13, when she left the Washington navy-yard under instructions to visit and make an examination of the Newfoundland Banks. Arriving at Newport, further preparations were made for the cruise, and on the 17th she again proceeded to sea. Two reported shoals were sounded on, in accordance with a request from the Bureau of Navigation, and their non-existence was verified. Numerous soundings and investigations of the bottom at various portions of the banks were made, with a view of furnishing data for a contour map of the fishing-banks, while the usual examinations were made to determine the biological conditions of the grounds. Some torpedoes were exploded for the purpose of ascertaining the results on the marine life of the vicinity. The vessel returned to Wood's Holl on July 16, where she remained until August 6, making necessary repairs and preparing for a fresh trip to the former tile-fish grounds.

During August and September two trips were made from Wood's Holl, having for their principal object the investigation of grounds where tile-fish were formerly found, and the taking of specimens of that fish if possible. Much valuable scientific work was done in dredging, sounding, taking temperatures, and in investigating some of the more obscure forms of marine life. No traces of tile-fish, however, were found. The result of the search of the Albatross for this fish during the year, taken in connection with the similar results of other investigations made since 1882, by this vessel and others, seems to indicate that the tile-fish have been entirely exterminated, or at least have abandoned our coast. The search has been made for them with much care, as they promised to be a fish of great commercial value, and had been taken in considerable numbers during the seasons of 1880 and 1881, previous to the unprecedented destruction of the species in March and April of 1882.

On October 8 the Albatross left Wood's Holl, and stopped at Newport and New York, before going on a short trip of investigation off the capes of the Delaware and the Chesapeake and a little farther south. On the 24th she returned to the navy-yard at Washington, where she remained until the end of the year, engaged in refitting and preparing for future work.

In the appended report of Captain Tanner on the work of the Albatross in 1885 will be found full details as to the officers and specialists on board, as well as of the several trips made; while added to his report in general on the operations of the vessel will be found reports of the navigator, engineer, surgeon, naturalist, and several valuable tables containing statistical and other details.

B.—The Steamer Fish Hawk.

As stated in the report of 1884, Lieutenant Wood was relieved from the command of this steamer December 31. Lieut. L. W. Piepmeyer succeeded him at that date and remained in command throughout the year. From the 1st of January to the 25th of April the vessel was engaged in various duties in connection with the Havre de Grace Station, and work in Chesapeake Bay. On the 7th of May the American Fisheries Society, which was holding its annual meeting in Washington, was invited to a trip upon the Fish Hawk to witness the shad work at Fort Washington. The excursion occupied the entire afternoon, furnishing the members ample opportunity for witnessing the hauling of the seine and the manipulation of the eggs in the hatching house. From the 16th to the 20th of May the vessel was moored at Fort Washington and the crew were instructed in spawn-taking. She then proceeded to the Delaware, arriving at Gloucester Point May 23, and remained in those waters until June 10, visiting the fisheries and collecting shad eggs. Of a total of 10,000,000 eggs, over 8,000,000 were hatched and the fry returned to the Delaware River. On the 11th of June the steamer was placed on exhibition at Burlington to enable those interested in the fisheries to inspect the process of handling and hatching eggs. The vessel was then transferred to the Chesapeake for the purpose of continuing shad work, where 4,500,000 eggs were obtained and 1,370,000 young fish hatched. During August the Fish

Hawk was at Saint Jerome Station assisting in the driving of piles on each side of the entrance to the new channel which had been cut. In September, after undergoing repairs at Baltimore, the vessel proceeded to Wood's Holl, where she arrived on the 27th. She remained there until the close of the year, performing such duties as were required in connection with that station.

C.—The Steamer Lookout.

The Lookout was under the command of Mate James A. Smith throughout the year. From January 1 to the 4th of February the vessel was at Baltimore. On January 22 orders were issued to prepare the steamer for a trip to the Gulf coast in order to make an investigation of the fisheries of the west coast of Florida and of the Gulf of Mexico. Arriving at Cedar Keys, Florida, March 14, Assistant Commissioner Ferguson joined the vessel and thereafter directed her movements. Among the places visited were Saint Joseph, Saint Andrew's Bay, Pensacola, Key West, Apalachicola, Cedar Keys, Anclote Keys, Clear Water Harbor, Tampa, Punta Rassa, and Havana. She returned to Washington May 7, and after some repairs entered upon the shad-hatching work on the Susquehanna and Delaware Rivers, and was so occupied until June 5. During the first part of July the vessel made various trips in Chesapeake Bay, and made an examination of the Spanish-mackerel fisheries. On July 20 the Lookout arrived at Wood's Holl. On the 29th a trip was made to No Man's Land for swordfish, and on the 31st a trip was made to New Haven to obtain oysters for us e in propagation at Wood's Holl. From the 12th to the 27th of August the vessel was detailed to service with Mr. E. G. Blackford, a Fish Commissioner of the State of New York, charged with investigating oyster-beds of Long Island Sound and vicinity. A trip was made with live fish from New York to Wood's Holl early in September. In October the Lookout was used to transport a large quantity of specimens to the Peabody Museum, New Haven, Conn., for investigation by Professor Verrill, after which, service was performed in Chesapeake Bay in connection with the stations located there. The close of the year found the vessel laid up in Baltimore.

D.—The Schooner Grampus.

In my report for 1884 mention was made that an appropriation of $14,000 had been asked for from Congress to build a vessel for a special purpose—that of transporting living fish from the oceanic fishing-grounds to the main station at Wood's Holl, Mass. The possibilities of artificial propagation, so far as sea-fish are concerned, seemed almost limitless, provided an ample supply of fish, such as halibut, cod, mackerel, &c., could be obtained. It is only possible to get a supply of these by using a smack containing a well, and the possession of such an adjunct has been considered a very important matter to the Commission.

The appropriation was made by Congress, and shortly afterwards, on his return from a cruise on the Albatross to the Gulf of Mexico, Capt. J. W. Collins began work on the model and plans for a vessel. It had been previously determined that a schooner-rigged sailing vessel of about 80 tons net register would be best adapted to the requirements of the Commission. The whole matter of designing her in all its details of model, interior arrangement, rig, &c., was placed in the hands of Captain Collins, who for several years past has made a special study of the fishing vessels of Europe and America. His studies and experiences have led him to believe that the fishing boats in use on our New England coast have heretofore been more or less faulty in model and rig for the special work which they have to perform, particularly in the winter season. Therefore, in designing this vessel for the Commission, an attempt has been made to produce a new and improved type of fishing schooner, one which would not only possess the best qualities of the clipper craft now employed in the New England fisheries, but would also be much more seaworthy. It is believed by those who have had the best opportunities for studying the question in all its bearings that the fishing schooners built during the past quarter of a century or more have generally been too shallow to insure requisite safety when exposed to gales, and that they are liable to be capsized by heavy seas. Since their center of gravity is not sufficiently low to enable them to right again, the consequence is that they have frequently filled and sunk with all on board.

The loss of life and property from this cause has on many occasions been enormous, and it is apparent that any improvement in the model of our fishing schooners which can obviate these distressing circumstances will be a great blessing to the fishing interests. The vessel designed by Captain Collins, for which the name of Grampus has been selected, has been made 2 feet deeper than the fishing schooners of the same length are usually built, and therefore should be very much safer, since her ballast can be placed lower and her stability correspondingly increased. In several other respects besides that of depth, the Grampus differs from the typical fishing schooner: First, instead of having a raking stem and a long projecting cut-water, her stem is nearly straight and perpendicular above water and curves away at an easy slope to join the keel below load-line. This is believed to be quite an important improvement, since the long cutwater, which is liable to be broken off by a heavy sea or otherwise damaged and thus become a source of constant expense, is dispensed with. At the same time, with a given length over all, the length of the load-water line is increased 4 or 5 feet at the bow; consequently the entrance can be made much easier and the buoyancy on the water-line forward increased. This change, everything else being equal, should produce a vessel that would be swifter and dryer than one of the common forms. Second, the after section has been made different from that of the ordinary fishing craft. The run of the latter is commonly hollowed out very much, leaving the quarters and counter very flat, while the horizontal lines in this part of the vessel are generally a series of very abrupt curves. The after section of the Grampus, while preserving a general semblance to that of a fishing schooner, has much easier lines, and the stern has a greater rake, which gives it a more symmetrical appearance and will enable the boat to run easier in a seaway.

The rig of the Grampus differs from that of fishing vessels generally, n having all wire standing rigging and in carrying a fore-staysail and small jib instead of the large jib which is almost universally used. This change in the head sails makes it possible, when a vessel is obliged to reef in heavy weather, to keep the center of effort of the sails nearly in its proper place and insures the easier management of the craft.

The ship was "laid down" and her molds were made by Mr. D. J. Lawlor, of Chelsea, Mass., who is widely known as an eminent naval architect, and who also gave Captain Collins considerable mechanical assistance in the preparation of the plans, &c.

Owing to the fact that it was found necessary to have Captain Collins go off on a cruise to the Eastern fishing-banks the work of preparing the plans for the Grampus was considerably delayed. However, the plans and specifications were completed early in September and bids were advertised to be received on September 22. The number of bidders was five, their proposals ranging from $9,300 to $17,000, as follows:

David Clark, Kennebunkport, Me	$17,000
James D. Leary, Brooklyn, N. Y	13,440
Arthur D. Story, Essex, Mass	9,500
Bishop & Murphy, Gloucester, Mass	9,500
Robert Palmer & Sons, Noank, Conn	9,300

The lowest bid was received from the firm of Robert Palmer & Sons, Noank, Conn., and the contract was awarded them, they entering into it on October 6. The bid given by Palmer & Sons was for building the hull and furnishing the spars only. A separate contract was awarded Messrs. E. L. Rowe & Son, of Gloucester, Mass., to rig the vessel and furnish her with chains, anchors, sails, and top iron-work complete for the sum of $1,913.

Work was commenced on the vessel's hull as soon as practicable after the contract was completed, and at the close of the year reasonable progress had been made, though considerable delay had been incurred on account of inclement weather. The frame and outside planks are of oak; she is ceiled with yellow pine; fastened with copper and yellow metal below water-line and with galvanized iron elsewhere.

The well is of a unique pattern for a large smack and is specially adapted for the needs of the Commission. It is nearly in the center of the schooner and is cone-shaped with the base at the bottom of the vessel and the apex at the deck, being what is commonly termed a "box-well." It is 16 feet long by 8 feet wide at the base, and 4 feet long by $2\frac{1}{2}$ feet wide at the top, which is flush with the deck. This form of well makes it possible to reach any fish that may be in it from the deck, without difficulty, and obviates the necessity which might occur of grounding the vessel when the contents of the well are to be removed.

Besides carrying on the work which has been mentioned it has been thought desirable to have the Grampus make experimental trials with the great beam-trawl which is so extensively used in the fisheries of Europe, in order to ascertain whether this form of apparatus can be profitably employed in the commercial fisheries of the United States. To handle this properly and successfully it is necessary to have steam power. The question of what form of steam apparatus would be best adapted to this work was referred to Lieut.-Commander Z. L. Tanner, U. S. N., commanding the steamer Albatross. After due consideration he decided that a steam windlass would be the most suitable, and a contract for making the same was awarded the American Ship Windlass Company, of Providence, R. I., and the apparatus was completed early in December. Passed Asst. Eng. I. S. K. Reeves, U. S. N., consulting engineer of the Commission, has been given charge of obtaining and putting on board the steam-boiler, steam-pump, water-tanks, and the necessary piping, &c., connected with the operation of the steam apparatus and water-tanks. This work will be accomplished with as little delay as possible, and the introduction of the steam windlass apparatus will conform as nearly as may be with the completion of the vessel's hull.

E.—Other Vessels.

In addition to the sea-going vessels already named, the Commission is provided with six steam launches, which are used either as attendants to the above-named steamers or for towing barges, transporting eggs and fish, or for miscellaneous work in connection with the stations. The list is as follows:

Albatross cutter, $26\frac{1}{2}$ feet long, 7 feet beam, and $3\frac{5}{6}$ feet deep.

Albatross gig, 25 feet long, $5\frac{1}{6}$ feet beam, and $3\frac{1}{4}$ feet deep.

Fish Hawk launch, $24\frac{5}{6}$ feet long, $5\frac{2}{3}$ feet beam, and $3\frac{3}{4}$ feet deep.

Cygnet (No. 82), 33 feet long, $8\frac{1}{2}$ feet beam, and 4 feet deep.

Launch No. 68, 37 feet long, 7 feet beam, and 3 feet deep.

Launch No. 55, 30 feet long, $7\frac{3}{4}$ feet beam, and 3 feet deep.

The two last-named launches are attached to the Havre de Grace Station, while the Cygnet has been in service alternately between Havre de Grace and Wood's Holl.

Launch No. 68 and launch No. 55 are the property of the Navy Department, and have been loaned to the Commission by the courtesy of the Bureau of Equipment and Recruiting.

F.—Assignments of Naval Officers.

The list of changes in the assignment of naval officers connected with the service of the Fish Commission, either on vessels or on shore, has been as follows:

On April 13 the apothecary of the Fish Hawk, Mr. J. Alban Kite, resigned his place and was succeeded by G. F. Nelson, M. D., on appointment of Surgeon-General F. M. Gunnell.

On April 22 Ensigns R. H. Miner and L. M. Garrett were detached from the Albatross.

On July 31 Passed Assistant Engineer W. L. Bailie was retired from service, and Passed Assistant Engineer I. S. K. Reeves was transferred from the Fish Hawk to fill the vacancy in shore duty at Wood's Holl.

On August 17 Engineer S. H. Leonard was ordered to the Fish Hawk.

On September 30 Lieut. H. S. Waring was ordered to duty on the Albatross.

On November 4 Ensign Franklin Swift, and on November 10 Lieut. A. C. Baker, were detached from the Albatross.

On December 3 Ensign W. J. Maxwell reported on board the Fish Hawk for duty.

On December 12 Lieut. C. J. Boush was detached from the Albatross.

On December 21 Lieut. Bernard O. Scott reported for duty on the Albatross.

I regret to record the loss of the services of Passed Assistant Engineer William L. Bailie, who in February, 1884, was ordered to duty with the Commission in connection with the steam engineering work of the Wood's Holl Station, being transferred from the steamer Fish Hawk. The efficiency and completeness of the work at the station is due in large part to the ingenuity exhibited by him in planning the necessary arrangements and combinations and in carrying them out.

His services, also, in connection with the steam engineering and plumbing work of the Fish Commission cars, of the Central Station at Washington, and at the United States carp ponds, &c., have been of very great importance.

In consequence of physical disability Mr. Bailie was placed on the retired list of the Navy on July 1, 1885, which, of course, relieved him from official duty with the Commission. He, however, volunteered his services in connection with the completion of the work, and remained at the station until September 16, when he left to take up his abode in Baltimore.

5.—CARS OF THE U. S. FISH COMMISSION.

The history of the construction and use of these cars has been detailed in previous reports, and need not here be repeated. The cars are as follows:

No. 1, constructed in 1881, now in charge of Newton Simmons.

No. 2, constructed in 1882, now in charge of George H. H. Moore.

No. 3, constructed in 1884, now in charge of J. F. Ellis.

These cars are in active service about six months of the year. During the remainder of the time they are stored in a shed erected for the purpose near Central Station, and the crews furloughed. In all the miles of travel, now aggregating many thousand, no serious accident has ever happened to any of these cars, if we may except a slight "smash-up" in Canada a few years ago, which damaged the end of one car, but injured none of the occupants.

As has been stated on a previous page, the experiment of using a car as a temporary hatchery was tried at Lambertville, N. J., with good results.

One of the cars was displayed at the New Orleans Exhibition, with its load of fish and eggs, and excited great interest.

6.—COURTESIES EXTENDED TO THE UNITED STATES FISH COMMISSION.

A.—By the Government.

Treasury Department—*Secretary's Office.*—The Acting Secretary, C. S. Fairchild, granted a permit May 1 for taking seals at the Pribylov Islands. On September 5 he directed the collector of customs at the port of New York to render facilities in connection with the landing of soles imported from England for the purposes of propagation. On the 6th of November the order to the collector at New York was made general to cover all importations of fish and eggs in behalf of the United States Fish Commission.

On the 16th of December the Department issued a circular to all collectors of customs at ports where fishing vessels are documented, requesting them to co-operate with the Fish Commission in obtaining statistics of the ocean fisheries.

Light-House Board.—This Board has continued to assist in securing ocean-temperature observations at thirty-five light-houses and light-vessels along the Atlantic coast. A list of these light-houses will be appended to this report. On June 15 the Board granted for the summer the use of the old laboratory building at the Wood's Holl buoy department, which has been previously of much service to the Commission. With the completion of the new buildings, however, the present season is probably the last that this courtesy will be desired.

Coast Survey.—Frequent calls have been made upon the Coast Survey for tide-tables, maps, and charts for use on the different vessels and at the stations of the Commission, which have been supplied very courteously. On July 2 it lent a set of hydrographic charts, to be copied and used in studying the movements of mackerel, menhaden, and other fish along the coast, thus saving a large amount of original work. The Superintendent of the Survey on May 14 offered to lend the schooner Matchless, but it was found unnecessary to accept the offer.

Life-Saving Service.—As in several preceding years, the keepers and patrolmen have reported the stranding of marine animals, and co-operated with representatives of the Smithsonian Institution in securing specimens for study and exhibition. Among the valuable accessions was a pigmy sperm-whale, reported on January 1 by James R. Hobbs, keeper of Kitty Hawk, N. C.

Another accession was found on the beach near High Head L.-S. Station by Mr. B. C. Sparrow, superintendent of the Second L.-S. District, and proved to be the so called "dish-rag gourd" (*Luffa ægyptica*).

October 24 Joel Ridgway, keeper of Barnegat L.-S. Station, reported a whale (*Kogia breviceps*) ten feet long, stranded near the station.

WAR DEPARTMENT.—Permission to use the facilities at Fort Washington for the purpose of hatching shad has been continued during the present year.

Signal Office.—General Hazen has continued to furnish weather indications to Wood's Holl during the summer season, as well as to the steamer Lookout during its trip along the southern coast and the Gulf of Mexico.

NAVY DEPARTMENT.—The officers and crews of all the vessels of the Fish Commission have been furnished by the Navy Department during the year, and the facilities of various navy-yards, particularly that at Washington, have been extended to the Commission.

Bureau of Construction and Repair.—The launches Nos. 55 and 68 have been furnished for several years, and their loan was continued during the present year.

Bureau of Steam Engineering.—On November 11 Commodore Charles H. Loring granted the loan of some tools for use at Havre de Grace and at Wood's Holl.

Bureau of Equipment and Recruiting.—Coal was furnished to the Fish Commission vessels upon requisition, at contract prices, as in preceding years.

INTERIOR DEPARTMENT—*Patent Office.*—The Official Gazette of the Patent Office has been supplied weekly, as heretofore, and specifications and drawings of all patents relating to fish and fishing apparatus as issued.

SENATE AND HOUSE OF REPRESENTATIVES—*Folding-Rooms.*—The superintendents of the Senate and House folding-rooms kindly consented to envelop the quarto report, which was issued in two volumes December 20.

HEALTH OFFICE OF THE DISTRICT OF COLUMBIA.—Statistics of the Washington fish-market have been furnished in monthly tables, as in previous years. These have been compiled and published in the Fish Commission Bulletin.

B.—BY THE RAILROAD COMPANIES OF THE UNITED STATES.

The courtesies extended by the railroad managers have been: (1) The transportation of Fish Commission cars gratuitously over several thousand miles of road; (2) the transportation of Fish Commission cars at the rate of 20 cents per mile over an even greater number of miles of road; (3) permission to carry fish and eggs in baggage-cars of passenger trains, and for the attendants to enter the cars for the purpose of caring for the fish; and (4) furnishing such repairs as have been needed to the cars at the shops of several companies, notably the Pennsylvania Railroad and the Baltimore and Ohio Railroad. A list of the roads furnishing free transportation, and also of those furnishing transportation at the 20-cent rate, will be appended to this report. It may be well to explain that the 20-cent rate is a very large reduction upon rates charged for hauling private cars. For instance, for hauling a private car from Philadelphia to Pittsburg the Pennsylvania Company would charge eighteen full fares, or $180, while for hauling the Fish Commission car it would charge 20 cents per mile, and as the distance is 352 miles the charge would be $70.40, which is $109.60 less than the charge to private parties for the same service.

C.—By Foreign Steamship Companies.

The foreign steamship companies have continued their liberal treatment of the Commission by free transportation of fish and eggs. The extent to which these facilities have been furnished will be seen by reference to the list of courtesies extended to and received from foreign countries, to be stated hereafter.

D.—Courtesies from Foreign Countries.

Germany.—On February 24 there were received from the Deutsche Fischerei-Verein 40,000 eggs of the brown trout (*Salmo fario*). From this lot, one-half of which were consigned to Mr. Blackford, about 19,000 fry were secured.

On January 30 a box of 50,000 eggs of *Coregonus albula* was received in New York and repacked by Mr. Mather and forwarded to the Bucksport Station.

On November 5 there were received by steamer Elbe 10 macropods or paradise-fish, from Paul Matte, fish-culturist, Lichterfelde, Germany. These were received in New York by Mr. Blackford, who transferred them to his aquarium in Fulton Market pending their final disposition. They had, however, been so exhausted by the journey that in a few days all had died. Mr. Matte sent these fish with the hope of procuring American ornamental fish in exchange, his collections including representatives from many parts of the world.

England.—Persistent efforts have been made during the present year to safely transport soles. On September 10 an installment from the National Fish Culture Association of England arrived per steamer Republic in care of Mr. W. T. Silk, but all the fish had died in the passage from Liverpool to New York.

The Marquis of Exeter, who is president of the National Fish Culture Association, had interested himself in the success of this shipment, and had kindly placed at the command of the National Fish Culture Association his private fish culturist, Mr. Silk, in order to insure the best possible results.

In his letter of September 25 Mr. W. Oldham Chambers, secretary of the National Fish Culture Association, said that complete arrangements had been made by him for catching soles on the Essex coast. They were deported from the boat at Harwich to Liverpool by special van in charge of a qualified attendant, who, on arriving at Liverpool, handed the fish over to Mr. Silk in perfect condition. Mr. Chambers further says: "I fear their loss was due to the fact that Mr. Silk placed the fish in the public baths at Liverpool, which is not only *brackish*, but full of *impurities*, naturally fatal to deep-sea fishes like soles. My council desire me to express their deep regret at the ill-fortune attending their endeavors to further the acclimatization of flat-fish in the United States, but at the same time wish me to assure you that they will take an early opportunity of renewing the experiment notwithstanding the recent failure, caused more from wrong treatment than from inherent incapacity on the part of the fish to withstand the strain of transportation."

On October 8 Mr. Thomas J. Moore, curator of Liverpool Museum, with the aid of Mr. W. A. Duncan, forwarded to Mr. E. G. Blackford 12 soles by the steamer Britannic, Capt. Hamilton Perry, of the White Star Line. These were received October 19 and presented to the Fish Commission. The 9 soles which reached New York alive were immediately sent to Cold Spring Harbor to be cared for until arrangements could be made to transport them to Wood's Holl in safety. From the time of arrival at Cold Spring Harbor, October 20, Mr. Mather made observations upon their habits, and reported them doing well until December 30, when the soles, together with a large installment of cod eggs, were frozen to death during a violent storm. An important feature of Mr. Moore's method was the use of six Mortimer ship aquaria containing 2 soles each. The bottom of the glass globes in which the fish were placed was covered with an inch or two of sand. The soles buried themselves therein and no chafing resulted. This shelter imitates quite well their native habitat.

On October 24 an installment of 500 soles was sent from Liverpool, by the Cunard steamer Gallia, in charge of Mr. William Little, of 32 Scratton Road, Southend, Essex County, England. These soles were taken off Norwich and transmitted by rail to Liverpool, where Mr. W. Oldham Chambers, secretary of the National Fish Culture Association, made arrangements for their reception and transshipment. The steamer arrived at her dock in New York on the morning of November 3. Mr. Blackford and Mr. Mather were there with a tug and suitable cans to receive them, but were greatly disappointed to find that most of the fish had died when the steamer was only two days out, and the remainder a few days later. They had been placed in several casks, without sand upon the bottom of the vessel. Consequently the soles, lying right upon the bottom, were very much chafed at their heads and tails. Mr. Little, the attendant, was selected because he was the fisherman who had caught these soles, and he was able to give information with regard to their habits, food, and movements. As the basins at Wood's Holl had been prepared for the reception of this large shipment, and the steamer Lookout had been sent to New York to convey them to Wood's Holl, and the facilities already alluded to had been secured from the custom-house, the bitter disappointment at the loss of the entire 500 fish may be readily understood.

Scotland.—On January 2, 100,000 eggs of Loch Leven trout (*Salmo levenensis*) were received from Sir James Gibson Maitland, of the Howietoun fishery, Stirling, Scotland.

7.—COURTESIES TO FOREIGN COUNTRIES.

Scarcely a year has passed since the organization of the Commission in which there has not been one or more transmissions of fish or eggs to foreign countries in response to requests made in behalf of their respective Governments. While in a few instances failure has resulted, the general success has been such as to lead to renewed demands. The present year has witnessed greater activity in this direction than in preceding years. As will be seen from the preceding paragraphs as well as from other reports, suitable returns have been made to the United States by several countries furnishing the Commission with fish or eggs of fish new to the United States.

The Commission has been called upon to extend courtesies to foreign countries in the way of imparting information upon the methods and success of American fish-culture, and accredited representatives of other Governments have been accorded the facilities of the office in Washington and of such stations as they chose to visit for the purpose of examination. The reports and bulletins of the Commission, notably the quarto report which appeared during the present year, have been very greatly sought by foreign fish-culturists, and so far as possible their wishes have been met. Scarcely a week has passed without receiving letters from such persons making inquiries with a view to increasing the efficiency of their work. These letters, whether received through the State Department or direct, have been answered promptly and as fully as practicable.

An interesting correspondence was held with Juan de la C. Cerda, Chilian consul-general at San Francisco, who was commissioned by the Chilian Government to secure California salmon eggs for Chili. The Chilian Government called upon this Commission to recommend a suitable person to take charge of the introduction of salmon into Chili, and it gave me much pleasure to nominate Mr. Livingston Stone. The year closed without any decisive answer having been received to Mr. Stone's proposition. A statement of what is hoped to be accomplished by the Chilian Government will be found in the Fish Commission Bulletin of 1885, page 247.

There has been considerable correspondence with a view to transmitting shad to Holland, but the apparatus for accomplishing this result with so delicate a species has not yet been perfected sufficiently to warrant making the effort.

The species covered by the transmission of fish or eggs of the present year include whitefish, rainbow trout, brook trout, Penobscot salmon, landlocked salmon, catfish, carp, bass, red-eye perch, and suckers.

The list of countries to which transmissions have been made includes Australia, Brazil, Canada, England, France, Germany, Mexico, The Netherlands, Scotland, and Switzerland.

Australia.—On January 5 there was forwarded from the Northville Station, in charge of special messenger as far as Council Bluffs, 1,000,000 whitefish eggs, consigned to the Ballarat Acclimatization Society, W. P. Whitcombe, president. The eggs were received in San Francisco by Mr. Robert J. Creighton, agent for the New Zealand Government, who placed them safely on board the Pacific mail steamer. His son, Mr. Charles Creighton, reported that the eggs reached Sydney in good condition, but while on the steamer plying between Sydney and Melbourne they were subjected to a rise in temperature which destroyed the entire lot before reaching their destination.

Brazil.—On March 28, 100 carp were sent to Preston A. Rambo, care of John C. Uhler, M. D., Baltimore, who left for Rio Janeiro March 30. The carp were from one to two inches in length, and being in charge of an attendant doubtless reached their destination in good condition, although nothing definite has been heard.

Canada.—During December of the present year applications for carp were received from twenty residents of the Dominion of Canada. As it was too late to supply them in 1885 the applications were held over for consideration in 1886.

England.—Eggs of whitefish, lake trout, Atlantic or Penobscot salmon, brook trout, landlocked salmon, and rainbow trout have been sent to Great Britain during the present year, the transportation being furnished free of charge by the Cunard Line.

The following shipments have been made to the National Fish Culture Association, South Kensington, London, England, care of Hon. Edward Birkbeck, M. P., vice-president of the association: On January 14, 250,000 eggs of the whitefish and 30,000 eggs of the lake trout were shipped by steamer Gallia, Mr. W. Oldham Chambers, secretary to the association, under date of February 10, announcing the arrival of the eggs in excellent condition, the rate of mortality being remarkably low. On February 4, 30,000 eggs of the Atlantic or Penobscot salmon were shipped by steamer Scythia, these also arriving in excellent condition, the death rate being under 1 per cent. On February 11, 25,000 brook trout eggs were sent by steamer Servia, their safe arrival being announced February 25. On March 27, 30,000 landlocked salmon eggs were transported by steamer Bothnia, and on April 18, 5,000 rainbow trout eggs were sent by steamer Servia. Mr. W. Oldham Chambers, in presenting the thanks of the association for the salmon and trout forwarded during the present year, reports that they "were hatched out at South Kensington with a very low minimum of mortality, and the fry were in due course transferred to our fish-culture establishment at Delaford Park, where they continue to thrive."

On October 20, 1885, Mr. W. Oldham Chambers wrote, "The propagation of whitefish this year having proved such a great success, we are particularly desirous of making a special feature of this species next year."

On the 11th of April a consignment of 10,000 rainbow trout eggs was sent by steamer Devonia, of the Anchor Line, to the same address. These also arrived in good order.

Concerning the above, Land and Water of February 28, 1885, says:

Foremost among the most interesting consignments of eggs which have been received from abroad are a large number of ova of various kinds forwarded by the American Government, through their Fishery Commissioner, Professor Baird. The United States Government has been most liberal in its presents of fish eggs, and English pisciculturists owe it a hearty vote of thanks for giving the National Fish Culture Association an opportunity of carrying on experiments with a view of ascertaining whether the introduction of certain fish from American waters into our English, Irish, and Scotch rivers and lakes can be practically and advantageously carried out.

On June 20 there were sent by the steamer Britannic, of the White Star Line, 50 catfish to the National Fish Culture Association. Under date of July 10 the secretary, W. Oldham Chambers, stated that 48 had arrived in safety and been placed in the establishment at Delaford Park. The London Globe of July 11 notices the fact and pronounces them of great economic value.

In October Mr. W. T. Silk, who had accompanied the consignment of soles already referred to, took back with him to England, for the Marquis of Exeter, 250 black bass and 50 red-eye perch, and for the National Fish Culture Aquaria at South Kensington, 20 suckers, all of which had been forwarded from the Wytheville Station.

France.—On March 1, a package of 10,000 rainbow trout eggs from Wytheville Station reached New York. These were presented to Mr. E. G. Blackford, who forwarded them to the Society of Acclimatization, Paris.

By steamer Amérique, on July 18, Mr. Blackford sent six cans containing 100 catfish (*Amiurus nebulosus*) to Havre. Of these 50 were forwarded to W. Coleman Burns, who received them at Paris in excellent condition. The other 50 were for the Society of Acclimatization, whose secretary reported under date of July 29, the receipt, in perfect condition, of 41 specimens.

Germany.—During the present year the eggs of whitefish, brook trout, landlocked salmon, and rainbow trout have been shipped to Herr von Behr, president of the Deutsche Fischerei-Verein, care of Mr. Busse, of Geestemünde, by the North German Lloyd Steamship Company. This line transported the eggs free of charge. I regret to say that three consignments intrusted to the steamer Eider arrived in bad, if not totally worthless, condition. As a rule this company has been successful with the eggs committed to its care.

On January 10, 1,000,000 whitefish eggs were shipped by the steamer Salier, the eggs arriving in Geestemünde in good order, but by some misunderstanding half of them were shipped from there to Switzerland. An additional lot of 1,000,000 whitefish eggs was sent on February 20 by the steamer Eider, but arrived in bad condition. On reaching Geestemünde no ice was found in the boxes.

The 40,000 brook-trout eggs shipped on February 7 were well cared for by the steamer Fulda and arrived at Geestemünde in good order.

On the 30th of March a lot of 40,000 landlocked salmon eggs and 10,000 rainbow trout eggs were shipped by steamer Eider. As was the case with the whitefish eggs shipped on the 20th of February, there was a lack of ice in the boxes and all of the rainbow trout and nearly all of the landlocked salmon were lost. Mr. F. Busse, of Geestemünde, under date of April 12, 1885, reports that the consignment of fish eggs arrived without any ice whatever, even the boxes being dry. The *Salmo irideus* had actually decayed, and not a single egg could be distinguished on the frames. The landlocked salmon on their arrival were found to be considerably developed, some young fish having already slipped out of the eggs.

On June 16, 50 live catfish were sent to the Deutsche Fischerei-Verein by steamer Ems. On July 17 Count Max von dem Borne reported that 49 had arrived safely at Berneuchen.

The last-named gentleman having expressed a desire to introduce into the fish-ponds of Berneuchen the wild-rice (*Zizania aquatica*), a bushel was obtained from Valentine Brothers, Janesville, Wis., and forwarded to him. On September 7 he reported that the seeds failed to germinate.

Mexico.—On March 14 the Fish Commission representative at New Orleans delivered to Dr. Barroeta a pail of 25 carp, to be taken by him to Mexico, the smallest and strongest carp of the different varieties being selected.

On April 6 Dr. Barroeta reported that 14 reached their destination alive. On that date he forwarded a second installment. On October 13 Señor Esteban Chazari, of the City of Mexico, made a request for carp and lake trout eggs. Carp four months old to the number of 800 were forwarded by Wells, Fargo & Co.'s Express, *via* El Paso, Tex., on the 4th of December, and on the 26th Mr. Chazari received them in good condition. On January 18, 1886, 25,000 lake trout eggs were forwarded to him, but were unfortunately received in poor condition.

The Netherlands.—On March 10 Mr. E. G. Blackford forwarded 5 black bass to Dr. C. Kerbert by steamer Edam, Captain Taat. On April 8 Dr. Kerbert reported their safe arrival. On July 7 Dr. Kerbert acknowledged the receipt of 30 catfish which had also been sent by steamer Edam through the assistance of Mr. Blackford.

Scotland.—On April 4, 20,000 landlocked salmon eggs were forwarded to the Tay District Salmon Board, care of John Anderson & Son, Edinburgh, by steamer State of Pennsylvania, of the State Line. A very courteous letter of thanks was received from Vice-Admiral W. H. Maitland Dougall, R. N., writing in behalf of the Tay District Salmon Board, but definite statements concerning the condition of the eggs on arrival are lacking. On April 18, 10,000 rainbow trout eggs were shipped by steamer Devonia, of the Anchor Line, to Sir James Gibson Maitland, of the Howietoun fishery. These arrived in good condition.

Switzerland.—As has already been stated, one-half of the million whitefish eggs sent January 8 to the Deutsche Fischerei-Verein were forwarded to Switzerland. Under date of February 19 the Swiss minister, Hon. Emil Frey, stated that the eggs reached Berne in fine condition and had been distributed to hatcheries at Zurich, 50,000; Berne, 100,000; Lucerne, 50,000; Zug, 50,000; Grisons, 100,000; Vaud, 100,000; and Geneva, 50,000.

8.—SERVICES RENDERED TO OTHERS.

On the night of Saturday, September 5, the steamer Monohanset, belonging to the New Bedford, Vineyard and Nantucket Steamboat Company, ran aground on a bar in the Great Harbor at Wood's Holl, about 200 yards from the railroad depot. The occurrence took place about 11 o'clock at night, and the vessel had on board about five hundred passengers, who had been to Cottage City to witness the annual illumination, and who were to take a train about midnight to Hyannis.

Although there was no danger in the occurrence, the probability of a long detention through the night was not comfortable to contemplate, and the case having been brought to my notice I authorized and directed the steamer Lookout and the steam launch, having a large scow in tow, to proceed at once to the scene. In two trips of the vessels the entire party was landed on the dock; and the cars being rapidly filled, the train proceeded to its destination.

The company, appreciating the services rendered, transmitted the following communication:

NEW BEDFORD, *September* 7, 1885.

DEAR SIR: Please accept our thanks for the valuable service rendered us in landing the passengers (something over four hundred) from the steamer Monohanset, ashore at Wood's Holl Saturday night, and for other assistance rendered. It was a rainy and disagreeable night, and it was a great relief to the large number of passengers when you came to their aid, taking them from the steamer and landing them on the wharf at Wood's Holl safe at midnight.

If we can hereafter serve you in any way please advise us, as we desire to show our appreciation for what you have done for us.

Very respectfully yours,

EDW. T. PIERCE,
Agent.

Prof. S. F. BAIRD,
U. S. Fish Commission, Wood's Holl.

9.—PARTICIPATION IN INTERNATIONAL EXHIBITIONS.

A.—LONDON, 1883.

The history of our connection with the great International Fisheries Exhibition, at London, has already been given in preceding reports. In 1885 the medals and diplomas which had been awarded to the U. S. Fish Commission arrived, the list of which is as follows:

Rigged models of fishing-vessels: Gold medal.
Mackerel and herring nets: Diploma.
Exhibit of artificial flies: Gold medal.
Fish transporting car: Silver medal.
Model of lobster-boiling establishment: Gold medal.
Collection of piscicultural exhibits: Gold medal.
Collective exhibit of invertebrata: Gold medal.
Whale-bone: Gold medal.
Enlargement of photographs and drawings illustrating fishing pursuits: Gold medal.
Collection of primitive fishing tackle, modern sea-fishing lines, gear, and hooks: Gold medal.
Collective exhibit of publications relating to the fisheries: Gold medal.
Herring smoke-house, collective exhibit of appliances: Silver medal.
Model of menhaden oil and guano factory: Gold medal.
Collection of oils, &c.: Gold medal.
Collective exhibit of fishery products: Gold medal.
General exhibit of fish-eating birds and mammals: Gold medal.
Collection of dredge exhibits: Silver medal.
Photographs of fish-culture: Silver medal.
Collective exhibit of deep-sea exploration apparatus: Gold medal.
Collective exhibit of boats: Gold medal.
Builders' models of fishing vessels: Gold medal.
Purse-seine net: Gold medal.
Collection of dry-salted fish: Diploma.
Collective exhibit of fish: Gold medal.

B.—NEW ORLEANS, 1885.

The U. S. Fish Commission, in 1885, participated in the World's Industrial and Cotton Centennial Exposition at New Orleans, sending exhibits to illustrate the fisheries, fish-culture, and deep-sea research.

The Board of Government Commissioners, appointed by the President in 1884 to make arrangements for a general Government display at the Louisville, Cincinnati, and New Orleans exhibitions, included Mr. G.

Brown Goode, Assistant Director of the U. S. National Museum, who was charged with the preparation of an exhibit from the Smithsonian Institution, the National Museum, and the U. S. Fish Commission.

In the fall of 1884 the collections were shipped from Washington and duly installed at New Orleans soon after the opening on December 16, 1884. The exposition continued till May 31, 1885. Mr. Goode being obliged to return to Washington, the care of the collection was given to Mr. R. Edward Earll, of the Fish Commission, who was assisted by Colonel McDonald and others.

The exhibit of fisheries and fish-culture occupied 2,345 square feet of the 24,750 square feet allotted in the Government buildings to the general display of the Smithsonian, National Museum, and Fish Commission. The collection included some of the exhibits which had previously done service at Berlin and London. Among the objects displayed were about one hundred and fifty photographs, size 30 by 40 inches, illustrating the apparatus and methods employed in the sea and river fisheries of this country, and a collection of models in plaster of the principal fresh and salt-water food-fishes of the United States.

A series of diagrams and tabulated statements, prepared by Prof. W. O. Atwater, showed in an instructive manner the relative food qualities of the leading food-fishes compared with other foods.

A full-sized whale-boat, with complete outfit ready for the chase, was an attractive exhibit.

Colonel Marshall McDonald, of the U. S. Fish Commission, had the direction of the fish-cultural exhibit, which consisted of a series of six tables containing hatching apparatus in which the embryos of white-fish, salmon, and other species were kept during their development, and small aquaria in which the newly hatched fry were exhibited. There were also six large aquaria containing trout, salmon, carp, and several other species of fish from the Fish Commission ponds at Washington. There was also a series containing numerous forms of hatching apparatus used at the hatcheries of the U. S. Fish Commission, and models of various kinds of fish-ladders or fishways.

Arrangements were made with the management of the exposition for a supply of pure water for conducting the hatching operations, and at intervals during the continuance of the exposition, eggs of different species were shipped to New Orleans and placed in the hatching apparatus, where they were allowed to remain until hatched. This exhibit was perhaps the most popular in the entire exhibition, and during the time when clear water could be obtained, and the young fish were hatching, a majority of the people attending the exposition found their way to the space, some of them lingering hour after hour.

On February 18 Colonel McDonald arrived with U. S. Fish Commission Car No. 3, containing a full equipment of hatching and transporting apparatus. This car was placed on a side track at the Prytania street entrance of the exhibition adjacent to the Smithsonian space, and was constantly open for inspection from 8 in the morning until 6 in the evening. In it were shown, not only the processes of hatching, but the methods employed in transferring the fry to waters very remote from the hatchery. After the fish-cultural exhibition had been installed Colonel McDonald returned to Washington, and J. Frank Ellis was placed in charge of the car, and James Carswell assumed control of the fish-cultural display in the Smithsonian space in the Government building. The car remained until the middle of May, when it was recalled to be used in the distribution of shad from the Fish Commission hatcheries in Washington and Maryland.

The Fish Commission steamer Albatross was engaged during the winter of 1884–'85 in scientific investigation of the currents, temperatures, and marine life in the vicinity of the West Indies and in portions of the Gulf of Mexico. She was stationed for a few days at New Orleans. On her arrival in that city the exposition management placed a portion of the exposition wharf at her disposal. She soon occupied the place assigned, and was thrown open for inspection by persons visiting the exposition as a part of the exhibit of the U. S. Fish Commission. The apparatus employed in her scientific investigations was arranged on deck, and interesting forms of marine life recently taken in the deep waters of the Gulf of Mexico were removed from the tanks and placed in glass bottles in the steamer's laboratory, where they could be viewed by those who might be interested. At the request of Capt. Z. L. Tanner, an efficient corps of officers and scientists remained constantly on duty to inform visitors of the general character of the work in which the steamer was engaged, and to explain the workings of the apparatus. After a stay of ten days, during which time she was visited by a very large number of people, she left the exposition in order to resume her work, which had been temporarily interrupted.

10.—MEETING OF THE AMERICAN FISHERIES SOCIETY.

The fourteenth annual meeting of the American Fisheries Society (formerly known as the American Fish-Cultural Association) was held at the National Museum in Washington, D. C., on May 5 and 6, 1885, under the presidency of Hon. Theodore Lyman, of Massachusetts. During the meeting twenty-seven names of gentlemen were proposed and elected to membership.

The first paper read was by Prof. Robert E. C. Stearns, on "The giant clams of Puget Sound," in which the habits, size, and edible qualities of the geoduck clam (*Glycimeris generosa*) were described. This was followed by a paper on the "Hibernation of the black bass," by Dr. James A. Henshall, in which he held that the hibernation of fishes is influenced more by the supply of food than by temperature, and that both species of black bass hibernate in the northern sections of America. Mr. Fred Mather presented a paper on "Protecting and hatching the smelt," which contained some interesting statements regarding the habits of the smelt, and showing some of his experience in procuring and handling the eggs. Mr. Frederick W. True read a paper on "The porpoise fishery of Cape Hatteras," in which he stated the objects to be pursued by a company recently organized in Philadelphia for the capture of porpoises near Cape Hatteras, in order to utilize these dolphins for producing oil, leather, and food. It may be noted that a considerable variety of opinions was expressed in the society regarding porpoise flesh as a food product, some holding it excellent when properly smoked and others maintaining that it is a very inferior article of food. Later in the season Mr. True ate some broiled steak cut from a young porpoise brought in by the steamer Albatross, and expressed himself as very favorably impressed by the edible qualities of this young cetacean.

In the first paper read on the morning of May 6 Mr. Frank N. Clark stated the "Results of planting whitefish in Lake Erie," and showed by testimony from many reliable fishermen and fish-dealers that while the aggregate catch is steadily increasing, so also are the whitefish on the increase in Lake Erie, and that this increase is due solely to the work of the hatcheries. The next paper was by Mr. J. S. Van Cleef, on "How to restore our trout streams," in which he showed that the destruction of the trees bordering on the streams and the changed condition of the banks produced thereby has resulted in depriving the trout of their natural hiding-places, and that this is the main cause of their depletion, in connection with excessive fishing with nets and hooks and lines. Mr. A. N. Cheney next discussed the question "Does transplanting affect the food or game qualities of certain fishes?" stating his opinion that fish in alien waters improve in food and game qualities only when they find better food or water, which causes a more vigorous condition. Then followed a paper by Mr. John A. Ryder "On some of the protective contrivances developed by and in connection with the ova of various species of fishes," giving some matter of considerable biologic value. Prof. Otis T. Mason next read a short paper on "The use of the throwing-stick by the Esquimaux," several specimens being shown, their use described, and the statement made that this implement is in use only in Australia, South America, and among the Esquimaux of North America. This was followed by a valuable contribution from Prof. Theodore Gill, entitled "The chief characteristics of the North American fish fauna." In this he considered only the fresh-water forms of America north of Mexico, stating that they numbered over six hundred species, representing nearly one hundred and fifty genera and about thirty-four families; and he concluded that the number of genera and types common to Europe and North America is comparatively small, while the special peculiarities of the North American fishes are sufficient to entitle this region to be considered as a primary geographical division of the globe.

The next paper in order was on "Some objective points in fish-culture," by Col. M. McDonald. This discussed what yet remains to be done in the way of intelligent and progressive fish-culture, speaking of the great value of scientific investigations, the need for competent legislation on the fisheries, and the practical worth to the Government of complete statistics, especially in relation to the sea fisheries. Mr. W. V. Cox followed with "A glance at Billingsgate," which gave an excellent description of that famous old fish-market, and ended with the conclusion that there is little, if anything, for American fish-dealers to learn at Billingsgate, except how far in advance of them in this respect we are on this side of the Atlantic. A paper was then read by Mr. E. G. Blackford on "The oyster-beds of New York," in which he spoke of the investigation in progress under his charge during the past year and the present condition of the oyster areas of the State. This investigation showed that the natural oyster-beds were in bad condition and much less in extent than they were twenty years ago, but that the loss in the natural areas was more than made up in the formation of planted beds, which increase the territory upon which oysters are grown, so that the number of oysters sent to market is three or four times what it was a score of years ago. The pollution of the water and the consequent destruction of the oyster-beds in the vicinity of New York City was referred to, and a plan was spoken of whereby individual owners may hold small areas of oyster-grounds and work them thoroughly.

Mr. Charles G. Atkins reported on "The biennial spawning of salmon," as learned from experiments conducted at Bucksport, Me. These seem to indicate that it is the normal habit of the Penobscot salmon to spawn every second year, while it seems to be fairly well established that a large part, perhaps nearly all, of the salmon, instead of proceeding to sea at once after spawning, linger in the fresh water all winter and descend only with the spring floods. The concluding paper was by Mr. Fred Mather on the "Work at Cold Spring Harbor," which gave a sketch of the operations at this hatchery with foreign and domestic fish during the season of 1884–'85. The facts stated are included in the Reports of the U. S. Fish Commission for 1884 and 1885.

Before the final adjournment the members of the society went to the White House and were presented to President Cleveland. A visit was also made to the Government carp ponds, near the Washington Monument.

On May 7 the society made a trip to the shad-hatching grounds of the Potomac, on the Fish Commission steamer Fish Hawk. At Fort Washington 4,000,000 eggs were exhibited in process of packing for shipment to the central station at Washingtion. On the homeward trip a meeting of the executive committee was held, at which it was decided to hold the next annual meeting in Chicago.

The following gentlemen were elected as officers of the society for the ensuing year:

President.—Col. M. McDonald, of Berryville, Va.

Vice-president.—Dr. W. M. Hudson, of Hartford, Conn.

Treasurer.— E. G. Blackford, of Brooklyn, N. Y.
Recording secretary.—Fred Mather, of Cold Spring Harbor, N. Y.
Corresponding secretary—W. V. Cox, of Washington, D. C.
The members of the executive committee are as follows:

Prof. G. Brown Goode, of Washington, D. C.
Roland Redmond, of New York, N. Y.
George S. Page, of Stanley, N. J.
W. L. May, of Fremont, Nebr.
Frank N. Clark, of Northville, Mich.
Dr. James A. Henshall, of Cynthiana, Ky.
S. G. Worth, of Raleigh, N. C.

11.—PUBLICATIONS IN 1885.

Reports.—The report for 1883 (Vol. XI) was completed, and much progress made upon the report for 1884 (Vol. XII) during the present year.

The printing of the report for 1885 (Vol. XIII) having been ordered by joint resolution of Congress March 2, 1885, several monographs were handed to the Public Printer, including a Catalogue of the Fishes of North America, by Prof. D. S. Jordan, of which extra copies were printed for immediate distribution.

The first section of the quarto report on the Fishing Industries of the United States was issued in two volumes, one of text and one of plates, in December of the present year. In addition to the copies distributed by the Commission and by members of Congress, a considerable number have been purchased by interested persons from the Public Printer at the low price of $2.45 for both volumes, Congress having made provision therefor in the resolution ordering the printing.

Bulletins.—The bulletin for the current year (Vol. V) was commenced promptly at the beginning of the year, the first signature bearing date of January 19, 1885; and sets of signatures were mailed to foreign and domestic correspondents March 12, August 22, September 5, October 20, and November 7. At the latter date the entire volume was in type, and there only remained the press-work and binding of the regular edition. This was completed and the edition distributed in March, 1886.

Pamphlets.—Six papers have been issued in pamphlet form during the year, as follows:

90. SHUFELDT, R. W. The osteology of *Amia calva:* including certain special references to the skeleton of Teleosteans.

[From Report for 1883, pp. 747-878.]

91. RYDER, J. A., and M. PUYSÉGUR. Papers on the development and greening of the oyster.

[From Report for 1882, pp. 763-805.]

92. GOODE, G. BROWN. The first decade of the U. S. Fish Commission: its plan of work and accomplished results, scientific and economical.

[From Report for 1880, pp. 53-62.]

93. COLLINS, J. W. Specifications for building a schooner-smack.
[Printed by Rockwell & Churchill, Boston, Mass.]

94. JORDAN, DAVID STARR. A catalogue of the fishes known to inhabit the waters of North America north of the Tropic of Cancer, with notes on the species discovered in 1883 and 1884.
[From Report for 1885, pp. 789–974.]

95. BAIRD, SPENCER F. Report of the Commissioner for 1883. A.—Inquiry into the decrease of food-fishes. B.—The propagation of food-fishes in the waters of the United States.
[From Report for 1883, pp. xvii–xcv.]

Carp publications.—During the year several editions of "The carp and its culture in rivers and lakes," by Rudolph Hessel, of "Carp and carp ponds," and of "Notes on the edible qualities of carp," by Chas. W. Smiley, have been printed and distributed to the numerous persons making inquiries about carp.

During the year Mr. Chas. W. Smiley, as heretofore, has had entire charge of the preparation of all matter for the printer, the correcting of the proofs of text and plates, and all else relating to the proper presentation of the several volumes, pamphlets, and circulars, as well as of their distribution to correspondents and applicants.

12.—THE WOOD'S HOLL STATION.

This station, which is second only in importance to the headquarters at Washington, and which is the center of all work of the Commission connected with the propagation and investigation of marine fishes and invertebrates, has always received especial mention in the reports of the Commission, so as to place fully on record its rise, progress, and current condition. Here, alone, in the United States, opportunities occur for studying marine fish in their natural conditions, by placing them in large basins or aquaria, and for testing the period of their spawning, the nature of their food, their relationships to other life of the sea, &c.

Congress has manifested a disposition to allow the experiment to be tried on a satisfactory scale, and, from time to time, has made liberal appropriations, the total amount of money appropriated for buildings and their equipment amounting to $70,000.

Previous reports have recorded the construction of buildings for the offices and quarters of the Commission, and for the accommodation of the pumps and tanks; also the commencement of the laboratory building, in which to carry on the work of hatching and investigation. This building was finished in February, and turned over to the Commission by the contractor, Mr. Brightman, of New Bedford, Mass., after which it was appropriately fitted up for its purpose.

The completion of the stone work of the harbor of refuge during 1884 has already been recorded in a previous report. This was done under the direction of Col. George H. Elliot, of the U. S. Engineers, from an appropriation for the purpose made in the river and harbor bill.

The wharfing necessary to complete this work was commenced in the spring of the present year, and as much of the same was finished as the appropriations would permit, this comprising the wharf on the western side of the pier wall, the cross wharf dividing the large inclosure into two distinct basins, and the coal wharf along the southwest retaining wall. A cut of 30 feet was left in the wharf and pier on the western side in order to permit the entrance into the northern basin, a safe harbor, of vessels of the size of the Fish Hawk; and a swinging bridge across this cut was constructed for the Commission by Messrs. Brown & Lucius, of Hoboken, N. J.

On the completion of the work of the U. S. Engineer, provision was made for the erection of a coal-shed, the contract for building the foundations for which was given to Messrs. Molthorp & Co., the constructors of the wharf under the direction of the Engineer Bureau. Subsequently, the shed itself, a building 40 by 42 feet, to accommodate about 400 tons of coal, was erected by Mr. Burdick. The erection of a fence, inclosing the property, finished the work for the year, leaving unconstructed, of the whole series of buildings, only a warehouse, 30 by 60 feet, to be built in 1886.

The laboratory building was occupied during the summer by the Commissioner and his staff, for the purpose of prosecuting special investigations in connection with the habits and development of fishes and other marine animals; and, as usual, a large number of specialists of distinction spent more or less time in assisting in the work.

The laboratory building was in charge of Prof. A. E. Verrill, the other biologists in attendance being Mr. Richard Rathbun, Prof. Sidney I. Smith, Mr. Sanderson Smith, Professor Linton, Prof. B. F. Koons, Dr. Harrison Allen, Prof. William Libbey, jr., and Prof. Walter Heape, of Cambridge, England.

The deep-sea fishes collected by the Commission were brought from Washington, and arranged for the action of Dr. Bean and Mr. Goode, who made a monographic examination of the whole series.

During the summer the Albatross made a number of trips to various points in the Atlantic Ocean, bringing back many collections of much interest. For fuller information on this subject I refer to the report, in which the work of the Albatross is given in detail.

In the month of June Mr. G. H. H. Moore was sent out by the Commission with his car to transport a lot of young shad to the waters of Washington Territory and Oregon. While there he took occasion to secure a large number of the *Tapes staminea*, an excellent bivalve mollusk, which he was directed to bring back to Wood's Holl. The weather, however, being very hot, quite a number died on the passage; but he succeeded in delivering several hundred in fairly good condition, which were planted in various localities in the vicinity of the station. Should these survive and multiply, a very important element will be added to the food resources of the Atlantic coast. There are other species which it is proposed to transport in a similar manner, but the experiment will be made in cooler weather, with better hope of success.

The account of the hatching of codfish and the methods of obtaining the parent fish are given in the report for 1884.

During the summer Mr. John A. Ryder made repeated experiments in regard to obtaining and developing the eggs of the oyster, and with fairly good success, using the special ponds constructed under his direction on grounds belonging to Dr. J. H. and Mr. Camillus Kidder. Many important facts of progress were noted in this connection, and we have good reason to hope for further success in the future.

13.—VISITS FROM FOREIGN SPECIALISTS.

In June of the present year Mr. J. K. Uchimura, a member of the Japanese Fisheries Society, visited the Wood's Holl and Gloucester stations for the purpose of examining the Fish Commission work. Mr. Uchimura is a graduate of the Sapporo Agricultural College, and took great interest in the biological and scientific phases of our fisheries.

In July Mr. Walter Heape, of the Marine Biological Association, Cambridge, England, visited the Wood's Holl, Bucksport, Northville, and Washington stations of the Commission, and was deeply interested, especially in the work carried on at Wood's Holl.

Mr. W. T. Silk, fish-culturist of Lord Exeter, representing in his mission the National Fish Culture Association of England, arrived in New York September 10. Reference has already been made in the proper place to the attempt to send by him an installment of soles. Mr. Silk remained in this country several weeks for the purpose of examining the fisheries and obtaining young fish to carry to England. On his return in October the Commission contributed several kinds of fish for him to take with him to England.

In December Dr. Filip Trybom, of the Swedish Fresh-water Fisheries Commission, Stockholm, was introduced to the Commission by Christian Bors, royal Swedish and Norwegian consul at New York. Dr. Trybom indicated his intention of remaining in the United States about nine months for the purpose of studying our fisheries and all their leading features.

14.—ICELAND HALIBUT FISHERY.

The success which attended the halibut fishery at Iceland in 1884, induced a larger number of vessels to engage in it this year (1885). Six schooners started from Gloucester to Iceland. They were the Concord, Captain Dago; Alice M. Williams, Captain Pendleton; the David A. Story, Captain Ryan (which three schooners formed the fleet to Iceland in 1884); the Marguerite, Captain Johnstone; the Lizzie H. Haskell, Captain Marshall; and the Carrier Dove, Captain Cousins.

Unfortunately, the stranding of the Concord near Arichat, Cape Breton, whereby her voyage was broken up, and the loss of the Alice M. Williams off Iceland, when just on the eve of sailing for home, were serious drawbacks to the complete success of the fleet.

Although the weather was unusually severe and the presence of ice close in to Cape North for several days interfered with fishing, halibut were so abundant that large catches were obtained, and all that returned home brought full fares, with the single exception of the Marguerite. She started from Gloucester some time after the other vessels and arrived in Iceland so late in the season (June 1) that she could fish only a short time before the weather grew too boisterous to stay on the bank. Her captain reported having found excellent fishing whenever the weather was suitable to carry on operations. On one occasion he estimates that his crew caught 50,000 pounds of halibut from a single set of the trawl-lines. During the month of June alone the Marguerite caught 80,000 pounds of flitched halibut.

The banks about Iceland afford our fishermen richer returns in the salt-halibut fishery than can be obtained elsewhere. It seems safe to predict that this new field for their enterprise, which was brought to their notice by the Commission, will be worked in the future, as in the past two years, with satisfactory results. This is all the more gratifying, too, in view of the marked depletion of the halibut on the old grounds and the practical failure of the supply from which we have been accustomed to obtain the fish used for smoking.

15.—SMOKED KINGFISH.

As a part of the practical work of the U. S. Fish Commission, the opportunity occasionally arises to introduce to fish-dealers, and through them to the general public, a new variety of food-fish, or to investigate and recommend new methods by means of which fish can be prepared for the markets. Such work is clearly in the interest of both producers and consumers, and even when nothing of great consequence comes from it, it at least adds to our knowledge and resources. In illustration of this the Commission caused experiments to be made in preparing kingfish by smoking, and then tested their edible qualities when so prepared. After concluding and announcing such experiments, it must be left to interested parties to develop a new industry, or to make such use of it as may be desirable or necessary.

Kingfish from off Key West are to a limited extent found in the markets of the large cities during the winter, and are well liked as a fresh fish. The favorite ground for catching them is in the vicinity of Sombrero Key, in which region kingfish are usually very abundant from November to April.* The method of fishing is by trail-lines, at which,

* For fuller information in regard to this fishery, see article by Capt. J. W. Collins on Gulf fisheries, in the appendix of this volume, p. 267.

under favorable circumstances, these large, gamy, and vigorous fish bite readily, and it sometimes happens that a boat will take a fare of 200 or 250 fish, some weighing from 20 to 30 pounds (the average weight being about 10 pounds), in a day. As a rule, the great bulk of the catch is disposed of fresh at Key West, though occasionally some fish are salted on the boats, and sometimes small quantities are salted and dried on shore in a rather primitive manner. Cured in this way it makes tolerably good food; but the texture and the oil contained in its flesh suggested that it might make an excellent article of commerce when smoked. The fact that it is seemingly abundant, and can be bought at a comparatively low figure, the average wholesale price not exceeding 2 cents per pound for fresh fish, favors its introduction as an additional article of smoked food, in which form it could be introduced all over the country, thus relieving the fishermen of their present dependence on the Cuban and local markets.

While the Fish Commission steamer Albatross was at Key West in the latter part of March, a considerable quantity of kingfish was obtained, and after being split and salted the fish were brought North by the Albatross, reaching Washington on April 6, from which point they were at once forwarded to Gloucester, Mass., to be smoked. The Commission is indebted to Messrs. William H. Wonson & Son for smoking free of charge this possible rival to smoked halibut, and for the great pains they took to have it cured in the best possible manner.

The samples were caught after the proper season for their catch was over and during the opening part of their spawning season; and some of the fish in consequence were in poor condition, while during the winter they are rarely poor. They proved, however, to be an excellent smoked fish, being tested by many experts, some of whom pronounced them equal or even superior to smoked halibut or salmon, being free from the rather rank taste that the halibut sometimes has.

16.—CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF FISH.

The report of the Commissioner for 1883 contains a brief account of a portion of an investigation which has been conducted by Prof. W. O. Atwater, in part at Wesleyan University and in part in Europe, upon the chemical composition and nutritive values of American food-fishes and invertebrates. The whole investigation is much more extended than this report implies, and includes not only chemical analyses of the flesh of nearly two hundred specimens of American food-fishes and invertebrates and a considerable number of other analyses, but also more abstract studies upon the constitution of the flesh of fishes. During the past year the investigation has been continued in the latter direction, this branch of the subject being important not only in its bearing upon chemical physiology but also upon the food values of the substances. The research has already attained a magnitude far greater than that of any other of the kind which has been attempted in this country or in

Europe. While Professor Atwater regards what has been done as only the beginning of a much needed research, the results already obtained throw a great deal of light upon the chemical nature and nutritive uses of fish and fish prepared for food, matters hitherto but very imperfectly understood. A monograph, embodying detailed results of this investigation and including with it those of other work in similar directions, is now nearly completed, and will not only give a large number of facts of use to the specialist, but also a very considerable amount of information of practical value, and in such form that it may be easily made use of by all intelligent readers.

The following statements by Professor Atwater are of interest in this connection:

"The chief uses of fish as food are (1) as an economical source of nutriment, and (2) to supply the demand for variety in diet, which increases with the advance of civilization and culture.

"As nutriment, the place of fish is that of a supplement to vegetable foods, the most of which, as wheat, rye, maize, rice, potatoes, &c., are deficient in protein, the chief nutrient of fish.

"The so-called nitrogenous extractives contained in small quantities in fish as in other animal foods are doubtless useful in nutrition. The theory that fish is especially valuable for brain-food, on account of an assumed richness in phosphorus, is not sustained by the facts of either chemistry or physiology.

"It is an interesting fact that the poorer classes of people and communities almost universally select those foods which chemical analysis shows to supply the actual nutrients at the lowest cost. But, unfortunately, the proportions of the nutrients in their dietaries are often very defective. Thus, in portions of India and China, rice; in Northern Italy, maize-meal; in certain districts of Germany and in some regions and seasons in Ireland, potatoes; and among the poor whites of the Southern United States maize-meal and bacon make a large part and in some cases almost the sole food of the people. These foods supply the nutrients in the cheapest forms, but all are deficient in protein. The people who live upon them are ill-nourished and suffer physically, intellectually, and morally thereby.

"On the other hand, the Scotchman finds a most economical supply of protein in oatmeal, haddock, and herring; and the rural inhabitants of New England supplement the fat of their pork with protein of beans, and the carbohydrates of potatoes, maize, and wheat flour with the protein of codfish and mackerel, and, while subsisting largely upon such frugal but rational diets, are well nourished, physically strong, and noted for their intellectual and moral force.

"As population becomes denser, the capacity of the soil to supply food for man gradually nears its limits. Fish gather materials that would otherwise be inaccessible and lost, and store them in the very forms that are most deficient in the produce of the soil. Thus, by proper culture and use of fish, the rivers and the sea are made to fulfill their office with the land in supplying nutriment for man."

17.—TURBOT AND SOLES.

In the great variety of excellent marine fish found on the coast of the United States, it has been necessary only to consider the question of the introduction of the turbot and sole, both fish of world-wide reputation, the possession of which the European epicure promptly offers as an offset to the pompano, the Spanish mackerel, the sheepshead, and our other esteemed varieties. The U. S. Fish Commission has frequently been urged to take the necessary steps to acclimate these fish in the waters of the United States; and several successive efforts have been made in that direction, some of which have failed entirely, and others resulted in the planting of a few individuals in the open sea off Boston Harbor and New York. As no care could be exercised over these fish, and there was nothing to prevent their being devoured, almost as soon as planted, by predaceous fish, no definite result could be expected from what has been done, in the lack of localities that could be completely controlled.

With the completion of the preparations at the Wood's Holl Station for the propagation of sea fishes, it has become possible to provide for permanent inclosures in the sea where the fish, while having their natural surroundings, can be watched and cared for, and from which they can be removed for the purpose of taking and fertilizing the eggs, to be subsequently hatched out.

For this purpose arrangements were initiated in the early part of the year to obtain from England a supply of these fish, and the services of a skilled attendant were bespoken. In the mean time the authorities of the National Fish Culture Association, to which the Commission had sent some highly-valued lots of eggs and young of various species of American fishes, asked that they might be permitted to make a transmission in return, and this proposition was gladly accepted.

It was found impossible to obtain any turbot; but the brill, a large flounder closely allied to the turbot, was substituted in its place. Several hundred young soles, about the size of the hand, and a number of brill were accordingly gathered and stored on the eastern coast of England, and the necessary arrangements made for their shipment per steamer Republic from Liverpool on September 1. The fish were sent to Liverpool the day before, but, being overcrowded in their tanks, most of them died in transit. The survivors being very much weakened, all the efforts of Mr. W. T. Silk, who had been deputed by the National Fish Culture Association to care for them, were unavailing, and the entire number died before being put on board. The experiment will, however, be renewed another season, as the stake is a great one, and is worthy of continued experiment until success is secured.

Contemporaneously with the efforts which were being made in our behalf by the National Fish Culture Association of England, Mr. E. G. Blackford was conducting negotiations with Mr. Thomas J. Moore, curator of the Liverpool Museum, for obtaining soles. The methods adopted by Mr. Moore for getting fish across the Atlantic proved successful, as nine out of twelve sent in October, with no special attendant, reached New York alive, thus apparently solving the question of method by which importations can be successfully made.

In the latter part of October a renewal of the efforts of Mr. W. Oldham Chambers in behalf of the National Fish Culture Association resulted disastrously, as has already been described under the head of courtesies received from foreign countries.

Notwithstanding the numerous disappointments of the present year, there is good reason to believe that in another summer enough flat-fish may be accumulated at Wood's Holl to form a nucleus for propagation. It is believed that the facilities at Wood's Holl are adapted to this work.

Referring to the recent efforts to introduce the sole, Mr. William Stowe, the president of the Gloucester Net and Twine Company, of Boston, says: "I regard it as being worth to us as a nation all the money the Government has spent on it. In England I had sole for every breakfast. It is the best tasted fish that swims."

18—SPONGES FOR AUSTRALIA.

A communication was received from Dr. R. von Lindenfeld, of Sydney, Australia, dated June 1, 1885, through Professor Hyatt, of the Society of Natural History, Boston, asking the services of the U. S. Fish Commission in sending a supply of live bathing sponges for introduction into the bay of Port Jackson, and offering the sum of £25 sterling to meet the necessary expenses.

On a careful consideration of the circumstances it was thought that while the project was perhaps not impracticable, yet it would be impossible to do anything with the amount named. These sponges could only be obtained conveniently at Key West or Bermuda; and there being no steamers going direct from those points to Sydney, it would be necessary to send them to England, or else intersect a steamer at Saint Thomas or other point of contact of vessels bound from Great Britain to Australia. To make a successful experiment it would be necessary to provide special apparatus for furnishing a constant supply of pure salt water to the sponges, involving preparations which would be difficult to secure from the steamers. Indeed, we do not yet know how far it would be possible to keep the sponges alive, experiments being lacking on this head. Should the opportunity present itself some aquarium experiments will be made to see in what way this work can be best accomplished under the proper conditions.

B.—INQUIRY INTO THE HISTORY AND STATISTICS OF FOOD-FISHES.

19.—PROGRESS IN PRINTING THE QUARTO FISHERIES REPORT.

During the year 1885 considerable progress was made towards the completion of the special quarto report upon "The Food-Fishes and Fisheries of the United States," ordered printed under act of Congress in 1882.

Section I of this report, "Natural History of Useful Aquatic Animals," was published and distribution begun late in the fall of 1885. This section is bound in two volumes, one containing eight hundred and seventy-five pages of text and the other two hundred and seventy-seven plates of illustrations of all the important species. The analysis of this volume was printed in the annual report for 1883.

Section II, "The Fishing Grounds of North America," which was partly in type in 1884, was completed in 1885, with the exception of an appendix on ocean temperatures, now being prepared by Mr. Rathbun. This section numbers pages i–xviii, 1–154, with seventeen charts and a number of temperature diagrams.

The table of contents of this section is as follows:

Introduction by Richard Rathbun.

A.—The sea-fishing grounds of the Pacific coast of the United States from the Strait of Fuca to Lower California. By David S. Jordan.

B.—The fishery resources and fishing grounds of Alaska. By Tarleton H. Bean.

C.—The fishing grounds of the Great Lakes. By Ludwig Kumlien and Frederick W. True.

D.—The geological distribution of fresh-water food-fishes in the several hydrographic basins of the United States. By David S. Jordan.

Section III will be a statistical review of the fisheries and fishing districts, with a list of fishing vessels, giving for each vessel the name, rig, tonnage, number of crew, fishery engaged in, and other details. This section is not yet in type.

The geographical review of the fisheries or "coast review," with statistics, which was to have formed Section III of this report, has been transferred to the Census Office, and will be issued by the Department of the Interior as one of the volumes of the Census Report. It was all put in type in 1885 and comprises about eight hundred pages. Its contents will be as follows:

PART I.—The coast of Maine and its fisheries. By R. Edward Earll.
II.—The fisheries of New Hampshire. By W. A. Wilcox.
III.—The fisheries of Massachusetts. By A. Howard Clark.
IV.—The fisheries of Rhode Island. By A. Howard Clark.
V.—The coast of Connecticut and its fisheries. By A. Howard Clark.
VI.—New York and its fisheries. By Fred Mather.
VII.—New Jersey and its fisheries. By R. Edward Earll.
VIII.—Pennsylvania and its fisheries. By R. Edward Earll.
IX.—Delaware and its fisheries. By J. W. Collins.

PART X.—Maryland and its fisheries. By R. Edward Earll.
XI.—Virginia and its fisheries. By Marshall McDonald.
XII.—North Carolina and its fisheries. By R. Edward Earll.
XIII.—The fisheries of South Carolina and Georgia. By R. Edward Earll.
XIV.—Eastern Florida and its fisheries. By R. Edward Earll.
XV.—Fisheries of the Gulf of Mexico. By Silas Stearns.
XVI.—The fisheries of the Pacific coast. By David S. Jordan.
XVII.—The fisheries of the Great Lakes. By Frederick W. True.
APPENDIX. Historical reference to fishermen of New England. By A. Howard Clark.

Section IV. "The fishermen of the United States," by George Brown Goode and Joseph W. Collins, was put in type during 1885, and with the index numbers 178 pages, and will probably be published during the coming year. The contents of this section were as follows:

A.—NATIONALITY AND GENERAL CHARACTERISTICS.

1. Review of the class as a whole.
2. The shore fishermen of Maine.
3. The vessel fishermen of Maine.
4. The fishermen of the Isles of Shoals.
5. The Indian fishermen of New England.
6. The British-Provincial fishermen of New England.
7. The Irish fishermen of New England.
8. The Scandinavian fishermen of New England.
9. The Portuguese fishermen of New England.
10. The negro fishermen of New England.
11. The "baymen" or fishermen of Long Island, New York.
12. The oystermen of Maryland.
13. The oyster-shuckers of Maryland.
14. The fishermen of Florida.
15. The fishermen of Mobile, Ala.
16. The fishermen of New Orleans, La.
17. The fishermen of Texas.
18. The American fishermen of California.
19. The Italian fishermen of the Pacific coast.
20. The Portuguese fishermen of the Pacific coast.
21. The Spanish fishermen of the Pacific coast.
22. The Greek fishermen of the Pacific coast.
23. The Austrian fishermen of the Pacific coast.
24. The French fishermen of the Pacific coast.
25. Southern European fishermen of the Pacific coast.
26. The Chinese fishermen of the Pacific coast.
27. Miscellaneous fishermen of the Pacific coast.
28. The Arctic whalemen from San Francisco.
29. The fishermen of the Columbia River.
30. The Indian fishermen of the Pacific coast.
31. The McCloud River Indians of California.
32. The fishermen of the Great Lakes.

B.—THE SAILOR-FISHERMEN OF NEW ENGLAND.

33. Shore education.
34. Sea education.
35. Mental and physical traits.
36. Superstitions.

37. Dialect.
38. Literary tastes.
39. Morals and religion.
40. Life ashore.
41. Life on board the vessels.
42. Public service.
43. Costume.
44. Food.
45. Diseases and longevity.
46. Financial profits.

C.—OFFICERS OF VESSELS; DISCIPLINE OF THE CREW; NAVIGATION.

47. Officers and discipline in fishing and whaling vessels.
48. Navigation.

D.—DANGERS OF THE FISHERIES.

49. Dangers to the vessels.
50. Dangers to the fishermen.
51. Relief for bereaved families.

E.—MANAGEMENT OF THE VESSELS.

52. Evolutions of the fishing schooner.
53. Amount of canvas carried.
54. Management of disabled vessels.

F.—APPENDIX.

55. Freeman's description of Cape Cod fishermen.
56. Autobiography of Capt. N. E. Atwood.

Section V is a discussion of the history and methods of the fisheries, and will be in two volumes. The first volume will discuss the capture of fish, and the second volume the capture of aquatic animals, crustaceans, sponges, &c. The greater part (or 565 pages) of Volume I was put in type in the summer and fall of 1885 and most of the illustrations were engraved. This section is made up as follows:

VOLUME I.

PART I.—The halibut fisheries.
II.—The cod, haddock, and hake fisheries.
III.—The mackerel fishery.
IV.—The swordfish fishery.
V.—The menhaden fishery.
VI.—The herring fishery and sardine industry.
VII.—The shore fisheries of Southern Delaware.
VIII.—The Spanish-mackerel fishery.
IX.—The mullet fishery.
X.—The red-snapper fishery and the Havana market fishery of Key West, Fla.
XI.—The pound-net fisheries of the Atlantic States.
XII.—The river fisheries of the Atlantic States.
XIII.—The salmon fishery and canning interests of the Pacific coast.
XIV.—The fisheries of the Great Lakes.

VOLUME II.

PART XV.—The whale fishery.
XVI.—The blackfish and porpoise fisheries.
XVII.—The Pacific walrus fishery.
XVIII.—The seal and sea-otter industries.
XIX.—The turtle and terrapin fisheries.
XX.—The oyster, scallop, clam, mussel, and abalone fisheries.
XXI.—The crab, lobster, crayfish, rock lobster, shrimp, and prawn fisheries.
XXII.—The leech trade and the trepang fishery.
XXIII.—The sponge fishery and trade.

Other sections of this report on "Fishing vessels and boats," "Apparatus of the fisheries," "Preparation of products," "The river fisheries," and "Bibliography of American ichthyology," will be published as soon as practicable.

20.—INVESTIGATIONS OF THE FISHERIES OF THE GREAT LAKES.

In 1871, at the very inception of the Commission, an investigation of these fisheries was made by the late James W. Milner; and statistics of this industry on the Great Lakes were again gathered, for the census of 1880, by Mr. Ludwig Kumlien. The comparison of the work of Milner and Kumlien led to very grave fears that the fisheries for whitefish were about becoming exhausted. While it was true that the total number of pounds obtained in 1880 was equal to or greater than that obtained in 1871, the effect had been accomplished by the use of apparatus increased enormously in effectiveness and by the addition of steam-tugs using a far greater number of gill-nets. More ominous than anything else was the fact that the average size of the fish taken was much smaller. It was realized that the utmost efforts should be made by way of artificial propagation to avert the impending catastrophe. Accordingly the United States Commission, as well as those of Ohio and Michigan, planted many millions of whitefish fry each year from 1878 to the present time, the number planted some years equaling 50,000,000.

At the close of the fishing season last year a limited investigation of the whitefish product of Lake Erie was made by Mr. Frank N. Clark. His conclusion was as follows:

"The results are most gratifying, as it is conceded by all and shown by the reports that the aggregate catch of whitefish was considerably in excess of that of any season for several years.

"No disappointment would have been felt had there been no perceptible increase, as much planting of fry was required to offset the extensive and exhaustive fishing carried on all over the lake, on both the spawning and feeding grounds. For many years these had been literally covered with nets during the spawning season, while hundreds of gill-nets have been employed on the feeding-grounds in deeper waters. Notwithstanding this, however, we find that not only has the decrease been arrested, but that there is a tangible and satisfactory increase."

The need of restricting the fishermen manifested itself at the meeting of the fish commissioners of the lake States, held at Milwaukee August 17 and 18, 1884, where resolutions were passed instructing the commissioners to urge upon the legislatures of the various States the enactment of statutes regulating the size of mesh so as to catch mature fish only and the adoption of the close season for certain kinds of fish.

With a view of ascertaining more definitely the present condition of the fisheries and of recording any important changes that have occurred in the locality of methods of the fisheries since the census of 1880, it was decided to make a careful examination of the entire chain of lakes from the American shores and to obtain accurate statistics for comparison with those of earlier years. The investigation began late in August, under the general direction of Mr. R. E. Earll. The territory was divided into districts and assigned to different employees of the Commission who from their familiarity with the work were best suited to assist in the investigation. To Messrs. Clark and Wires was assigned the American shore of Lake Huron and the Detroit River; to Mr. Ellis, the American shore of Lake Ontario and eastern part of Lake Erie; to Mr. Bowers, western shore of Lake Erie, and to Mr. Earll, Lake Superior and both shores of Lake Michigan. The investigation began in August and was continued until November. The following plan of operations, which had been prepared by Mr. Earll, was carefully followed:

(1) Obtain a brief description of each settlement, especially of those containing post-offices, however small and scattered the population, in order that its relative importance or insignificance may be known.

(2) Fill out in detail the blank form of each fishing station, note the number of men employed, number of tugs or sail-boats employed, the kind and number of gill-nets, pound-nets, seines, fykes, or set-lines, the number of pounds of hard fish, soft fish, or other fish caught in 1885, the gross value of the seine, stating particularly the quantity of white-fish taken.

(3) Fill out a blank for each fishing settlement showing separately the seining, spearing, hand-line, net-fishing, &c.

(4) Fill out a blank at each fishing settlement estimating the amount of fish consumed by fishermen's families or by local trade.

(5) Record on the proper blanks all fishing steamers and all sailing vessels that use custom-house papers.

(6) Note the number of fishermen's boats, nets, and pounds employed the preceding year, as far as practicable, for the purpose of comparison with 1885 and for estimate in case information is not obtained for 1885.

(7) Mark on charts the exact location of each pound-trap and other stationary forms of apparatus, with the name of owner. Show the location of important fishing banks and reefs, their shape, size, name, location, depth of water, character of bottom, and history.

(8) Leave circulars with each fishery operator to be filled up and forwarded at the close of the season. Do not leave any village or locality until a satisfactory estimate has been obtained of the extent of the fishery, and the total catch, especially of whitefish and trout.

Many of the fishermen were found to be deeply interested in the work of the Commission, and they willingly furnished the desired information and rendered such other assistance as they were able. The impression of the gentlemen engaged in the investigation was that there had been a decided increase in the fisheries over those of previous years and that they now furnish employment to a larger number of men and a greater amount of capital than at any previous period in their history. If the opinions of the fishermen are to be accepted, there has been a very perceptible increase in those localities where the planting of fry has been most extensive, and in a number of other districts where the catch has been falling off from year to year further decrease seems to have been checked. The compilation of statistics and the preparation of a report will be pushed forward as rapidly as possible.

21.—USE OF THE COD GILL-NETS.

The introduction of this mode of taking codfish, dating from 1880, with the exception of one season, has been a success. There has been during these years a yearly increase in the number of vessels, men, and nets employed.

This mode of fishing is one in high favor with the fishermen, as it requires less labor than any other, the catch is greater for the labor employed than by any other way, there are no bait bills, and it enables the fishermen to make harbor every night, as the grounds are always near shore. It is conceded to be a fact by the men themselves that, notwithstanding the great expense, their clear profits are larger for the time engaged than by any other method of taking codfish, or, in fact, than in any other kind of fishing.

The season of cod gill-net fishing on our coast dates from about October 1 to June 1, in the extremes. Nearly all vessels, however, close the season about May 1.

The fish are caught in water varying from 8 to 35 fathoms in depth. The greater depths are objectionable, owing to the extra labor required in handling, so that the fishermen avoid deep water. The distance from the shore varies from 200 yards to 7 miles; and it is reported that the fish are being taken in deeper water than formerly.

The number of vessels engaged in this industry last season was about forty, employing about four hundred men; the tonnage of vessels was from 15 to 70 tons, with twenty-four to forty nets per vessel.

These nets are made to hang 50 fathoms in length and 12 to 15 feet in depth, and the size of mesh now used almost entirely is 9-inch. They are floated with glass balls about 5 inches in diameter, and costing, covered, so that they can be attached to the top of the net, about 20 cents each; there are twenty to each net, or one to every 2½ fathoms; weighted with bricks, &c. They are treated by a process called the "Eureka process," which is believed by the American Net and Twine Company to preserve the net much better than any other they have ever tried or known of.

During the season it has been found necessary to employ two sets of nets, particularly as during the early part of the season there is a run of pollock, which are generally large, and being much more powerful fish than cod, are very destructive to the gear.

The expense per man for the entire outfit is about $90; one-half of this is perishable and the other half, including buoys, lines, anchors, hangings, balls, and boats, stands the "wear and tear" for several seasons. Nets with floats all rigged for fishing cost about $18 each.

The catch for the season of 1885–'86 was not far from 15,000,000 pounds of codfish and pollock, about one-quarter being the latter. The fish are taken in Massachusetts and Ipswich Bays in the shoal water, and the industry, I think, may be considered an established one, and I know no reason why it should not continue to increase from year to year.

It is a matter of considerable speculation whether this mode of capturing codfish might not be successfully prosecuted in the bank fishery. Several imperfect trials have been made without success. Ivers W. Adams, president of the American Net and Twine Company, who has furnished the above facts, says: "I have no reason to doubt, with nets properly rigged and hung, that they would be successful, and I should be pleased to manufacture a gang of these nets for the Commission, with special reference to their trial in the bank fishery. We have always made a specialty of this industry, and last year we supplied, without doubt, 90 per cent of the nets fished to the fleet."

22.—THE MACKEREL FISHERIES OF 1885.

The following summary of the year's mackerel fishery has been furnished by Mr. W. A. Wilcox:

The mackerel season off the United States coast began by the taking of two fares, aggregating 325 barrels, caught on March 26 and 27, 30 miles south of Cape Henry, by the schooners Nellie N. Rowe and Emma W. Brown. Most of the fleet followed the fish from that time until November 14, working off the United States coast as far east as Mount Desert, and returning taking the last fares off Cape Cod in November. The catch off the United States coast by American vessels aggregated 378,515 barrels, of which 80,788 barrels were sold fresh. In size and quality the fish were an improvement over the catch of 1884, packing mostly No. 2's, with a smaller portion No. 1's and 3's. The average price for inspected mackerel was $4.50 to $5.50 for No. 3's, $6 to $7 for 2's, extra 2's $7.50 to $9, and $16 to $18 for No. 1's. Extra 1's sold from $20 to $32. Some very large and fat fish were taken off Block Island, bringing the extra prices named. Mackerel were taken in the weirs at Truro, Mass., as late as November 19.

The few vessels that fished in the Gulf of Saint Lawrence at times found mackerel very scarce, at times very abundant; but they were small and of poor quality. With the hopes of finding larger and better fish soon, the vessels in many cases forwarded their catch by rail or steamer to Boston or Gloucester, the same selling for \$2.12½ to \$3.50 per barrel, frequently not bringing enough to pay the cost of barrels, salt, freight, insurance, and commission, not mentioning the time, labor, and expense of the voyage. The crews fishing on shares in many cases received nothing, and the vessels' expenses exceeded their gross receipts. The catch in the Gulf of Saint Lawrence by 40 vessels, all from the United States that took any fish in those waters, aggregated 26,633 barrels, of which 6,564 barrels were taken within 3 miles of the provincial shore. These fish were mostly No. 3's with a small proportion of No. 2's. On November 21 schooners Spencer F. Baird, William E. McDonald, and William H. Jordan arrived at Gloucester from a six weeks' cruise in the Gulf of Saint Lawrence and off the Nova Scotia shore, none of these vessels having caught a single mackerel during the entire trip.

Vessels from Gloucester, Mass., are the only ones that entered provincial ports for the purpose of obtaining barrels and supplies. These purchased 9,572 empty fish-barrels, valued at \$7,425.95, and paid in addition \$9,759.05 for provisions and \$331.26 as harbor dues.

During the year 3 vessels, 22 boats, and 7 seines were lost and 4 fishermen were drowned.

American mackerel catch for the season of 1885.

[Reported to the U. S. Fish Commission by W. A. Wilcox, assistant.]

Port.	No. of vessels.	Tonnage.	Value of vessels.	Value of outfit.	Number of crew.	Total number of trips.	Inspected, caught off United States coast.	Sold fresh, caught off United States coast.	Total caught off United States coast.	Caught in Gulf of Saint Lawrence.	Taken within 3 miles of provincial shore.
							Bbls.	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*
Grand total	358	27, 035. 67	\$1, 693, 406	*\$1, 294, 225	5, 425	1, 821	297, 727	80, 788	378, 515	26, 633	6, 564
Maine.											
Biddeford	1	52. 51	5, 000	1, 500	14	5	255	200	455	......	.....
Boothbay	12	865. 34	45, 200	13, 950	174	53	7, 481	3, 965	11, 446	......	.....
Bristol	1	21. 08	600	250	14	3	190	......	190	......	.....
Deer Isle..............	3	205. 00	9, 500	2, 700	46	7	1, 796	......	1, 796	......	.....
Eastport	1	97. 34	10, 000	2, 000	18	6	625	900	1, 525	......	.....
Harpswell	1	41. 67	3, 000	1, 200	12	4	325	350	675	......	.....
Camden	2	108. 05	3, 000	3, 000	28	8	1, 050	.....	1, 050	......	.....
Cranberry Isles	3	145. 47	8, 000	3, 800	34	14	1, 685	100	1, 785	......	.....
Matiniens Island	1	36. 83	1, 500	1, 400	13	3	595	......	595	......	.....
New Harbor	1	41. 58	1, 200	500	12	2	198	......	198	......	.....
North Haven	16	1, 039. 19	60, 500	24, 600	240	77	16, 389	2, 400	18, 789	......	.....
Port Clyde	1	41. 04	2, 000	800	12	3	386	......	386	......	.....
Portland	55	4, 459. 66	335, 300	75, 630	889	286	47, 230	12, 640	59, 870	580	380

*Including \$324,360 for salt and barrels and \$128,400 for provisions and running-gear not shown separately by ports. The amount shown in the table is for seines, pockets, and boats.

American mackerel catch for the season of 1885—Continued.

Port.	No. of vessels.	Tonnage.	Value of vessels.	Value of outfit.	Number of crew.	Total number of trips.	Inspected, caught off United States coast.	Sold fresh, caught off United States coast.	Total caught off United States coast.	Caught in Gulf of Saint Lawrence.	Taken within 3 miles of provincial shore.
Maine—Continued.							*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*
Rockland	1	88.11	$9,000	$1,700	14	5	996	......	996	......	.....
Swan's Island	7	497.44	31,200	11,800	112	34	7,404	1,400	8,804	......	.....
Southport	10	649.73	41,500	11,500	158	41	7,606	2,100	9,706	......	.....
Vinal Haven	2	130.81	10,500	2,850	30	8	1,650	......	1,650	......	....
Total	118	8,520.85	577,000	159,180	1,820	559	95,861	24,055	119,916	580	380
Portsmouth, N. H.	1	85.19	9,000	1,800	17	6	619	300	919	......	.....
Massachusetts.											
Barnstable	1	84.49	6,000	1,500	16	7	1,800	......	1,800	......	.....
Boston	18	1,359.11	66,000	24,100	257	89	12,412	3,040	15,452	941	.....
Dennis	4	396.83	36,000	4,000	67	30	6,087	1,600	7,687	.....	.....
Chatham	4	289.59	13,400	2,050	58	40	3,851	1,350	5,201	......	.....
Cohasset	3	211.75	10,500	3,000	47	13	2,169	......	2,169	......	.....
Gloucester	146	11,168.84	713,106	248,335	2,152	775	122,694	46,143	168,837	24,379	5,984
Harwich	6	454.03	23,500	9,500	97	46	6,541	450	6,991	......	.....
Newburyport	1	42.69	3,000	500	14	6	72	600	672	......	.....
Plymouth	2	198.90	8,000	1,800	31	10	2,232	......	2,232	......	.....
Provincetown	15	1,117.33	46,600	18,900	227	75	13,766	2,000	15,766	733	200
Wellfleet	36	2,866.19	158,300	61,900	572	150	26,412	......	26,412	......	.....
Total	236	18,189.75	1,084,406	375,585	3,538	1,241	198,036	55,183	253,219	26,053	6,184
New London, Conn	1	74.55	4,000	2,000	15	6	1,123	......	1,123	......	.....
New York, N. Y	1	82.01	7,000	2,100	17	5	1,257	1,000	2,257	......	.....
Philadelphia, Pa	1	83.32	12,000	800	18	4	831	250	1,081	......	.....

23.—INVESTIGATION OF THE RED-SNAPPER FISHERIES.*

During the early months of the year the steamer Albatross was engaged in a series of cruises in the Gulf of Mexico. A part of the valuable work carried on at this time was an investigation of the fisheries for red snappers off the west coast of Florida. Two trips were made from Pensacola, one in February and the other in March, to the fishing-grounds which were known, and search was made for new ones. This was the first effort made under the auspices of the Government to examine the offshore fishing-grounds of the Gulf of Mexico, and its success and that of others bid fair to add materially to the resources of the country.

Their development must be of considerable consequence to our Gulf coast, and if methods should be applied by which the products of these fisheries could get into the general markets of the country our food supply might be materially augmented.

* A valuable discussion of this subject may be found in an article by Capt. J. W. Collins in the appendix to this Report, p. 217.

The red snapper (*Lutjanus vivanus* Cuv. & Val. [or *Lutjanus blackfordi* Goode & Bean]) has long been locally known as a favorite food-fish, but the fishery for it has been developed within recent years when it has become known to the markets of the North and West. It is a fish that will keep for an unusually long time in ice. Thus packed in barrels or boxes it may be sent all over the country, being found in the markets of Boston, Chicago, and Denver, where, because of its bright crimson color, it is the most conspicuous fish seen. The favorite fishing-grounds for the red snapper are in the vicinity of Cape San Blas off the west coast of Florida, but specimens have been taken as far north as off the coast of New Jersey and even beyond. The Florida reefs, however, and rocky spots on the bottom at a depth of from 10 to 40 fathoms seem to be their favorite resorts, being gregarious in habit and strictly carnivorous in their food.

In the beginning of the red-snapper fishery the inshore grounds were most resorted to, but at present the most important grounds are those lying offshore, where the snapper can be found most abundant in winter, when the fishery is at its height. The headquarters of this industry is at Pensacola, which is nearer to the grounds than any other important port, and which is the most available market for the receipt and distribution of the fish.

The character of the grounds, in respect to the abundance of fish to be found upon them, seems to be changing in a very marked manner. This change, which has been most noticeable during very recent years, is still going on, and localities formerly remarkable for the abundance of fish on them only a year or so ago are now of comparatively little importance. This is shown by the fact that vessels are continually obliged to extend their cruises farther off in order to meet with success; and it is feared that this decrease in the abundance of the fish may continue until the fishery will be no longer profitable. There are several reasons why the abundance of red snappers may be more easily reduced than can be the case with the majority of food-fishes, inasmuch as these snappers are local in their habits, occupying a region of comparatively small proportions and being found only in small areas or banks within this region, and as they are taken at all seasons of the year, though preferably in winter.

Much of the work is done by fishermen from New England, some of whom are engaged off the coast of Florida during the winter, and fish off the New England coasts in summer. The vessels used in this fishery are naturally, then, for the most part, of Northern build, though it should be stated that there are vessels and boats of nearly all styles and rigs, just as the fishermen are of all classes and climes.

The fishing for red snappers is done almost exclusively with hand-lines, which are rigged in a very primitive manner, as the snapper is a greedy biter, from which fact it gets its name, and the lines are exposed to frequent loss. The bait used is taken from a wide range of smaller fish, such as lady-fish, skipjacks, porgies, &c. A vessel engaged in this fishery usually carries from 300 to 400 pounds of salt bait on each trip. Other fish when caught may be used as bait, and this, when fresh, has the advantage of being tougher than the salt bait, and not so easily torn from the hooks. Much care must be exercised in searching for the small and closely circumscribed spots on which the snappers are found; and, even when found, the fish, which are usually so ready to take the bait, cannot always be caught.

Some vessels put the whole of their catch in ice and thus carry them to market; others carry the fish in the wells of the vessels, where much care must be taken to prevent them from dying of suffocation. In either case, when a fare is obtained it is necessary to reach the market as soon as possible. From Pensacola all the fish shipped go by rail, except those sent to New York, which are generally carried by the Savannah Steamship Company's line.

During October, November, and December the best catch of the year is made, while from the middle of March to the middle of June comparatively little is done, so that the vessels generally haul up for two or three months in summer. The fish range in weight from 2 to 35 pounds, averaging 7 pounds. The average price paid by the Pensacola dealers for the fresh fish is about 3 cents per pound, while the total amount of red snappers taken during 1885 was about 2,000,000 pounds.

As those who have the best opportunities for knowing claim that the red snappers are rapidly becoming scarcer on the grounds where they are now taken, it seems eminently desirable that some means should be adopted for preventing this depletion. If the abundance of this fish should be exhausted, a promising industry would be broken up, and the country at large would be deprived of one of the finest of our edible fishes. This may be prevented by two methods: First, the application of artificial propagation to the red snapper; and, second, the discovery of new fishing-grounds that may be worked while the old ones are recuperating. As to the artificial propagation of this fish, it must be said that at present so little is known of its breeding habits that nothing can now be done. It is a matter of congratulation that the recent researches of the Albatross have demonstrated the important fact that there is a large area of ground yet unworked off Tampa and south of it where the snapper is seemingly more abundant than where it has formerly been sought. This may give relief to the old grounds before they are too much exhausted, and may lead to further investigation and discovery.

24.—THE BLACK COD OF THE PACIFIC.

The black cod (*Anoplopoma fimbria* Pallas) of the North Pacific Ocean is not a true cod (*Gadus morrhua* Linn.) in its family relation, but in its appearance somewhat nearly resembles the pollock (*Pollachius carbonarius* Linn.), having a color on the back which has obtained for both itself and the pollock in some regions the name of "coal-fish." Generically the black cod is a member of the *Chiridæ*, or rock-trout, family of the Pacific, which has, so far as is known, no species in the Atlantic.

As in order to obtain the common codfish (*G. morrhua*) the fish-dealers of the Pacific coast are obliged to send large vessels on trips of 3,000 miles or more to the Shumagin Islands, Behring Sea, or the Sea of Okhotsk, the occurrence of the black cod, which is found in abundance in Puget Sound, Fuca Strait, and from Cape Flattery up along the coast to Alaska, may be of great commercial significance. Black cod are not common in the markets of San Francisco, where they are small in size, weighing about 3 pounds, and are little esteemed; but farther northward they are better and larger. The fish are found of larger size and in greater numbers in the deep waters, at a distance of a few miles from the coast, being especially abundant, so far as is yet investigated, off the west coast of the Queen Charlotte Islands.

Most of the fishing has thus far been in the hands of the Indians, whose appliances are necessarily rude, though evidencing a considerable degree of skill in their adaptation to circumstances.

The problem is to catch these fish on a bottom that is more or less rocky and studded with coral, in about 100 fathoms or more of water, with a current of 4 miles an hour running in many places most of the time. This cannot be done very well with gill-nets, unless possibly they may be used as drift-nets, while the hooks of trawl-lines are apt to catch on the uneven bottom and be lost.

The best method of curing and preparing the fish for market will probably be found only after some experimenting. This cod, though fat, does not easily rust, and they may be kept in pickle, like mackerel, or preserved in various ways. Already they have been dry-salted and sent across the continent, arriving in Washington and Boston in good condition. They have been cooked in different ways and eaten by several experts, and various opinions have been expressed as to their edible qualities, all being more or less favorable. They are somewhat different in taste from any Atlantic fish; but they have a firm flesh with a good deal of fat, and are characterized by an oily savor, which some call a little "strong."

The way to treat them in order to get their true flavor is said to be to soak them for at least twenty-four hours, changing the water frequently in order to freshen them thoroughly (this is, of course, when they have been well salted), and then simply to boil them, and serve with plain boiled potatoes. When cooked in this way, they are called fat and rich, with the flavor of the best mackerel. Made into fish-cakes, the strong taste, which sometimes is found, disappears; and when broiled and eaten cold they are much liked. The black cod has been thought to resemble a bluefish or a quinnat salmon a little in its oily taste. Some have declared that when boiled the black cod tastes much like halibut's fin; others, that it closely resembles the corned Newfoundland turbot; and, as is well known, halibut's fins and turbot are considered great delicacies by those who are fond of fat or oily fish. It makes a good salt fish, though scarcely equal to our regular codfish, which it is not at all likely to displace in the Eastern markets.

When smoked it seems to be a success, and competent judges have declared it equal to the best smoked Greenland halibut. Prepared in this way, it bids fair to become a valuable article of commerce in all parts of the country, if its catch, preparation, and distribution are not attended with too great expense.

25.—THE FISHERIES OF THE PACIFIC COAST.

Mr. Charles H. Townsend was sent to Alaska and the Pacific coast during the present year to study the whale and other fisheries. A preliminary report of his work, furnished by himself, is as follows:

I was in Alaska, at the Pribylov Islands, in June, 1885, engaged in zoological work, when the U. S. revenue-cutter Thomas Corwin called there on her way to the Arctic. An opportunity offering to accompany as naturalist an exploring party to be sent up the Kowak River, I went on board, and after several days' uneventful voyaging, during which we called at Saint Michael's, Golofnin Bay, and Port Clarence, the Corwin entered Behring Strait on July 1. Here we encountered much loose drift-ice, which impeded our progress into Kotzebue Sound, where we arrived at 11 o'clock on the night of July 2, the midnight sun still shining brightly, as might be expected from the high latitude and the season of year. The steam-launch was put overboard, and our party, consisting of Lieutenant Cantwell, two seamen, and myself, and several Eskimos, started up Hotham Inlet to the mouth of the Kowak. This river flows into the inlet through a delta about 40 miles wide, the islands of which bear a thick growth of low pines, the first I had seen in Alaska. It is probable that the forests approach nearer the coast here than at any other point in Northern Alaska.

In about eight days, by continuous traveling, we reached the head of steam-launch navigation, at a distance of nearly 350 miles from the sea, finding plenty of pine fuel all the way for our little steamer. Here, with the assistance of two seamen, I set up my laboratory on board the launch, which was supplied with a good canvas cover, and began collecting, Lieutenant Cantwell and the natives going on to the source of the river with the canoes. During the three weeks that I remained at this camp, a remote spot in the interior of Alaska, and considerably north of the arctic circle, I gathered a goodly collection of fishes, birds, mammals, and plants, and filled my note-book with memoranda on the natives and the physical aspects of the country.

Lieutenant Cantwell found the source of the Kowak in a large lake among the mountains nearly 450 miles from the sea, a lake swarming with the largest of trout (*Salvelinus namaycush*). Photographs were taken at many places along the river, as well as observations for latitude and longitude. The Kowak flows through a well-wooded country, the forests frequently being separated by long stretches of open tundra land. We saw a few reindeer, and had evidence of the presence of many kinds of fur-bearing animals. Birds, 53 species of which I found along the river, were numerous, and we fared well on the abundant fish and wild fowl. Nearly every day we passed camps of natives engaged in fishing, by whom we were always kindly received. The Kowak teems with fish, of which I secured 18 species, including a few salt-water forms from Kotzebue Sound.

We joined the Corwin at Kotzebue Sound on September 1, having passed Lieutenant Stoney's party late in August as we descended the river. Another party sent out from the Corwin, in charge of Engineer McLenegan, had in the mean time explored the Noätak River, which also flows into Kotzebue Sound.

At Hall Island, in Behring Sea, on our return trip, I killed an immense polar bear, which I succeeded in preserving in good condition for the national collection, with the help of the sailors Captain Healy kindly sent to me.

On September 10 I disembarked at Saint Paul Island, where I spent a month collecting and studying the fur seals. From there I went to Oonalaska, where I spent two weeks with the birds and the fishes, and returned to San Francisco by the Alaska Commercial Company's steamer Dora, arriving on November 8.

My entire Alaskan collections are as follows:

Mammals, 36 specimens (19 of which were fur seals), the rest mostly small animals, representing 12 species; birds, 268 specimens, embracing 80 species; fishes, a collection representing 18 species. One bird from Otter Island (*Tringa damascensis*) is new to the fauna of North America.

My report on the natural history and ethnology of Northern Alaska is now in the hands of the Public Printer.

From San Francisco I proceeded to Humboldt Bay, Northern California, where I remained until December 17, gathering statistics relating to the fishes of that part of the coast, and where I also obtained 150 birds and 11 mammals. I then spent a month visiting the whaling stations along the southern coast of California and making inquiries respecting the present condition of the gray-whale fishery. Owing to stormy weather I was unable to obtain a skeleton of this whale. My studies of this once valuable and now somewhat rare whale indicate that the species is gradually re-establishing itself, now that it is undisturbed in its breeding resorts in the lagoons of Lower California.

26.—TREATY RELATIONS WITH GREAT BRITAIN.

As is well known, the provisions of the treaty of Washington relative to the situation of Americans in the fisheries of Canada terminated on

July 1, the United States having given the requisite notice to bring about such result. Although an understanding was reached between the Governments of Great Britain and the United States that fishing privileges would continue until January 1, 1886, substantially as they had heretofore existed, the necessity of obtaining data on which to base subsequent negotiations was clearly seen. In order that this Commission might co-operate in the fullest way with the other branches of the Government, it was determined to enter upon the most practicable arrangements for collecting information. I accordingly, on the 10th of December, addressed the following letter to the honorable Secretary of the Treasury, which resulted in the desired instructions being given to the customs officers and in the cordial co-operation of the Chief of the Bureau of Statistics of the Treasury Department in the work. It is yet too early to speak concerning the results of this undertaking.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., December 10, 1885.

SIR: The necessity of shaping and negotiating a new fishery treaty with Great Britain affecting colonial waters in North America, and the frequent petitions to Congress for general and special legislation affecting the localities, seasons, and apparatus to be used in the capture of different species, render it especially desirable to have at hand, available for reference, full and accurate information regarding our fishery interests.

A very large percentage of the fish are taken by means of vessels licensed to engage in the fisheries by the Treasury Department. The regulations of said Department require that the papers permitting the vessel to be used in fishing be renewed at least once a year, and that the owner or master of said vessel, or both, appear before the proper officials of the Department to make the necessary signatures.

The owner and master of each fishing vessel are thoroughly informed regarding the movements of the vessel and the amount of fish taken during the last period of enrollment or license. I have, therefore, caused the inclosed list of questions calling for general and statistical information to be prepared for your consideration, and if it meets with your approbation would respectfully request that you will cause the same to be printed and distributed among the various customs officers along the coast and in the region bordering on the Great Lakes, and that you will instruct the officials of your Department to fill out the blank from information obtained from the owner or master whenever they shall present themselves at the custom-house to obtain or renew the necessary papers for their vessel. I have further to request that such blanks as may have been filled out, or copies of the same, be forwarded to me for compilation on the first day of the month following the renewal of the vessel's papers.

By such an arrangement it is possible to obtain general and statistical information of the greatest value to the Government for purposes of legislation and record. The compilations from the blanks will, if so desired, be sent to the Treasury Department for publication.

I have the honor to be, yours very respectfully,

SPENCER F. BAIRD,
Commissioner of Fish and Fisheries.

The Hon. SECRETARY OF THE TREASURY,
Washington, D. C.

A circular with numerous questions was prepared and sent out to fishermen and owners interested in cod, halibut, and other ground fisheries. A copy of this circular will be found in the supplement, page CXI.

C.—THE INCREASE OF FOOD-FISHES.

27.—BY PROTECTIVE MEASURES.

In addition to the reasons mentioned in previous reports for enacting protective measures, it has been ascertained that a very slight pollution of river water by the refuse from gas factories is fatal to shad. In response to a request from the Commissioners of the District of Columbia, in May of the present year, I directed Colonel McDonald to investigate this subject. The following is extracted from his report:

I respectfully transmit herewith a report of a series of experiments made in obedience to your instructions, with the object of determining the extent of the injurious or deleterious influences exerted upon young shad confined in water containing different proportions of the waste products from the ammonia works in West Washington.

The sample experimented with was furnished by the Board of Health, and was obtained from the above-named works. A portion of the original solution has been retained for reference. The result of the experiments shows that this waste product exerts a distinctly deleterious influence when present in the water to the amount of one-fourth of 1 per cent or in the proportion of 1 gallon to 400 gallons of Potomac River water. No experiments were made with solutions of less strength than one-fourth of 1 per cent. If we consider only the direct effect on young shad which have not yet begun to feed, it is probable that the area of injurious pollution in the case of the Potomac River does not extend very far from the point at which the waste products are discharged into the river.

Before coming to any definite conclusion, however, we must take into consideration the fact that the very young shad, which have not yet begun feeding, are much less sensitive to injurious influences in the water in which they are than the same fish after their sacs have been absorbed and they have begun feeding. We must further consider that the minute food upon which the young shad feed is much more sensitive to injurious influences (especially those exerted by the presence of coal-tar products) than are the young fish which feed upon them.

Other investigations point to the same conclusions, as shown by the following quotation from the Popular Science Monthly:

Messrs. C. Weigett, O. Sacre, and L. Schwab have investigated the effects on fisheries and fish-culture of sewage and industrial waste waters, and find them very damaging. Chloride of lime, 0.04 to 0.005 per cent chlorine, exerted an immediately deadly action upon tench, while trout and salmon perished in the presence of 0.0008 per cent of chlorine. One per cent of hydrochloric acid kills tench and trout. Iron and alum act as specific poisons upon fishes. Solution of caustic lime has an exceedingly violent effect upon them. Sodium sulphide, 0.1 per cent, was endured by tench for 30 minutes.

28.—BY THE USE OF FISHWAYS.

Fishway over the Great Falls.—Reference has been made to this work in previous reports. Since then a site has been selected for the construction of a suitable fishway which it is hoped will enable shad, striped bass, and other food-fishes to ascend to the upper portion of the Potomac.

A plan of fishway, suggested by Colonel McDonald, who prepared the necessary working drawings for the purpose, was adopted, and recommended to the Secretary of War for such further action as he might think proper.

A contract having been given out by direction of the Secretary of War for constructing the fishway, work was pushed forward during the summer of 1885. The conditions of the contract required the entire work to be completed on October 31 of the present year. Five sections were at that date in process of construction, and high water occurring at about that time found none of the six sections completed, and put an end to the work for the season.

The lowest or sixth section was most advanced toward completion, needing only the setting of the line of coping provided for in the plans and specifications to insure the permanence and durability of the construction. It suffered little or no injury from the floods and ice of the winter, and needs only to be completed as planned to render this part of the construction permanent.

The work remaining to be done at the end of the year is as follows:

(1) The erection of a weir dam, about 40 feet long and 5 feet high, from the abutment of the fishway to the opposite shore, the object of this being to regulate and control the supply of water to the fishway, and, at the same time, to provide for discharge of the surplus water.

(2) To clear out the channel below the weir dam, so that the water flowing over the dam may be discharged into the river below by the side of the fishway, instead of over the lower end, as is now the case.

(3) The placing and securing of the 12-inch coping to cover the rubble masonry walls forming the sides of the fishway.

(4) The removal of the loose rock piles up at the lower end of the fishway and excluding fish from access to it.

The matter will be brought to the attention of the Secretary of War in the spring of 1886 with the request that at least section 6 be completed at once. An additional appropriation may be required for completing the other sections.

29.—SOME OPINIONS OF THE IMPORTANCE OF ARTIFICIAL PROPAGATION.

Sir Lyon Playfair made a very careful examination of the Wood's Holl Station and other appliances of the Commission, and on his return to England endeavored to stimulate endeavor in Great Britain by the following allusions to the United States:

"In regard to the special subject of carp, much progress has been made in the United States by the introduction of the two German varieties. It is curious that they should have done so before the mother country, for the remains of old fish ponds are spread over England, and are almost always near the old monasteries. Tens of thousands of old carp ponds once existed in England, but as the carp were no longer cultivated they reverted to their wild state and became valueless. In China and Germany the culture of carp is still an important industry. The United States, in introducing the culture, wisely selected the German species. In 1882 the carp bred in the Commissson ponds at Washington were distributed in lots of twenty to ten thousand applicants in every State and Territory. The average distance to which they were sent was 900 miles, and the total mileage of shipments was 9,000,000 miles; while the actual distance traversed by the transportation railway cars was 34,000 miles. Already German carp have been introduced into thirty thousand separate waters.

"But I do not wish to limit my letter to carp by any means. Aquaculture has become an important affair of the State among our transatlantic brethren. The separate States prosecute it, and in 1882 spent £24,000 in its promotion. The National Government spent nearly £30,000 on the same object. The scale on which this is done may be indicated by the fact that the Government at Washington provided the Fish Commission with two steamers, commanded by officers of the Navy, and specially designed for scientific research and for fish propagation. The Albatross, of 385.82 tons, is a model of what a ship should be for the first purpose; the Fish Hawk, of 205.71 tons, is not good in heavy seas, but is well fitted for the latter purpose. There are seventeen hatching stations, of which the head is at Wood's Holl, in Massachusetts. Having paid a short visit to Professor Baird there this year, I am tempted to enlarge upon it; but I will only say that there is an excellent house for the staff, containing thirty beds, laboratories for research, and hatching ponds for 2,000,000 young cod. Much of the work is done by volunteer agency. The various universities send their naturalists, and the Smithsonian Institution devotes money for special researches and publications.

"There is an essential difference between the mode of proceeding of the Government of the United States and that of our own country in relation to fisheries. We have had commissions without end, on some of which I have served. Vast bodies of contradictory evidence have been obtained from fishermen, who, I agree with Huxley, know less about fish than the community. Our commissions have led to little useful result. The American commissioners act in a different way. They put questions directly to nature and not to fishermen. They pursue scientific methods, and not those of "rule of thumb." They make scientific investigations into the habits, food, and geographical distribution of fishes, and into the temperature of the seas and rivers in which they live or spawn. Practical aims and experiments are always kept in view. As an experiment, they tried to introduce shad on the Pacific coast and succeeded; they tried to introduce California salmon to the Atlantic slope and failed. As an instance of a practical aim, they have restocked the Sacramento and its tributaries so effectually that the annual increase each year, for the last few years, has been 5,000,000 pounds.

"The object of my letter is to show that, while the private propagator may cultivate young fish by thousands, aquaculture can only be undertaken by a government, for its statistical results must be counted up by hundreds of millions. In the United States all the departments of the Government cordially co-operate in fish-culture; the railways assist, and provincial bodies are active. In Scotland we have a fishery commission, willing and able to make experiments, but the Admiralty cannot find a vessel to make dredging experiments, and the Treasury cannot find £1,000 to carry out important researches only half complete. Biological stations in England and Scotland are being formed slowly on account of deficient public support."

A very interesting series of articles published in the American Field by Mr. A. Booth, a well-known fish-dealer of San Francisco and Chicago, commencing with the number for November 7, 1885, contains some very important suggestions. He calls attention to the fact of the very great decrease that has taken place in the fishery industry, and quotes the statement of an old and experienced fisherman of the lakes, as follows:

"Fifteen years ago a sail-boat, with a crew of four men, used to run from eight to twelve gill-nets, and catch 2,000 or 3,000 pounds of fish at a haul. Now it takes a gang of sixty to eighty nets to catch as many pounds, and it takes a steam-tug and seven men to tend the nets. We may catch more fish now, altogether, but we don't make as much money as we did a while ago."

He further remarks that originally "whitefish in almost any quantity could be taken at almost any point along the shores of the lakes and their connections, even by the use of seines, and the pound-nets rarely needed to be more than 20 feet in depth. Now the fish have become so scarce that it is no unusual thing to run out as much as 40 miles to their fishing-grounds, and pound-nets are used 40, 60, or even 100 feet in depth."

An examination of the books of a very successful fisherman of Milwaukee shows that where formerly his catch averaged 1,000, 2,000, and 3,000 pounds, now it scarcely amounts to as many hundreds.

In an article on the improvement of fisheries, by Mr. A. Booth, he states in reference to the utility of artificial propagation that, about eleven years before (in 1871), he started a salmon cannery on the Sacramento River, in California, but was forced to abandon it for lack of fish. About the same time the U. S. Government started a salmon hatchery on the McCloud River, a tributary to the Sacramento. In about three years he went back to his cannery, and year before last (1883) there were eleven canneries on that stream, and each had all the fish it could handle.

He thinks, therefore, that the depletion of the finer fish in the Great Lakes as well as in the river, whether salmon, whitefish or other species, can, without any question, be remedied by artificial propagation.

So impressed was Prof. J. Cossar Ewart, of Edinburgh, with what he saw of the American methods in his visit in 1884, that, at his suggestion, the Scotch Fishery Board cabled to send, at their expense, a fish-culturist competent to conduct operations in connection with the sea-fisheries, and to assist them in inaugurating methods for the multiplication and propagation of various species.

The Chilian Government, similarly impressed with the importance of preserving its fisheries, placed the matter in the hands of an engineer and entered into negotiations with this Commission as has already been described under the head of "Courtesies to Foreign Countries."

30.—BY THE DISTRIBUTION OF FISH AND EGGS.

Since the fish transportation cars were constructed, the method of the distribution of fish and eggs has been almost entirely changed; namely, from service by means of messengers using the baggage-cars of passenger trains, to the employment of cars built or fitted by the Commission expressly for the purpose. A great economy of service has been the result; and where a shipment of ten thousand was formerly possible, millions can now be sent. This work has been under the direction of Colonel McDonald.

The total distribution of fish to public waters in the United States during ten years of activity, viz, from 1872 to 1882, has been tabulated under Colonel McDonald's direction, and the table will be found on pages CX and CXI of this report. It shows the following totals:

Fish.	Number.	Fish.	Number.
Shad	200, 946, 350	Brook trout	88, 200
Whitefish	77, 072, 000	Salmon trout	40, 600
California salmon	33, 172, 734	Cod	25, 000
Atlantic salmon	12, 519, 887	Rangeley trout	12, 500
Fresh-water herring	9, 833, 000	Schoodic salmon (hybrid)	10, 000
Landlocked salmon	6, 404, 961	Rhine salmon	4, 500
Rockfish or striped bass	400, 000	Moranke	409
Spanish mackerel	270, 000		
White perch	180, 000	Total	341, 096, 971
California trout	116, 830		

31.—SPECIES OF FISH, ETC., CULTIVATED AND DISTRIBUTED IN 1885.

The species of fish and invertebrates receiving the attention of the Commission during the year, with the exception of the addition of a few of more or less interest, are the same as heretofore. Work has been prosecuted on a large scale in regard to only a few species; those receiving special attention, in addition to the several varieties of *Salmonidæ*, are the shad, the carp, and the codfish. The scale of the operations on which the work has been conducted has, however, in many cases been much greater than heretofore; not only a larger number having been hatched out, but the area of distribution being greatly extended

The following is a list of the species included:

a. The Codfish (*Gadus morrhua*).
b. The White Perch (*Roccus americanus*).
c. The Whitefish (*Coregonus clupeiformis*).
d. The Moranke (*Coregonus albula*).
e. The Grayling (*Thymallus tricolor*).
f. The Brook Trout (*Salvelinus fontinalis*).
g. The Lake Trout (*Salvelinus namaycush*).
h. The California, Rainbow, or Mountain Trout (*Salmo irideus*).
i. The Atlantic or Penobscot Salmon (*Salmo salar*).
j. The Schoodic or Landlocked Salmon (*Salmo salar* subsp. *sebago*).
k. The Brown or European Trout (*Salmo fario*).
l. The Loch Leven Trout (*Salmo levenensis*).
m. The Quinnat or California Salmon (*Oncorhynchus chouicha*).
n. The Shad (*Clupea sapidissima*).
o. The River Herring (*Clupea æstivalis*).
p. The Smelt (*Osmerus mordax*).
q. The Tomcod (*Microgadus tomcodus*).
r. The Carp (*Cyprinus carpio*).
s. The Goldfish (*Carassius auratus*).
t. The Golden Ide or Orf (*Leuciscus idus*).
u. The Tench (*Tinca vulgaris*).
v. The Catfish (*Amiurus nebulosus*).
w. The Little Round Clam (*Tapes staminea*).
x. The Oyster (*Ostrea virginica*).
y. The American Lobster (*Homarus americanus*).

In addition to the species mentioned in the foregoing list, the red-eye perch (*Ambloplites rupestris*) and black bass (*Micropterus dolomiei*) have received favorable consideration and may perhaps be added to the list of species cultivated at an early date. A small lot of each was collected the present year for the special purpose of meeting a request from the Marquis of Exeter.

The black bass, although frequently called for, cannot be recommended to farmers generally, or for use in limited waters, on account of the carnivorous nature of the species, the necessity of keeping them apart from other fishes, and the expense of providing them with suitable food. They are, however, frequently used to advantage for stocking rivers and large bodies of water.

The Commission is in receipt of many requests for eels, but it has not been feasible to attempt their propagation for the purpose of distribution. Eels are found so generally throughout the country that persons wishing to cultivate them can quite readily obtain them without the assistance of the General Government.

a. **The Codfish** (*Gadus morrhua*).

The Wood's Holl Station.—Preparations were made on an extensive scale for hatching the eggs of the codfish at this station, and during the winter considerable valuable work was done. Early in December Col. M. McDonald and Prof. John A. Ryder visited the station to observe the operations in cod hatching, which were carried on under the direction of Capt. H. C. Chester. The first eggs, 6,000,000 in number, were taken on December 2. Many million eggs were taken during the season from comparatively few fish, and were hatched with a relatively low percentage of loss. In one case, with the use of the Chester apparatus, fully 90 per cent were hatched. The filtering of the water through cotton in the McDonald jars was found to be an improvement; and cones with Captain Tanner's attachment were also used. In some instances the density of the water seemed to be too little, causing a considerable loss of the eggs. Several millions of fry were planted near the station; while early in 1886 about 500,000 fry were sent to Washington, thence to Pensacola, from which point they were carried by a revenue-cutter some 25 miles out in the Gulf of Mexico and there safely deposited with a loss of only about 10 per cent.

b. **The White Perch** (*Roccus americanus*).

The Battery Station.—Several large ripe perch were taken in the seine while hauling it for shad, and their eggs were impregnated and developed in a Chase jar. During the season 1,250,000 perch eggs were thus obtained, and 1,000,000 fry were hatched and planted.

c. **The Whitefish** (*Coregonus clupeiformis*).

The Northville Station.—The work at this station, which remained under the supervision of Mr. Frank N. Clark, was carried on by much the same methods as formerly in use and shows a satisfactory increase in results over those of the previous year. During November and December, 1885, more than 100,000,000 eggs were received at this station, mostly from the island region of Western Lake Erie and from fish penned at Monroe, Mich. The first eggs came from the spawning beds of Lake Erie on November 11, and the last on December 7. For hatching, the eggs were carried forward in creek water, which is several degrees colder than spring water, until about six weeks before the time of hatching out. Then different lots of eggs were transferred at intervals to spring water, thus causing them to hatch at slightly different times and preventing an overtaxing of the facilities for handling and shipping. The hatching began on March 7 and ended on April 20, the average period of incubation being 125 days. The temperature of the water used varied from 32° to 43° Fahr., the average being 34¼°. The shipments of eggs for the season, amounting to 42,800,000, which is an increase of 11,800,000 over those of last year, were made principally during December and January, of which total, 2,000,000 were sent to the National Fish Culture Association of England; 2,000,000 to the German Fishery Association, through Herr von Behr, its president; 1,000,000 to the Swiss Government; 1,000,000 to New Zealand, by way of California; while the bulk of the stock went to Pennsylvania and Minnesota; 2.000,000 to the central station at Washington; and the rest to three States and one Territory, as well as to all the waters of the Great Lakes. In general, the shipments reached their destinations in good condition, and but a very small percentage of loss was reported. In every instance the eggs were carefully handpicked, and the details of each shipment were carefully attended to. The car work, also, was very successful, owing largely to the employment of two cars instead of one as heretofore, which prevents the accumulation and overcrowding of fry and allows of their disposal while in a vigorous condition. In the nineteen trips the two cars ran a distance of over 10,000 miles, no roads making any charge for this service, except the Chicago and Northwestern. Whenever possible, a tug was procured, from which to make the deposit of fry, care being taken to convey them not less than 2 miles from shore.

The Alpena Station.—The work at this station is carried on in conjunction with that at Northville, and 16,000,000 of the eggs taken in at Alpena were repacked and sent to Northville where there are better facilities for shipping. During the season 68,000,000 eggs were received at the Alpena hatchery. Most of this supply came from the west shore of Lake Huron and from Lake Michigan, 20,000,000 being obtained from new territory along the north shore of Lake Michigan where eggs were taken as late as December 16, when the fish were still spawning. The hatching season at Alpena was about a month later than at Northville, but the busy periods at the two hatcheries about coincide.

The number of eggs hatched at both stations for distribution to the Great Lakes was 92,000,000 (distributed from Northville, 52,000,000; from Alpena, 40,000,000), an increase of 4,000,000 over the preceding year, while the number actually planted was considerably greater than last year, owing to slighter losses in transportation. These fry were distributed to the great lakes as follows:

To Lake Huron	30,000,000
To Lake Michigan	29,000,000
To Lake Erie	15,000,000
To Lake Ontario	12,000,000
To Lake Superior	6,000,000
	92,000,000

The Cold Spring Harbor Station.—On January 1, 1885, a case containing 1,000,000 whitefish eggs was received from the Northville station in excellent condition. These eggs were placed in the McDonald jars and hatched well; and 990,000 fry were planted in the deep lakes of Long Island.

d. The Moranke (*Coregonus albula*).

The Bucksport Station.—On January 30, 1885, a case containing 50,000 eggs of the small species of *Coregonus* inhabiting Lake Constance, Switzerland, was received at the Cold Spring Harbor station from the hatchery of Carl Schuster in Baden. The eggs were in good condition, and were repacked and shipped to the Bucksport station, which they reached with a loss of only 300 dead. Subsequent losses in hatching left 40,000 fry, which in April were planted in Heart Pond, near Orland, and Lake Hebron, near Monson, in Maine.

Two consignments of the eggs of this fish, aggregating 150,000, were also received from the Deutsche Fischerei-Verein, 100,000 of which were allotted to the Bucksport station for hatching and planting in Maine waters, and 50,000 were sent to the Northville station for stocking suitable lakes in the Northwestern States.

It appears from the proceedings of the Acclimatization Society of France in 1885 that while the United States was receiving eggs of *C. albula* from Germany the above-named society was also being favored by the Deutsche Fischerei-Verein, 100,000 eggs having been received at Paris in the spring of that year. M. Raveret-Wattel, secretary of the society, reports it to be an excellent species for introduction into the lakes of Northern Europe and of especial value to the fresh waters of France, such as the lakes of Auvergne.

Of it Herr von dem Borne says: "It is a very fine fish found in deep lakes of Northern Germany, growing to one or one and one-half pounds weight."

The following description of *Coregonus albula* is by the late Prof. B. Benecke, of Königsberg:

The body is six times as long as it is high, and 2 to 2½ times as high as it is thick; the head is pointed; the snout does not have a blunt end; the lower jaw projects a little, and its thick chin fits in a shallow cut of the middle jaw. The jaws have no teeth; only the tongue has very diminutive and tender teeth. The shape and position of the fins resemble that of other kinds of *Coregonus*. The color on the top is bluish-green, on the sides and belly silvery; the dorsal, ventral, and caudal fins are gray, and the other fins colorless. The milters are much more slender than the spawners. The small *Marane* is found in nearly all deep lakes of the Uralo-Baltic range from Russia to Mecklenburg, also in the southern part of Scandinavia and in Finland. Generally living in deep water where they feed on small crustaceans, worms, and mussels, they come to the surface only at night, especially during warm summer nights, when they sport in the water so that the splashing can be heard for some distance. In November and December they go into shallow water for the purpose of spawning, generally only at night, and leaping about in an exceedingly lively manner, and making a great deal of noise they drop each from 2,000 to 5,000 eggs, about 2 millimeters in size, into the water. The eggs sink to the bottom, and generally adhere to the petioles of aquatic plants which are, with hardly an exception, found in all spawning places. In larger lakes the *Coregonus albula* regularly wanders about in large schools; thus, *e. g.*, in September and October they leave the Mauer Lake and the Lowentin Lake in East Prussia and go into the Spirding Lake, to return again in spring. In most of the lakes this fish reaches a length of 12 to 15 centimeters; but in many waters, *e. g.*, the Dadey Lake, near Bischofsburg, the Lyk Lake, near Lyk, and many others, it reaches a length of 20 to 35 centimeters. As it is highly esteemed on account of its delicate meat, this fish is caught in large numbers with nets and seines, and is brought into the market either fresh or smoked.

e. **The Grayling** (*Thymallus tricolor*).

The Michigan grayling is native to the waters of only a small portion of Michigan, but is also found in the headwaters of the Missouri, in Montana, and in the region of the Yellowstone Park. It never occurs south of latitude 43° north, and its principal habitat on this continent is, or was until recently, in the northern part of the southern peninsula of Michigan, in the clear, cold, rapid streams emptying into Lakes Michigan and Huron, especially in the Manistee and Au Sable Rivers.

The Michigan grayling was first called to the attention of local scientists in 1854 or 1855, and it was described and locally known as *Thymallus michigansis* up to 1864, when its present name of *T. tricolor* was given it after a careful examination by Prof. E. D. Cope. The Fish Commission Report for 1872–'73, printed in 1874, contained a valuable article on this fish by the late James W. Milner.

The average size of the grayling is about 10 inches in length and 8 ounces in weight; though they have been taken 16 inches long and weighing 2 pounds, and even more. It is said to be equal to the brook trout in flavor, and is one of the gamiest of fish; but, unlike the trout, it is more likely to be found in the swift ripples and shallows than in the quiet pools of the stream. While the adult trout and grayling live together in harmony, the eggs and young of the latter often furnish a dainty meal for the trout, and hence the grayling is being driven from streams which are congenial to the trout.

Thirty years ago the grayling were very abundant in some of the streams and rivers of Michigan; but of late years they have been disappearing so rapidly that their final extermination in this region is feared, unless something is done to prevent it. This disappearance is due somewhat to excessive fishing, but largely to the migration or introduction of the trout into the famous grayling streams, and perhaps still more to the settling up of the country and the consequent increase in lumbering. The grayling spawns in spring, about or immediately preceding the beginning of running the logs down the streams, generally spawning in the body of the stream where the water is not very deep. Then the logs come down, driving off the fish, raking up the beds, and destroying the spawn.

In favorable waters this fish is prolific (more so than the brook trout), yielding an average of from 3,000 to 4,000 eggs per spawner. Its spawning season seems to range, in Michigan, from about the middle of March to the middle of April, according to the severity of the season. In 1878 it was found that the spawning season in the Manistee was about over on March 30; while in 1885 the last eggs were taken in the Manistee on April 24, and in the Au Sable on April 18.

Several attempts have been made to propagate the grayling, but all without much success. Some have gone so far as to hold that it is beyond the reach of artificial fish-culture, but it has been done on a small scale with a slight measure of success, and may succeed with more experience, as the previous work has been largely experimental. In the spring of 1876 there were handled at the Northville station 2,000 eggs taken from grayling caught by Mr. Fred Mather, and a small percentage hatched; and in April, 1885, 20,000 eggs were taken from fish caught with hooks in the Au Sable and Manistee Rivers, and the hatching was fairly successful, but heavy mortality occurred after hatching, as no suitable food was found for the young fish. Those that lived, however, did well and grew rapidly. The Michigan State Fish Commission has made several experiments in cultivating this fish, but all without definite result. Experience seems to show very clearly that the grayling will not successfully endure domestication or confinement in trout ponds, as in 1884 the Michigan Commission placed a number of adult grayling in its trout ponds at Paris, Mich., but not a fish has spawned or showed the slightest inclination to do so, while they have gradually died, till but few are left. Experiments in this line will probably be continued under more favorable and natural conditions. Credit is due to Mr. Martin Metcalf for first obtaining the eggs artificially from grayling reared in the ponds of the Michigan Fish Commission, and for impregnating and hatching the same. This was done in the winter of 1879–'80.

The Wytheville Station.—In the spring of 1885 about 300 grayling were hatched from eggs collected from wild fish in the streams of Michigan by Mr. F. N. Clark and forwarded to Wytheville. These 300 fish are being kept for breeders, and at the close of the year were in fine condition.

f. The Brook Trout (*Salvelinus fontinalis*).

The Northville Station.—The work of the past season may be regarded as fairly successful, though not so much was done as usual. In all, 225,000 eggs were obtained; from which number, 145,000 eggs were shipped, 25,000 fry hatched, and 25,000 eggs sent to the Michigan fish commission at Paris, Mich., in exchange for an equal number of eggs of the same species which were hatched at Northville and mostly retained for breeding purposes. Of the 145,000 eggs shipped, 36,000 went to Mr. Fred Mather, 25,000 of which were reshipped to the Deutsche Fischerei-Verein of Germany, 10,000 to the National Fish Culture Association of England, and 1,000 to the Government of Switzerland, the rest being distributed among State commissioners and private applicants. There were shipped to Indiana and Michigan 4,000 fry during April and May, while the remaining fry were kept to replenish the ponds. During June 305 yearling and two-year-old wild trout were taken from the streams of Northern Michigan and brought to the Northville Station. During March, April, and May 550 yearling brook trout were distributed from the station to six private persons in Michigan, Indiana, and Ohio.

The Cold Spring Harbor Station.—During January 7,000 eggs were received from the Northville Station, from which about 5,800 healthy fry were obtained. These fry, with 10,500 others from eggs taken at the hatchery, were planted in streams of Long Island.

g. **The Lake Trout** (*Salvelinus namaycush*).

The demand for some species of fish other than carp for pond culture is growing so rapidly that it bids fair to equal that which has heretofore existed for carp. In ordinary ponds fed by surface water, the summer temperature of which rises above 60°, some species of *Centrarchidæ* would probably be best. There are, however, all over the Northern States facilities for the construction of ponds by damming back spring branches in which the summer temperature of water is certainly too low for the proper cultivation of carp. To supply the desideratum in reference to this it will be necessary to provide some species of *Salmonidæ* adapted to pond culture. The California trout and the lake trout—especially the latter—would seem to be best adapted to the purpose. The experiment should be made on such a scale and under such variety of conditions as will thoroughly test its feasibility. Believing that the lack of success heretofore experienced in planting *Salmonidæ* has been due to their helpless condition when planted, it seems advisable to hold them until they have attained a length of 5 or 6 inches, when, from their size and vigor, they are almost safe from the attack of predaceous fishes that may be in the water. A trout of the size and age indicated would seem to have as fair a probability of life as a full-fledged birdling. One hundred such placed in a stream or pond, under natural or artificial conditions which are favorable, would give a better promise of success than the planting of 10,000 fry under the same conditions prior to the absorption of their sacs.

The Bucksport Station.—For the purpose of furthering the experiments indicated, Mr. Clark was directed on November 14, 1885, to forward to Bucksport, from the eggs then ready for distribution, 50,000 lake trout eggs and an additional 50,000 as soon as they were ready. Mr. Atkins was instructed to retain as large a number as he could safely care for, planting the balance in suitable waters in the vicinity. It was thought that the fry could be retained in the hatching-troughs until the following May or June, which would meantime give an opportunity to make provision for them in the ponds. The 100,000 eggs safely reached Bucksport and were hatched without material loss, and in the middle of May, 1886, were still in good condition.

The Northville Station.—The work done with this species during the past season was more than three times as great as that of any preceding year. The number of eggs collected was 1,475,000; of which 1,031,000 eggs were shipped away, and 115,500 fry hatched. During the winter and spring 75,500 fry were sent to various points in Michigan, Indiana, and Ohio, while 40,000 fry were retained at the hatchery. Thus there was a total of 1,146,500 eggs and fry successfully handled. More eggs were taken at Thompson, Mich., on the north shore of Lake Michigan, than at any other point, though this was the first attempt in that region, while many were also taken from the island shoals of Thunder Bay and vicinity in Lake Huron. The eggs were taken by Mr. S. P. Wires and his assistants, of the Alpena station, and were at once forwarded to Northville, with scarcely any loss in transit. Of the eggs distributed, 50,000 each were reshipped by Mr. Fred Mather to the Deutsche Fischerei-Verein of Germany, the National Fish Culture Association of England, and the Government of Switzerland; while 25,000 were sent to Mexico. The remaining were shipped to twelve States and to the central station at Washington. As far as known, all of these shipments arrived in good condition, except that to Mexico, which was too long on the way and was probably exposed to too high a temperature.

h. **The Rainbow, California, or Mountain Trout** (*Salmo irideus*).

The McCloud River Station.—Mr. Livingston Stone retains the general superintendence of this station, while Mr. Loren W. Green was there in person to attend to the actual work during the season. The spawning began a little later this year than heretofore and did not last as long as usual, the first eggs (15,000) being taken on December 27, 1885, and the last (3,000) on April the 29th following. A violent storm visited the river just before the beginning of the spawning season, which caused some injury to the trout by making the water in the ponds very muddy. This storm was followed by a remarkably dry winter, which was unfavorable to the taking of spawning trout and caused very few eggs to be obtained in April. A total of 313,600 eggs was taken during the season, which was very creditable under the circumstances. Of the 246,000 eggs sent away, with the exception of one lot to Washington that was frozen in transit, all were received in good condition, and Mr. Green's method of packing seems very satisfactory. There were hatched and planted in the McCloud River 28,700 fry, and 11,300 were hatched for the ponds at the station.

Early in the fall the trout in the McCloud River and in the ponds were observed to be dying from some unknown disease. The symptoms were peculiar, and the disease seemed to be contagious, being apparently communicated to those in the ponds by the fish caught in the river, and attacking chiefly the larger trout. This has probably greatly reduced the number of spawners for the season of 1885–'86.

The Northville Station.—During the season 167,000 eggs were taken, of which number 5,000 were shipped and 30,000 were hatched, while the remainder died in the hatching-boxes. Of the 30,000 hatched a large percentage died within six weeks, in spite of the greatest care and attention, while no more than 5,000 survived. These small returns indicate that this species of trout does not successfully become acclimatized in the waters of the station, although special efforts have been made for a number of years to bring about this result. A total of 3,364 yearling and two-year-old fish were distributed by means of car No. 2 and special messengers for stocking streams and lakes in Indiana, Michigan, and Ohio.

The Cold Spring Harbor Station.—During February and March 20,000 eggs in good condition were received from the Northville Station. These hatched very well, and 14,500 fry were planted in streams of New York, mostly on Long Island.

The Wytheville Station.—From this station there were forwarded to applicants 30,000 eggs, while 166,000 were retained to be reared. The distribution from Wytheville was made to the headwaters of the Shenandoah, in Augusta County, Virginia, to tributaries of the Potomac in Washington County, Maryland, and to a number of spring-fed, cold-water ponds in Maryland, Southwestern Virginia, and Tennessee.*

i. The Atlantic or Penobscot Salmon (*Salmo salar*).

The Bucksport Station.—Mr. Charles G. Atkins remained in charge of this station, the operations being conducted as formerly by the United States, the Maine, and the Massachusetts Fish Commissions. The breeding salmon were purchased, as heretofore, from the Penobscot River fishermen, beginning on June 1 and ending on June 20. In all, 691 were

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* Writing under date of July 28, 1885, Colonel Marshall McDonald says:

"I had the seine drawn yesterday in one of our ponds containing California trout (breeders). I found them in splendid condition, but not averaging as large for their age as they will hereafter, as our original stock was badly handled at the start, and stunted. Many of them will, however, average from 2 to 2½ pounds, and from the whole, barring accidents, we ought to get not less than 150,000 to 200,000 eggs next season. We have lost but *one* breeding fish this season, and that I believe was choked. Last year during the hot weather we lost about 1,100 two-year-old fish; then the wooden tanks or ponds in which the fish were kept were entirely above ground. Since then I have had them banked around with earth and the upper ends of the ponds filled in with clay, gravel, and bowlders. The present fine condition of the fish I attribute to these changes. The new ponds on the hillside below the hatchery all have earth bottoms, and the advantage is seen in the remarkable growth of the fish in them; some of the yearlings are now 8 inches to 9 inches long. This spring's hatching (the fish are now about four months old) will range from 3½ to 4½ inches long.

"I regret very much to have to report that the losses in the California trout after they began feeding were very great, and we will not have over 30,000 for distribution. This mortality Mr. Seagle attributes to the fact that the fry had to be held in the hatching-troughs long after they had begun feeding. I think he is probably right; at any rate, this cause of loss will no longer exist, as we shall hereafter be able to place the fry on earth-bottom ponds as soon as they begin feeding."

obtained, of which number 610 were placed alive in the inclosure of a part of Dead Brook, 81 having perished in transit from the excessive heat of the river water. At the spawning season 501 were recaptured, being about 82 per cent of those placed in the inclosure, and 72½ per cent of all those obtained.

The size of the salmon this year was small. At the spawning season, when most of the fish were weighed, the females averaged 12¾ pounds before spawning, and the males averaged 10 pounds; the average length was about 31 inches, and the females yielded an average of 8,667 eggs apiece. The spawning, which was accomplished between October 27 and November 5, furnished nearly 2,500,000 eggs. The available stock of eggs, after losses were deducted, was 2,316,000, of which number 1,000 were kept for experiment, while the remainder were shipped to the order of the contributors to the fund, as stated below. The transfers were made with exceedingly small loss.

Contributor.	Amount of contribution.	Computed share of eggs.	Eggs actually delivered.
United States	$1,899 71	1,254,000	1,251,500
Maine	1,000 00	663,500	663,500
Massachusetts	600 00	397,500	400,000
	3,499 71	2,315,000	2,315,000

The share of the United States was sent agreeably to orders as follows:

To Cold Spring Harbor, New York 500,000
To Plymouth, N. H., for New Hampshire 150,000
To Plymouth, N. H., for Vermont 150,000
To Maine 451,500

The Cold Spring Harbor Station.—This was the second year of the operations with these fish at this station, and the work was very successful. During January eight cases containing 500,000 eggs arrived in good condition from the station at Orland, Me. Of the 425,000 hatched and planted, including a small loss in transportation, 270,000 were deposited in the tributaries of the Hudson, 100,000 in the tributaries of the Delaware, 50,000 in Oswego River, and 5,000 were distributed in small lots. Favorable accounts have been received of the plantings in Clendon Brook, from which it seems that this stream is becoming well stocked. Later reports indicate that salmon are again found in the Hudson, probably from the planting of 1882.

j. The Landlocked or Schoodic Salmon (*Salmo salar* var. *sebago*).

The Grand Lake Stream Station.—The work of this station continued under the supervision of Mr. Charles G. Atkins. The fishing lasted from October 24 to November 18, resulting in the capture of 811 fish, about three-fourths of them being females. In length the fish averaged about the same as those of 1884, but there was a slight decrease in weight (from about 4.1 to 3.6 pounds), and a considerable falling off in the average number of eggs to the spawning female (from 2,350 to 1,720).

The station is operated jointly by the U. S. Fish Commission and the State commissions of Maine, Massachusetts, and New Hampshire, and the eggs obtained are allotted according to contributions to the expenses of the station by the commissions. The expense during the present year ($1,678.01) was distributed as follows: United States, $578.01; Maine, $500; New Hampshire, $300; Massachusetts, $300.

Total production of eggs for the season	994,355
Losses during incubation	127,655
Available for distribution	866,700
Hatched at the station and returned to Grand Lake stream (less a loss of 891)	225,700
Available for pro rata distribution	641,000

Which were alloted as follows:

To the U. S. Fish Commission	222,000
To the Maine Fish Commission	189,000
To the Massachusetts Fish Commission	115,000
To the New Hampshire Fish Commission	115,000
	641,000

Those allotted to the U. S. Fish Commission were assigned as follows:

To the Deutsche Fischerei-Verein, Germany	20,000
To the National Fish Culture Association, England	20,000
To State commissioners and individual applications	182,000
	222,000

In general, these eggs reached their destinations in good condition, and were successfully hatched and planted. Full details regarding the fish caught, their size, and the shipments of eggs may be found in tables appended to the report of Mr. Atkins.

The Northville Station.—On March 19 a case containing 29,000 eggs was received from the Grand Lake Stream Station in excellent condition, and on April 14 hatching was completed with a loss of only about 600. A few weeks later 22,000 fry were planted in streams in the northern central portion of Michigan.

The Cold Spring Harbor Station.—In March 60,000 eggs were received from the Grand Lake Stream Station in excellent condition. It was intended to plant the fry in some of the Adirondack lakes, but through some misunderstanding the fish were kept too long, and were finally deposited during May in lakes on Long Island.

k. **The Brown or European Trout** (*Salmo fario*).

The Northville Station.—A few of the German trout reared at this station spawned in December, 1885, and 8,000 eggs were obtained. Two lots of eggs, 23,000 in number, were forwarded from the Cold Spring Harbor Station, the second lot of which (13,000) arrived in poor condition. From these 31,000 eggs 20,000 fry were hatched, which were retained at the station. The stock fish of this species in the Northville ponds show a better growth than the brook trout, and the outlook for the future is very promising.

The Cold Spring Harbor Station.—In February a box containing 40,000 eggs in very good order was received from the German Fischerei-Verein through its president, Herr von Behr. The fry from these eggs, which when hatched and ready for distribution amounted to about 28,000, were mostly planted on Long Island and near the Hudson, while a few that were kept at the station grew remarkably and are handsome and gamy fish.

During the year eggs were taken by several other persons, as well as at the Cold Spring Harbor Station, from fish which had been bred from eggs sent over from Germany two or three years before. The average number of eggs taken in one case (the fish being three-year-olds) was 540, and there are indications that this yield will increase. This indicates that this valuable fish has been successfully acclimatized in this country, and their cultivation may be greatly extended, as they are considered superior in many respects to our native brook trout.

l. **The Loch Leven Trout** (*Salmo levenensis*).

The Northville Station.—On January 2, 1885, six cases, estimated to contain 102,000 eggs, were received at the Cold Spring Harbor Station from the Howietoun hatchery in Scotland. They were in remarkably good condition, only 870 being dead. Mr. Mather sent 10,000 of the eggs from the Cold Spring Harbor Station to the Bisby Club, in Herkimer County, New York, where they were received in good condition, and the young trout are reported as doing very well. The remainder were shipped to the Northville Station, where they arrived on January 7 in excellent condition, there being practically no loss on the eggs. Of the eggs, 55,000 were thence reshipped to other stations, while 36,500 fry were distributed in Michigan and 7,000 young retained at the hatchery for breeding purposes.

The Bucksport Station.—During February, 1885, a case of 10,000 eggs was received from the Northville Station by way of Grand Lake Stream. At this last place they were in excellent condition, but they were partly frozen before reaching Bucksport; about 3,000 were lost, and the remaining 7,000 fry were planted on May 4 in Branch Pond and its tributary brooks near Ainsworth, Me.

m. **The Quinnat or California Salmon** (*Oncorhynchus chouicha*).

The McCloud River Station.—Active operations in taking the eggs of this fish were suspended at this station during the year. There was a very small run of salmon in the river, and it is feared that unless something is quickly done the Sacramento River will soon be depleted of its most valuable fish.

n. The Shad (*Clupea sapidissima*).

The Fort Washington Station.—For the two years previous to the season of 1885 the eggs collected from shad taken in the vicinity of Fort Washington were transferred to Central Station, in Washington City, where they were hatched and whence the young fry were distributed to suitable waters. In February of 1885 this work was reorganized under the direction of Col. Marshall McDonald, who made Fort Washington the headquarters of the collecting force, where all the eggs taken were held pending convenient transportation to Central Station on the river steamers.

An inspection of the Fort Washington Station showed the desirability of an additional building to be used exclusively for holding the eggs and keeping them in good condition until shipped. Accordingly such a building, 16 by 22 feet, was erected, and equipped in time to receive the first eggs taken. Mr. James Carswell was placed in immediate charge of the station, and on March 30 took possession with a part of his force, the others being called in as the season advanced and the work required it. By April 5 the station was fitted for service, but there being no shad in the river the seine was not regularly fished till the 16th, and no eggs taken till the 20th, when the temperature of the river was still low (52° Fahr.). After that date the temperature steadily rose, and up to May 28 an average number of eggs was taken daily, after which date there was a gradual decrease until the 5th of June, when the last eggs for the season were obtained. The total of 22,576,000 shad eggs were obtained during the season, more being derived from the Fish Commission seine at the station than from any other source, while the largest amounts for the season were taken on May 5 and 6, over three and a half millions of eggs being secured on those two dates. From eggs retained at the station 1,000,000 fry were hatched and planted in the Potomac. The gillers and the fishermen at the different shores in the vicinity rendered valuable assistance, having furnished over 15,000,000 eggs. It may be noticed that for the entire season the number of females was considerably in excess of the number of males, the proportion being 54.3 per cent; while the proportion of ripe females to the number of females taken was 17 per cent. Also it may be stated, as generally applicable to the shad in the Potomac, that the average yield of eggs per ripe female was 28,888.

Central Station.—After the eggs had been held at Fort Washington for periods varying from twelve to thirty-six hours, they were forwarded to the Central Station in charge of a special messenger. The total number of eggs thus forwarded was 21,019,000; of which number, 16,536,000 reached the station in good condition, and yielded 14,791,000 fry for distribution. The aggregate number of eggs received at this station did not vary greatly in the past three years, though a little the smallest in 1885, but the production of young for distribution was larger during this last season than in either 1883 or 1884.

Records were kept of the different lots of eggs, thus securing data of their impregnation, temperature of water, time of hatching, &c. From these it is seen that, under the same conditions of temperature, the period of time from impregnation to hatching varied from a few hours to several days, thus indicating that the period of incubation does not simply vary inversely to the temperature as indicated by the thermometer. It is suggested that the increased temperature produced in the eggs by the action of either direct or reflected sunlight, but which cannot be measured accurately by any instruments now known, may have much to do with this varying development. The earlier runs of shad habitually spawn in a lower temperature than those which come later in the season. It may be, therefore, that a difference in the rate of development of separate lots of eggs is to some extent a matter of heredity. In general, however, it seems to be indicated clearly by the record that the lower the temperature during incubation the longer does this period last.

In making the distribution from Central Station, which was done by car and messenger service, care was taken to stock liberally the Potomac, Susquehanna, and many of the lesser tributaries of the Chesapeake, which it was supposed would furnish suitable nurseries for the young fish during the first summer of their existence.

The general planting of shad fry, summarized by regions or drainage basins in which they were deposited, was about as follows:

To tributaries of Chesapeake Bay	8,588,000
To Hudson River	1,250,000
To Palmer River, tributary of Narragansett Bay	825,000
To tributary of Albemarle Sound	1,500,000
To tributaries of the Atlantic south of Albemarle Sound	1,475,000
To minor tributaries of the Gulf of Mexico	2,349,000
To tributaries of the Mississippi River in Illinois	1,104,000
To tributaries of the Mississippi River in Kansas	872,000
To Colorado River of the West, tributary of the Gulf of California	848,000
To tributaries of the Columbia River	60,000
Total	18,871,000

The results of the work of shad production on the Potomac River during the season may be summarized as follows:

Number retained at Fort Washington Station	1,557,000
Number forwarded to Central Station	21,019,000
Total number of shad eggs collected on the Potomac River, season of 1885	22,576,000
Number of eggs received at Central Station in good condition	16,536,000
Number of eggs shipped to other points	325,000
Number of eggs hatched at Central Station	16,211,000

Number of shad fry planted in the Potomac River at Fort Washington Station	1,000,000
Number hatched and distributed from Central Station	14,531,000
Total product for distribution from Potomac River stations	15,531,000

The average loss from impregnation to the period of hatching was 31 per cent.
The average loss during incubation at Central Station was 10 per cent.

The cost of production was, in round numbers, at the rate of $330 for each million shad fry furnished for distribution, or more than 30 young shad for each cent of expenditure.

Battery Station.—This station was continued under the superintendence of Mr. William Hamlen much as it was in 1884. Advantage was taken of every opportunity to make the work successful, and although the results of 1885 were almost three times as great as those of the previous season, the capacity of the station was by no means developed to its utmost.

The system followed in 1884, of fishing the seine by contract, not having resulted so satisfactorily as was hoped, a different plan was adopted and the seine was operated under the direct management of employees of the Commission, an experienced fisherman being engaged to act as captain of the seine.

The season was unusually backward, owing to the prolonged presence of ice in the river. The time during the earlier part of the season, however, was occupied in removing obstructions from the seine-hauls and in getting ready for the season's operations. Frequent storms, the muddy condition of the water, and the troublesome state of the apron upon which the seine was landed were all influential in keeping the catch of shad below what was anticipated. The first haul of the seine was made on April 16, and it was thereafter worked regularly and thoroughly until the 27th of May, during which period one hundred and nine hauls were made; the total catch of shad was 3,512, only 42 being ripe females. During the entire season, which ended on June 11, the total number of eggs obtained from the seine, from gillers, and from other sources was 13,357,000. From these, 10,292,000 fry were hatched and 433,000 were received from the steamer Lookout, making a total of 10,725,000; of which, 5,044,000 were planted in local waters, and 5,681,000 were shipped away by car and messenger service and deposited in various suitable localities.

Experiments were repeated this season in confining unripe shad in the pool, but with little or no success. At intervals the shad were removed and examined, most of them proving utterly unsatisfactory, while the few eggs taken refused to hatch. A troublesome feature was noticed in this connection, in consequence of the water used in the hatching-jars being pumped from this pool. The pollution of the water in the pool caused such danger to the eggs in process of hatching that finally the fish were allowed to escape, after which the eggs resumed their normal condition. This difficulty could be obviated, of course, for another season by getting the supply of water elsewhere; but the experiments thus far conducted in penning shad seem to indicate that this is not an advisable means for obtaining eggs.

Fish Hawk assistance.—In the early work preparatory to opening the season the Fish Hawk, under the command of Lieut. L. W. Piepmeyer, rendered assistance at Battery Station by dragging the seine-haul and clearing it of obstructions. Most of the shad work of this steamer, however, was done on the Delaware River.

As stated elsewhere, on May 23 the vessel was in the Delaware, and from this date to the 10th of June the fishing-shores were visited, information relative to the work was gained, and eggs were collected to the number of 10,604,000. From these, 8,063,000 fry were hatched on board, all of which were deposited in the Delaware River. At the time the Fish Hawk arrived on the Delaware, the fish had evidently been spawning for some time; and with an earlier start the work of the season could have been much increased.

Lookout assistance.—On May 8 the hatching equipment was taken on board the steamer Lookout, commanded by Mate James A. Smith, and on the 13th the vessel proceeded to Battery Station to assist in the operations in that vicinity. This was done by tending gill-boats, transferring spawn-takers to and from suitable points, and in collecting and transferring shad eggs, thus handling 1,406,000 eggs.

From May 17 to June 5 the Lookout was engaged in two trips to the Delaware River and one in the upper part of Chesapeake Bay, procuring eggs and investigating the fisheries, particularly those of the Delaware above Philadelphia. Many fishermen were interviewed as to the condition of the fishery, and the spawn-takers were kept busy in visiting fishing-shores and gill-boats to obtain eggs. The total number of eggs taken by the Lookout during the season was 4,409,000; and from this number 2,115,000 eggs and 454,000 fry were transferred to Battery Station, and 340,000 fry were successfully planted, 190,000 being put into the Delaware River and 150,000 into the Chesapeake Bay and its tributaries.

Experiments in planting shad.—In 1884 a shipment was made to the Colorado River of the West. This experiment was repeated in 1885, and 848,000 fry were planted in good condition. Should these attempts at stocking this region result successfully, the fry deposited in 1884 would probably reappear as mature fish in the spring of 1887 or 1888.

The reasons for selecting the Colorado River for stocking were as follows:

1. The Colorado is free from alkaline salts and of a suitable spring and summer temperature; the other physical conditions are also favorable.

2. The Colorado empties into the Gulf of California, which extends south for 700 miles before reaching the open ocean; and it is thought

that the warm waters of the lower part of the gulf would be a barrier to keep the shad from being lost in the Pacific. The shad then would return to the Colorado and Gila to spawn.

It is believed that the rivers of Washington Territory draining into Puget Sound can be stocked with shad and be made to furnish profitable fisheries, the importance of which to that region can scarcely be overestimated. In order to try the experiment, 900,000 vigorous fry were selected, and sent off with much care, the distance being such as to require all the time during which shad fry can be transported with safety. A detention of three days by the washing away of a bridge resulted in almost total loss, but 50,000 were planted alive in the Willamette River at Portland, Oreg. A small shipment of 10,000 was also planted without any appreciable loss at Ainsworth, Wash., in the Snake River, near where it empties into the Columbia.

The Gloucester City Station.—This station on the Delaware was in operation this year for the first time. The steamer Fish Hawk, commanded by Lieut. L. W. Piepmeyer, secured over 10,000,000 eggs between May 23 and June 10, the period during which she was stationed at this point.

The steamer Lookout, Mate James A. Smith commanding, also procured shad eggs from the Delaware, the greater part of which were transferred to Battery Station.

The following remarks of Mr. A. M. Spangler, a member of the Pennsylvania State Fish Commission, show at once some of the difficulties which are encountered in restocking our streams, as well as the high appreciation of the Pennsylvania commissioners and of the people of Philadelphia of the efforts made by the U. S. Fish Commission in their behalf. Mr. Spangler's letter, dated Philadelphia, June 22, was published in the Philadelphia Press of July 4, 1885, as follows:

Your reporter quotes me as saying that "the feat of the U. S. Fish Commission in dumping millions of young shad into the Delaware was as sensible as throwing them on the Jersey sands." In order that the true meaning of the remark may be understood, it is proper to say that it referred wholly to the planting of shad fry in the Delaware in the immediate vicinity of Gloucester. It is not necessary to state the reasons for such an opinion. They are obvious to all who have given the subject a moment's consideration.

As to the restocking of the Delaware with shad I have only to say that I have the most implicit faith in it, and can only regret that the kindly efforts of the U. S. Fish Commission, supplemented as they have been by those of the fishery commissioners of Pennsylvania and New Jersey, have not met with full appreciation at the hands of many of the residents along the stream.

The shad naturally seeks the upper waters of a stream to do its spawning. Hence that is the place where the young fish hatched on the Fish Hawk or elsewhere should be planted, and there is where I understand the planting is being done. The great drawback to this is that those upper waters abound in fish-baskets, the most infernal contrivance ever devised by man for the destruction of young shad. Though not intended for that purpose, yet such is their certain effect.

I have it on the authority of a former fish commissioner of this State, also upon that of Mr. F. M. Ward, of the New Jersey Commission, that it has not been an uncommon thing for farmers to haul away a wagon-load of small shad intercepted by and drowned in those deadly fish-baskets, and use them for fertilizing purposes. It is to this more than to any other single cause that the gradual and steady decline in the shad yield of the Delaware is attributable.

If the people living along the river were as fully alive to their own and the general public interest as they should be, they would at once and forever rid themselves of those most indefensible violations of statute law; for the law expressly condemns and forbids them. If the State fish commissioners were provided with the means wherewith to compensate wardens, the evil could be remedied; or if the sheriffs and constables of the counties bordering on the river had proper respect for their sworn obligations, the outrages could be prevented. Possibly the legislature will in its wisdom grant the appropriation asked for by our board of State fish commissioners, in in which event fish-baskets will have short leases.

But for the restocking of the Delaware by the commissioners already referred to the shad supply of that river would be much less than it is. With additional hatching facilities, with a proper observance and a somewhat more extended close season, and the complete abolishing of illegal fishing, that supply would certainly be quadrupled. It requires little calculation to demonstrate that such a result would prove hundreds of thousands of dollars in value to the States of Pennsylvania and New Jersey.

Allow me to say in conclusion, then, that the people of Philadelphia, as well as those residing on both sides of the Delaware, from its mouth to its source, owe a large debt of gratitude to Prof. Spencer F. Baird, of the U. S. Fish Commission, for the unselfish and happily successful efforts he and his assistants have been and are making in the behalf of the fishing interests of that stream. The sending of the Fish Hawk into the Delaware, the hatching of shad on board of her, and the shipping to and planting of the young fry in its upper waters, which are the natural spawning-grounds of the shad, are kindnesses and compliments meriting much higher appreciation than appears to have been accorded them by the general public.

The Lambertville Station.—Car No. 3, in charge of J. Frank Ellis, with complete shad-hatching apparatus, arrived here about the first of June and a temporary station was established. It met with fair success during its stay, and left about the middle of July. This is the first time any of the cars of this Commission have been used as a shad hatchery.

Experiments in raising shad in the carp ponds at Washington.—On June 14, 1885, a lot of just hatched young shad, brought over from Central Station in eight fish-cans, was planted in the northwestern part of the west pond, in the so-called old canal. In the same pond, which is about 5 feet deep at one end, were kept 100 good-sized carp which had spawned a fortnight before, and the young carp were in excellent condition.

On July 20 the first young shad was noticed, which was then about half an inch long. Eight days later they were from three-fourths to one inch in length; on August 14 they were from 2 to 2¼ inches long; September 20, from 3 to 4 inches; and October 1, from 4 to 4½ inches in length.

During the summer almost no fish could be seen during the daytime; but after sunset, when they were seeking for food, hundreds were visible jumping about, sometimes leaping about a foot out of water, catching mosquitoes and small flies.

On November 4 the water was drawn out of the pond in order to catch the carp for distribution. The shad found in the pond were from 5 to 7 inches long and from 1 to 1½ inches broad through the body. It is well known that the shad is a very tender fish; and as the water became lower and lower many of them died in the shallow water. Dr. Hessel counted over a thousand that died in this way, though they had plenty of water in which to swim.

He made several attempts to keep a few hundred of the shad alive, but without much success, as nearly all died after being transferred from the pond to the tub or tank. The whole number of shad was about 7,850, of which about 7,500 were sent to the Smithsonian Institution, and 200 of the rest died within two days in a tank with running water. Fifty of the living fry were put in the east pond, where there were no other fish. On December 10, 1885, there were still about 40 alive on the island, in a tank with running water. Efforts to keep them alive by feeding them were made, but without expectation of success, as they want living food, such as small crustaceans, &c., which can scarcely be found in the water during the cold season.

In addition to the shad and carp in the pond, there were also some herring, and winter shad, and about 3,000 young sunfish and 10 large ones. The herring and winter shad came in as spawn or young fry through the fine-wire screen when the supply of water was coming in from the Potomac on April 25. The young sunfish, which were from half an inch to 3 inches long, were the fry of the large ones, which were about 5½ inches long and 3½ inches high from dorsal to ventral fins. The large sunfish were probably thrown in by boys who had caught them from the river, as it does not seem likely that they could have come through the screen on April 25, and the pond had lain entirely dry during the six weeks before this.

On December 11 Mr. Barton A. Bean, speaking of the table qualities of these fish, said: "I have tested the edible qualities of the young shad and have found them palatable and appetizing, I would say similar to the whitebait, but not equal to the anchovy. Quite a number of the National Museum employees tried these fish, and all speak very highly of them."

o. **The River Herring** (*Clupea æstivalis*).

Battery Station.—During the season, 167,125 herring were taken in the seine at this station in connection with the shad work. Some of these were confined in the pool with the shad. Attempts were made to hatch the eggs of the herring, but the apparatus apparently was not adapted for the work and but little success was attained. By careful management, however, about 200,000 fry were produced and planted in the waters near the station.

Central Station.—In addition to the principal work of the station, considerable attention was given to devising a successful method for hatching the adhesive eggs of the herring. Several forms of apparatus were used without success; and it is thought that the failure should be attributed to the low temperature of the water which prevailed during the experiments.

p. **The Smelt** (*Osmerus mordax*).

The Cold Spring Harbor Station.—Considerable success was attained in hatching these eggs, which, on account of their adhesive nature, give a good deal of trouble. The fish were obtained from streams emptying into Great South Bay, and brought to the station during the first week in March, 120 in number, from which about 200,000 eggs were taken. About 50 per cent of the eggs hatched; and 100,000 fry were liberated in different streams near Cold Spring Harbor.

q. **The Tomcod** (*Microgadus tomcodus*).

The Cold Spring Harbor Station.—The eggs of this species which comes close to the shore and along the docks in November and December to spawn, were taken in milk-pans, after the manner of handling trout and similar fishes. These eggs are not adhesive, nor are they so buoyant as those of the codfish. They hatched in about twenty-five days, and the fry, about 210,000 in number, were planted in the harbor.

r. **The Carp** (*Cyprinus carpio*).

The cultivation of carp has come to be among the most important of the operations of the Commission. Good results have been manifested in nearly every State and Territory, and the demand for the species is still maintained.

The Washington Station.—The number of carp raised in Washington, as reported by the superintendent of the ponds, Mr. Rudolph Hessel, was as follows:

Place.	Scale carp.	Leather carp.	Blue carp.
North pond	....	56,000	....
South pond *	....	35,000	....
East pond †	....	192,600	....
West pond	....	50,000	....
Arsenal pond	25,800	....	....
Canal pond	....	10,500	....
Little Island ponds	....	....	1,600
Total	25,800	343,100	1,600

*This pond was drained October 28 and the increase over past years was very gratifying. In 1884, it produced 12,000 leather carp and in 1883 but 7,000.

†In 1883 this pond produced 60,000 carp; and in 1884, 70,000 carp.

The total distribution for the season aggregated 348,784; of which number 187,414 were sent to individual applicants, and 161,370 were distributed to public waters. The number of individual applicants supplied was 6,273; and the distribution was general, including 1,347 counties in 309 Congressional districts. The distribution to public waters embraced the principal river basins of the Middle and South Atlantic States and the Gulf region.

Table of German carp planted in public waters of the United States, from October 27, 1885, to March 26, 1886, inclusive, under the direction of Col. M. McDonald, Chief of the Division of Distribution, U. S. Fish Commission.

State.	Date.	Place at or near which.	Waters stocked.	Number of fish.
Alabama	Dec. 8, 1885	Lake near railroad	Lake on A. and W. P. Railroad	500
Arkansas	Dec. 29, 1885	Fulton	Red River	3,200
Colorado	Dec. 20, 1885	Granada	Arkansas River	5,000
Delaware	Dec. 10, 1885	Wilmington	Brandywine Creek	500
	Dec. 10, 1885	Wilmington	Christiana Creek	500
	Dec. 10, 1885	Wilmington	Delaware River	500
	Dec. 10, 1885	Wilmington	Shellpot Creek	500
Florida	Dec. 5, 1885	Jacksonville	Lakes near Jacksonville	600
Georgia	Dec. 11, 1885	Way Cross	Satilla River	2,400
Illinois	Jan. 2, 1886	Aurora	Fox River	1,000
	Dec. 30, 1885	Carlyle	Kaskaskia River	400
	Jan. 2, 1886	Chicago	Lakes in Lincoln Park	1,600
	Jan. 2, 1886	Chicago	Lakes in South Park	1,050
	Dec. 30, 1885	Clinton	Railroad water-tank	200
	Jan. 1, 1886	Dixon	Rock River	1,000
	Dec. 30, 1885	Equality	Saline River	400
	Jan. 2, 1886	Kankakee	Kankakee River	1,000
	Dec. 30, 1885	Lanesville	Lanesville Lake	800
	Jan. 1, 1886	La Salle	Illinois River	3,000
	Dec. 30, 1885	Louisville	Little Wabash River	200
	Jan. 1, 1886	Mendota	Little Vermilion River	1,000
	Dec. 30, 1885	Mill Shoals	Little Wabash River	400
	Jan. 2, 1886	Naperville	Des Plaines River	200
	Dec. 30, 1885	Pekin	Lake Cooper	100
	Dec. 30, 1885	Riverton	Sangamon River	1,000
	Dec. 31, 1885	Riverton	Clear Lake	1,000
	Dec. 30, 1885	Vandalia	Kaskaskia River	1,000
	Dec. 30, 1885	Wood Lawn	Big Muddy River	400
	Jan. 16, 1886	Ponds near railroad	Ponds of Vandalia R. R	2,520
Louisiana	Jan. 5, 1886	Delhi	Bayou Macon	1,000
	Dec. 7, 1885	La Fourche	Bayou La Fourche	1,000
	Jan. 5, 1886	Monroe	Washita River	2,000
	Jan. 5, 1886	Quebec	Tensas River	1,000
	Jan. 5, 1886	Rayville	Crew Lake	1,000
	Jan. 5, 1886	Richland County	Grassy Lake	1,000
	Dec. 10, 1885	Shreveport	Red River	2,500
	Jan. 5, 1886	Tallulah	Lake One	1,000
Maryland	Nov. 17, 1885	Battery Station	Susquehanna River	20,000
Massachusetts	Oct. 27, 1885	Attleborough	Bungay River	200
	———, 1885	Winchester	Tewksbury Reservoir	600
Minnesota	Nov. 4, 1885	Slayton	Lake Beauty	500
Mississippi	Jan. 5, 1886	Jackson	Pearl River	5,000
New Mexico	Dec. 21, 1885	Albuquerque	Rio Grande River	6,000
Ohio	Dec. 8, 1885	Youngstown	Mahoning River	3,000
	Mar. 26, 1886	Zanesville	Muskingum River	3,750
South Carolina	Dec. 21, 1885	Society Hill	Great Pedee River	600
Tennessee	Nov. 28, 1885	Dyersburgh	Fork of Forked Deer River	1,000
	Nov. 30, 1885	Fowlkes	Fork of Forked Deer River	1,000
Texas	Dec. 12, 1885	San Marcos	San Marcos River	5,050
Virginia	Dec. 4, 1885	Brooke's Station	Acquia Creek	6,250
	Nov. 24, 1885	Charlottesville	Ivy Creek	400
	Nov. 24, 1885	Charlottesville	Rivanna River	1,600
	Dec. 23, 1885	Chatham	Banister River	3,000
	Dec. 23, 1885	Danville	Dan River	6,000
	Nov. 28, 1885	Junction	North Anna River	7,000
	Dec. 23, 1885	Lynch's Station	Staunton River	6,000
	Nov. 27, 1885	Milford	Mattapony River	8,000
	Dec. 23, 1885	Otter River	Otter River	5,000
	Dec. 4, 1885	Potomac	Potomac River	5,500
	Dec. 4, 1885	Quantico	Quantico Creek	6,250
	Nov. 15, 1885	Rockfish Depot	Rockfish Creek	200
	Nov. 28, 1885	Taylorsville	Little River	5,000
	Nov. 28, 1885	Taylorsville	South Anna River	5,000
	Dec. 4, 1885	Wood Bridge	Occoquan River	7,000
		Total number planted		161,370

The following plants and seeds were received at the Carp Ponds of the U. S. Fish Commission at Washington, in March, 1885, from the Royal Gardens at Kew, London:

Plants.—Nelumbium speciosum (1), *Thalia dealbata* (1), *Sagittaria* *heterophylla* (6), *Villarsia nymphæoides* (1), *Polygonum amphibium* (1 bunch), *Ranunculus lingua* (6), *Nymphæa alba* (2).

Seeds.—*Nelumbium speciosum*, *Nymphæa ampla*, *Nymphæa cyanea* (*stellata*), *Nymphæa lotus*, *Victoria regia* (50).

Under date of July 26, Mr. Hessel reported:

"Pond No. 6 now has the richest growth of nelumbiums I ever saw. The vegetation is even with the wire fence and the flowers are about one foot higher, making the growth fully 7 feet high. I counted this morning about 350 open flowers of nelumbiums in this pond. All the nelumbiums in this pond got some bone-dust this spring, and the insects (moths) are almost all destroyed.

The Northville Station.—In the fall of 1884 a Fish Commission car when on a western trip left at Northville 1,000 carp. On January 24 of the present year Mr. Clark reported that 800 of them were still in the ponds, several shipments having been made to individuals and a small number having been lost. The loss was due to the carp being placed in tanks in the house for convenience in shipping. But few orders for shipping having been received, the carp were turned into a vacant pond in January, after which there was no loss. The 800 carp were held primarily for the purpose of answering the calls in the spring from people in Michigan whose ponds were not ready the preceding fall.

s. The Goldfish (*Carassius auratus*).

The Washington Station.—The propagation of Japanese and common goldfish was carried on as usual under the direction of Mr. Hessel. The number of each variety was as follows: (1) Common goldfish, 3,700; (2) Japanese (including fan-tail), 4,600; total, 8,300.

Mr. Henry W. Elliott, writing from Cleveland, Ohio, September 14, 1885, says that the 25 goldfish received from the U. S. Fish Commission he put into his pond last April, and that they were then only 3 inches long. They have grown to 8 inches in length, and produced thousands of young, so that the pond is fairly alive with them. Some of the young fish are nearly 6 inches long already.

Mr. Frank N. Clark, writing on September 21, 1885, says: "From two pairs of Japanese goldfish, received from the U. S. Fish Commission last winter, Mr. J. D. Yerkes has from 500 to 1,000 little fan-tails hatched this summer."

t. The Golden Ide or Orf (*Leuciscus idus*).

The Washington Station.—On account of the unusually low temperature of the water during the spawning season of this fish, which event occurs in May, the spawn was completely destroyed.

The following items are added for the information of persons desiring to cultivate this species:

The golden ide should not be kept in the same pond with carp. The carp make the water muddy and the ides destroy the ova of the carp.

Carp should never be kept in an ide pond if it is desired that such ponds should be clear and that the ides should show to a good advantage.

The golden ide spawns in the neighborhood of Washington in April and the beginning of May, and in cool ponds (spring water) at the end of May. In the Southern States they spawn by the middle of March.

In regard to hatching in ponds, they would do better in large and deep ponds, with a good crowded vegetation, than in small or shallow ponds. The water in such smaller ponds, during cool nights, often attains a low temperature, which would prevent the ova from hatching out advantageously.

The golden ide likes a cool, clear water. Notwithstanding, it can be kept in ponds where the water reaches a higher temperature—from 70° to 80°. In clear, cool water, such as spring water, it will obtain a more brilliant color than in muddy water.

The ide has the habits of a river fish, likes deep better than shallow water. It seeks under plants and stones such food as larvæ, worms, and snails. It takes almost the same food the carp takes, including bread, cooked cornmeal, &c. Green vegetable food it will not take.

u. **The Tench** (*Tinca vulgaris*).

The Washington Station.—The number of tench cultivated in the Washington ponds during the year was as follows: (1) Small pond, 830; (2) north pond, 376; total, 1,206.

v. **The Catfish** (*Amiurus nebulosus*).

During the summer of 1885 several shipments were made to Europe of live specimens of this fish. In June 50 were sent to the German Fishery Association, 49 of which arrived safely and were placed in a pond at Berneuchen. In July 100 were shipped to France, 81 of which reached their destination in excellent condition. Thirty were forwarded to the Netherlands, all being received in the best condition. Fifty were sent in June to the National Fish Culture Association of England, 48 of which survived the journey and were at once placed in the tanks of the association, which is striving to acclimatize this food-fish in the waters of Great Britain. Late in 1884 there were sent to Belgium 100 live catfish, 93 of which were reported in January as doing well in the botanical garden at Ghent. These fish were all taken from the Delaware and Schuylkill Rivers, and were sent from New York by Mr. E. G. Blackford. These attempts bid fair to acclimate the catfish in Europe, which at present has only one species of this fish and that of a different type from ours.

w. **The Little Round Clam** (*Tapes staminea*).

The Wood's Holl Station.—The sending of Fish Commission car No. 2 to Puget Sound with a car-load of shad furnished the opportunity for bringing back live specimens of several species of mollusks indigenous to that region. The car left Washington on June 2, and Mr. Moore was instructed to secure specimens of *Glycimeris generosa*, *Saxidomus nut-*

tallii, *Schizothœrus nuttallii*, and *Tapes staminea*. As it was doubtful whether the proper arrangements could be made for carrying the first-named species, experiments were to be confined to the last three. Special instructions for their care were furnished by Prof. R. E. C. Stearns, of the National Museum, whose contributions to the subject have several times appeared in the Fish Commission Bulletin. Mr. Moore was instructed to remain at Puget Sound two or three weeks, if necessary, in order to make such preliminary experiments as would satisfy him that a transcontinental trip could be made successfully. On June 26 Mr. Moore arrived at Wood's Holl with about 500 live *Tapes staminea*, the survivors of about 4,000 with which he started from Tacoma. It is hoped to save enough of them to plant a colony at Wood's Holl and another at Provincetown, Mass.

As illustrative of the facility with which clams may be introduced in localities which have favoring conditions, some facts which were brought to light by Mr. Stearns may be here recited. Mr. Donald Macleay, president of the Board of Trade, Portland, Oreg., forwarded to the National Museum in February of the present year a box of clams for identification. He stated that they were eastern clams found at Shoalwater Bay, Washington Territory, and they proved to be *Mya arenaria*. They had been introduced into Shoalwater Bay by Captain Simpson, a public-spirited citizen of San Francisco, and a member of the firm of Simpson Bros., lumber dealers. Captain Simpson obtained the clams near San Francisco (where this species had previously been introduced and is now abundant), and they were sent on a lumber vessel to Washington Territory, where after their introduction they multiplied extensively and were abundant as early as May, 1884. The *Mya arenaria* being an eastern species the question of course arises how it came on the Pacific coast. To which question Mr. Stearns makes reply that following the completion of the transcontinental railroad, about 1869–'70, some of the oyster firms in San Francisco imported small oysters (*Ostrea virginica*) from the Atlantic Coast and planted them in the bay, where they soon attained a good merchantable size. With these importations of small oysters the spat of *Mya arenaria* undoubtedly was accidently introduced to the Pacific coast.

x. The Oyster (*Ostrea virginica*).

The Saint Jerome Station.—This station remained under the superintendence of Mr. Wm. de C. Ravenel during the year, and experiments were continued in collecting the spawn and artificially raising the young oysters. Spawning operations were begun on June 20, and from then until the end of August oysters were opened every day. Young oysters were found twenty-eight days after the first lot of spawn was put into the ponds. The results of the experiments indicate that it is of great importance that the ponds should have the full rise and fall of the tides, which is exceedingly difficult where the water has to be carefully filtered to prevent the passing of spawn. The collectors on which the best results were obtained were pieces of mortar-coated slate placed in wire trays resting on trestles about 8 inches high. Full details regarding the tides, temperatures, weather, and density of water may be found in the table appended to Mr. Ravenel's report.

The Cold Spring Harbor Station.—At this station, which is more particularly under the direction of Mr. E. G. Blackford, representing the New York State Commission, Mr. Mather carried on some very successful experiments. On August 31 he reported that he had used a wooden tank 6 by 12 feet containing water pumped from the harbor for collecting spat and that at that date sets on shells and gravel, four weeks old, were one-eighth of an inch long.

Investigation in New York waters.—From the 15th to the 26th of August Mr. E. G. Blackford was engaged in an investigation into the oyster fisheries of New York waters, aided by the steamer Lookout, during which time seven different localities were visited.

The first trip was to the eastern end of Long Island. In the vicinity of Montauk Point the ponds were found to contain but few oysters and these almost without flavor. Near Greenport a plan was in operation in accordance with which oysters were systematically cultivated by individuals and companies, most of the seed being brought from Connecticut. The most serious evil against which the planters had to contend was the starfish. In the kills emptying into New York Bay it was found that much damage was done to the oysters by the acid and oily refuse poured into the waters from the factories along the shores and by the general pollution of the water. The condition of the oysters at Execution Light-house Rock showed a considerable improvement over that of last year, although not much young growth was found. During the trip up the Hudson several dredgings were made on the different beds, generally showing them to be in a fair condition, but frequently showing more or less green coloration. All of the beds of the Hudson are worked for the purpose of obtaining seed with which to plant other beds, as these oysters do not fatten well until transplanted, though many are used for local consumption. In Port Jefferson Harbor much of the bottom is leased and cultivated by private parties, and the beds are generally well cared for and in good condition, the growth not being great but the quality excellent. Most of the seed in the harbor comes from the Connecticut beds, it being generally from one to three years old, and from 200 to 300 bushels per acre being used. Outside the harbor the oysters had been destroyed by starfish or some other enemy. In Prince's Bay and its vicinity oysters were found of good size and in fair number, but usually thin and greenish and sometimes of unpleasant flavor. Much damage is done by the dredgings and the dumping of refuse over or in the neighborhood of the oyster-beds. In the face of such difficulties, the propagation of the oyster, while not to be despaired of, must be a patient and somewhat unpromising matter.

y. The American Lobster (*Homarus americanus*).

Attention has already been called in the report of the Commissioner for 1883 to the increasing scarcity of the American lobster and the danger of its practical extinction as an article of commerce within a comparatively short time. Investigations that have been made clearly indicate that the abundance of lobsters, as well as their average size, has been rapidly decreasing from year to year on many portions of the coast where the fishery has been vigorously pushed. A study of their habits shows that such a decrease is far more possible with lobsters than with the true fishes, which are, as a rule, more secure from the attacks of man.

All the States interested in the lobster fishery, except New Jersey, whose fishery is small, have enacted protective laws, but they have failed to stop the diminution, though they may have checked it somewhat. As a result, we are already more or less dependent on the British Provinces for the supplies of our larger markets. The same trouble with the lobster supply exists in Europe, where this fishery has been controlled by legislation for many years. In Norway, which country has the most important European fishery, as a last resort they have sought relief in artificial lobster culture, and experiments in this have been carried on there since 1873. One of the strongest evidences of decrease in the abundance of our lobsters is found in the continual diminution in the size of those sent to the markets, the greater portion of the lobsters now canned being less than 10 inches in length. An investigation shows that there is a steady demand for lobsters of all sizes, and that but a limited protection is afforded by either laws or custom.

The Delaware Breakwater may be regarded as practically the southern limit of the range of the American lobster, though a few specimens have been found south of this; while it was formerly most abundant along the coast of New England, and especially off the coast of Massachusetts, in suitable localities. Maine is now the principal source of supply for all the larger markets of the country, the yearly fishery of that State greatly exceeding in quantity and value those of all the other States combined. Lobsters are not known to migrate, except over very short distances, mainly in the spring and fall, when they change their grounds, moving into deeper water on the approach of cold weather, and returning in late spring nearer to the shore, where the shallower grounds probably furnish a better supply of food.

Lobsters are found during the entire year with spawn attached to the abdomen. This fact is recorded of both the American and the European species, but the length of time this spawn is carried before hatching and the limits of the hatching season are not precisely known. From observations made by fishermen it seems that the eggs hatch in the wells of their smacks in the greatest abundance during May, June, and July, and that the hatching at other seasons is only an accidental or occasional occurrence. It is also not at all inprobable that the young hatched during cold weather perish soon after they leave the egg. The hardy character of the eggs, which appear well adapted to endure the hardships of a long winter, favors the idea of a long period of development.

In the United States the only practical attempts, previous to those of the Fish Commission, towards the artificial propagation of lobsters have been in connection with their "parking," that is, their protection in large inclosed natural basins, in which lobsters that have been injured, soft-shelled individuals, those below salable size, and occasionally females with spawn, have been placed and reared for the markets. Two such parks have been specially called to our attention; one on the coast of Massachusetts, established in 1872 and afterwards abandoned; the other on the coast of Maine, established about 1880, which is believed to be still in operation. The effect of such establishments upon a general increase of supplies would probably never be very great.

The Wood's Holl Station.—The partial completion last August of the new laboratory building at Wood's Holl, with its convenient system for the distribution of salt water, permitted the beginning of the needed experiments in the artificial hatching of lobsters. Unfortunately the hatching season had then closed, but it was deemed advisable to ascertain the best methods of handling the eggs in order that there might be as little delay as possible in beginning operations in the spring of 1886. The problem of lobster hatching on a practical scale is one that the Fish Commission has long had in view, but all of its marine laboratories heretofore have been temporary structures with insufficient accommodations and without the means for obtaining continuous supplies of water in suitable quantities. The hatching of small quantities of lobster eggs, as well as the eggs of other kind of crustaceans, had been successfully accomplished by members of the Fish Commission interested in biological studies, and the possibility of doing this on a small scale, and of carrying the young through at least the first few stages of growth, needed no further proof; but the question now is as to doing it on a scale great enough to influence practically the supply of lobsters in our markets.

As the eggs of the lobster have a specific gravity that is considerably greater than that of water, the apparatus selected for the first experiments was the McDonald automatic hatching-jar, and a trial of about two months demonstrated its superiority over the other appliances tested. It does not seem practicable to keep the eggs of more than one lobster in each jar, as the eggs of different individuals vary more or less in specific gravity, and it is impossible to regulate the flow of water so as to give them all the required motion. The number of fertilized eggs carried by a lobster during the spawning season has been ascertained by careful computations in several cases, and varies from 12,000 to 24,000, the number generally being between 15,000 and 18,000; the eggs are comparatively large, measuring about one-twelfth of an inch in diameter.

The chief annoyances to the hatching work at Wood's Holl were iron-rust in the pipes and sediment from the harbor. The difficulty with the iron-rust was overcome to some extent by the substitution of cement-lined pipes, but the eggs were saved from injury by the sediment only by the exercise of constant care. The experiments made so late in the season at Wood's Holl may be regarded as fairly successful, but had they been undertaken during the proper hatching season more satisfactory results would undoubtedly have been reached. The principal object in hatching the eggs in jars is to have the embryos under control immediately after hatching; but the best methods of caring for the young have yet to be decided upon, and present an interesting problem for future investigation. It is not known how long the young can be kept in confinement, nor at what age it would be advisable to turn them over to the care of nature, but it will probably be possible to transport them alive to any other portion of the New England coast.

Summary of distribution of fish and eggs by the U. S. Fish Commission during the season of 1885.

Whitefish (*Coregonus clupeiformis*):	
Eggs	*42,800,000
Fry	†92,000,000
Brook trout (*Salvelinus fontinalis*):	
Eggs	*145,000
Fry	*25,000
Large fish	*550
Lake trout (*Salvelinus namaycush*):	
Eggs	*1,031,000
Fry	*75,500
Large fish	**1,791
Rainbow trout (*Salmo irideus*):	
Eggs	††281,000
Fry	**250
Large fish	‡‡4,664
Atlantic salmon (*Salmo salar*):	
Eggs	§1,251,500
Fry	‖419,550
Landlocked salmon (*Salmo salar* subsp. *sebago*):	
Eggs	‡222,000
Fry	§§41,500
Brown trout (*Salmo fario*):	
Fry	‖28,900

* From Northville Station.

† From Northville and Alpena Stations.

‡ From Grand Lake Stream Station.

§ From Bucksport Station.

‖ From Cold Spring Harbor Station.

** From Wytheville Station.

†† Of these 5,000 were from Northville Station, 246,000 from McCloud River Station, and 30,000 from Wytheville Station.

‡‡ Of these 3,364 were from Northville Station, and 1,300 from Wytheville Station.

§§ Of these 22,000 were from Northville Station, and 19,500 from Cold Spring Harbor Station.

Shad (*Clupea sapidissima*):	
Eggs	*325,000
Fry	†34,659,000
Carp (*Cyprinus carpio*):	
Fry to public waters	*161,370
Fry to private ponds	*187,414
Goldfish (*Carassius auratus*)	*4,344
Black bass (*Micropterus dolomiei*)	‡500
Red-eye perch (*Ambloplites rupestris*)	‡250
Total	173,666,083

D.—ABSTRACT OF THE ARTICLES IN THE APPENDIX.

32.—CLASSIFICATION OF ARTICLES.

In the general appendix to this report will be found a series of twenty-five separate papers treating upon matters relating to the work of the Fish Commission. These are classified under five headings, as follows:

A.—Reports of Steamers and Stations.

The first article is by Lieut.-Commander Z. L. Tanner, and gives a full account of the work of the steamer Albatross during 1885 in the Gulf of Mexico, on the Newfoundland fishing banks, and along the coast, illustrated by five plates and provided with a special index. In this report are also included subordinate reports by Lieut. Seaton Schroeder on navigation, Passed Assistant Engineer G. W. Baird on all matters pertaining to the machinery of the vessel, Surgeon James M. Flint on the medical department, Mr. James E. Benedict on the scientific work of the naturalists, and also various tables of temperatures, specific gravities, stations occupied, records of dredgings and trawlings, and lists of fishes, invertebrates, &c., taken. The second report is by Lieut. L. W. Piepmeyer on the work of the Fish Hawk during the year 1885, followed by a report on the operations of the Lookout during the year, by Mate James A. Smith. The ten papers which follow relate chiefly to the hatching and propagating operations of the Fish Commission, and are composed of reports from the persons charged with the work of propagation, distribution, or investigation. They consist of a report of the operations of the trout-breeding station at Wytheville, Va., from its occupation in January, 1882, to the close of 1884, by Col. Marshall McDonald; two reports of fish hatching and shipments, and an account of eggs shipped to and received from foreign countries during 1885 and a part of 1886, at the Cold Spring Harbor Station, by Mr. Fred Mather; the operations at the Northville and Alpena Stations during the season

* From Central Station.

† Of these 15,531,000 were from Central Station, 10,725,000 from Battery Station, 8,063,000 from steamer Fish Hawk, and 340,000 from steamer Lookout.

‡ From Wytheville Station.

of 1885–'86, by Mr. Frank N. Clark; the operations at the United States salmon and trout stations on the McCloud River, in California, for 1885, by Mr. Livingston Stone; two reports on the work in Maine (on the propagation of Penobscot salmon and Schoodic salmon) by Mr. Charles G. Atkins; a report on an oyster investigation in New York waters with the steamer Lookout, by Mr. Eugene G. Blackford, one of the fish commissioners of New York; the operations at the Saint Jerome oyster-breeding station, by Mr. William deC. Ravenel; and a report on the thermometers of the U. S. Fish Commission, by Dr. J. H. Kidder.

B.—The Fisheries.

The four articles in this section are of a more general nature, three of them pertaining to the fishing industries of European countries. The first is a report by Capt. Joseph W. Collins on the discovery and investigation of the fishing-grounds visited by the steamer Albatross during a cruise along the Atlantic coast and in the Gulf of Mexico, with notes on the Gulf fisheries, having special reference to the fisheries off the west coast of Florida. This is illustrated by ten plates, and has a special index. A paper follows containing extracts from the Norwegian fishery statistics for 1884, by Boye Strom. The next article is a translation from the Norwegian Fishery Gazette on the manufacture of klipfish, which treats of the salting and drying of codfish in general, but with more particular reference to the process as carried on in Norway. The last paper is an extract from the report of G. Bouchon-Brandely to the French minister of marine and the colonies, on pearls and mother-of-pearl at Tahiti and the Tuamotu Archipelago, which gives a very good idea of this new and growing industry in the South Pacific.

C.—Oyster Culture.

The one article in this section it is hoped will prove of remarkably practical value, in that it contains an exposition of the principles of a rational system of oyster culture, together with an account of a new and practical method of obtaining oyster spat on a scale of commercial importance. It is by Prof. John A. Ryder, is illustrated by four plates, and is provided with a special index.

D.—Scientific Investigation.

Of the five papers in this section, the first is a report by Sidney I. Smith on the decapod crustacea of the Albatross dredgings off the east coast of the United States during the summer and autumn of 1884, illustrated by twenty plates and having a special index. The next is an article by John A. Ryder on the development of the cetacea, together with a consideration of the probable homologies of the flukes of cetaceans and sirenians. This is furnished with three plates, and has also an index of its own. The following article is also by Mr. Ryder, on the development of osseous fishes, including marine and fresh-water forms, which is illustrated by thirty plates. The next paper is by Prof. H. E. Webster and James E. Benedict, on the Annelida Chætopoda, from Eastport, Me., which has eight plates and is provided with a special index. The last paper is by John Murray and A. Renard on the nomenclature, origin, and distribution of deep-sea deposits, which was read before the royal society of Edinburgh.

E.—MISCELLANEOUS.

The first of the two articles in this section is a catalogue of the fishes known to inhabit the waters of North America north of the Tropic of Cancer, with notes on the species discovered in 1883 and 1884, by Prof. David S. Jordan, which is provided with a valuable special index of forty-three pages. The last article of the appendix is by Robert G. Dyrenforth, giving a list and description of the patents issued by the United States during the years 1882, 1883, and 1884, which relate to fish and the methods, products, and applications of the fisheries, the article being illustrated by one hundred and fifty pages of plates.

This series of twenty-five papers contains many of high value, and is illustrated by two hundred and thirty plates. Seven of the longer articles are provided with special indexes, as it is often desirable to issue these papers in separate pamphlet form for distribution to specialists not interested in the contents of the entire volume.

E.—SUPPLEMENT TO THE REPORT PROPER.

33.—LIST OF LIGHT-HOUSE KEEPERS RENDERING ASSISTANCE.

The following is a list of the light-houses (with their keepers) at which temperatures and the occurrences of ocean fish have been observed during a portion or all of the present year:

List of light-houses on the Atlantic coast at which ocean temperatures have been taken during the year 1885, *together with the number of monthly reports made at each one.*

Petit Manan light-house, Petit Manan Island.
George L. Upton, Millbridge, Me 12
Mount Desert light-house, Mount Desert Rock.
Thomas Milan, Southwest Harbor, Me 12
Matinicus Rock light-house, Penobscot Bay.
William G. Grant, Matinicus, Me 12
Seguin light-house, Seguin Island, Kennebec River.
Thomas Day, Hunnewell's Point, Me 12
Boon Island light-house, Boon Island, Me.
Alfred J. Levitt, box 808, Portsmouth, N. H 12
Minot's Ledge light-house, Cohasset Rocks, Boston Bay.
Frank F. Martin, Cohasset, Mass 12
Race Point light-house, Cape Cod Bay.
James Cashman, Provincetown, Mass. (Thomas V. Mullins reported October, November, and December) 12
Pollock Rip light-station, entrance to Vineyard Sound.
Joseph Allen, jr., South Yarmouth, Mass 12

Nantucket New South Shoal light-station, Davis New South Shoal.
Andrew J. Sandsbury, Nantucket, Mass 12
Cross Rip light-station, Vineyard Sound.
Luther Eldridge, Chatham, Mass 11
Buoy Depot, Government wharf, office of light-house inspector.
Benjamin J. Edwards, Wood's Holl, Mass 12
Vineyard Sound light-station, Sow and Pigs Rocks.
William H. Doane, 13 Kempton street, New Bedford, Mass 12
Brenton's Reef light-station, off Brenton's Reef and Newport Harbor.
Charles D. Marsh, 54 John street, Newport, R. I 12
Block Island light-house, southeast end of Block Island.
H. W. Clark, Block Island, R. I 12
Bartlett's Reef light-station, Long Island Sound.
Daniel G. Tinker, New London, Conn 12
Stratford Shoals light-house, Middle Ground, Long Island Sound.
James G. Scott, Miller's Place, Suffolk County, N. Y. (Ezra S. Mott reported September, October, November, and December) 12
Fire Island light-house, south side of Long Island.
Seth R. Hubbard, Bay Shore, N. Y 11
Sandy Hook light-house, entrance to New York Bay.
R. H. Pritchard, 120 Spencer street, Brooklyn E. D., N. Y 12
Absecom light-house, Absecom Inlet.
A. G. Wolf, Atlantic City, N. J 12
Five-Fathom Bank light-station, off Delaware Bay.
William W. Smith, Cape May, N. J 12
Fourteen-Foot Bank light-station, Delaware Bay.
Ed. A. Howell, Delaware City, Del 8
Winter-Quarter Shoal light-station, Chincoteague Island, Va.
C. Lindemann, Brooklyn E. D., N. Y 12
York Spit light-house, Chesapeake Bay.
James K. Hudgins, Port Haywood, Va 12
Wolf-Trap Bar light-house, Chesapeake Bay.
John L. Burroughs, New Point, Matthews County, Va 12
Stingray Point light-house, Chesapeake Bay.
Charles F. Sadler, Hudgins, Va 12
Windmill Point light-house, mouth of Rappahannock River.
James G. Williams, Hudgins, Va 12
Point Lookout light-house, mouth of Potomac River.
William Yeatman, Cornfield, St. Mary's County, Md 12
Body's Island light-house, north of Cape Hatteras.
Peter G. Gallop, Manteo, Dare County, N. C 12
Cape Lookout light-house, Cape Lookout.
Denard Rumley, Beaufort, N. C 12
Frying-Pan Shoal light-station, Cape Fear.
Henry Swan, Smithville, N. C 12
Rattlesnake Shoal light-station, off Charleston.
John McCormick, Charleston, S. C 12
Martin's Industry light-station, off Port Royal.
John Masson, Beaufort, S. C 12
Fowey Rocks light-house, Fowey Rocks.
John J. Larner, Miami, Fla 12
Carysfort Reef light-house, Florida Reefs.
Martin Weatherford, Key West, Fla 12
Dry Tortugas light-house, Loggerhead Key.
Robert H. Thompson, Key West, Fla 12

34.—LIST OF RAILROADS FURNISHING TRANSPORTATION AT REDUCED RATES.

It has already been mentioned that the railroads of the country in general have transported the cars of the Commission at a rate of 20 cents per mile, this including the fare of five messengers—a figure very much less than the usual charge for such service, and showing the favorable consideration entertainted by the companies toward the work of the Commission. For many thousands of miles the service has been conducted without any cost whatever to the Commission. The only road that charged more than 20 cents per mile is the Union Pacific.

List of railroads that moved cars, and messengers to the number of five accompanying, at the rate of 20 cents a mile during the year 1885.

	Miles.
Alabama Great Southern Railroad; Chattanooga, Tenn	143
Boston and Albany Railroad; Springfield, Mass	800
Central Railroad of Georgia; Savannah, Ga	690
Charlotte, Columbia and Augusta Railroad; Columbia, S. C	489
Chesapeake and Ohio Railway; Richmond, Va	1,032
Chesapeake, Ohio and Southwestern Railway; Louisville, Ky	392
Chicago, Burlington and Quincy Railroad; Chicago, Ill	374
Chicago, Milwaukee and Saint Paul Railway; Milwaukee, Wis	1,220
Chicago and Northwestern Railway; Chicago, Ill	580
Chicago, Saint Louis and Pittsburg Railroad; Pittsburg, Pa	381
Columbia and Greenville Railroad; Columbia, S. C	107
Cumberland Valley Railroad; Chambersburg, Pa	222
Delaware, Lackawanna and Western Railroad; New York, N. Y	154
East Tennessee, Virginia and Georgia Railroad; Knoxville, Tenn	242
Georgia Railroad; Augusta, Ga	171
Illinois Central Railroad; Chicago, Ill	1,756
Indianapolis, Decatur and Springfield Railway; Indianapolis, Ind	153
Louisville and Nashville Railroad; Louisville, Ky	127
New York Central and Hudson River Railroad; New York, N. Y	298
New York, New Haven and Hartford Railroad; New York, N. Y	240
New York, Providence and Boston Railroad; Stonington, Conn	128
New York, West Shore and Buffalo Railway; New York, N. Y	705
Norfolk and Western Railroad; Philadelphia, Pa	727
Ohio and Mississippi Railway; Cincinnati, Ohio	43
Pennsylvania Railroad; Philadelphia, Pa	15,329
Pittsburg, Cincinnati and Saint Louis Railway; Pittsburg, Pa	5,715
Richmond and Danville Railroad; Richmond, Va	2,628
Richmond, Fredericksburg and Potomac Railroad; Richmond, Va	40
Saint Louis, Keokuk and Northwestern Railway; Keokuk, Iowa	262
Savannah, Florida and Western Railway; Savannah, Ga	666
Shenandoah Valley Railroad; Philadelphia, Pa	909
Terre Haute and Indianapolis Railroad; Terre Haute, Ind	3,334
Union Pacific Railway; Omaha, Nebr	2,603
Virginia Midland Railway; Alexandria, Va	4,506
Wabash, Saint Louis and Pacific Railway; Saint Louis, Mo	902
Western Railway of Alabama, and Atlanta and West Point Railroad; Montgomery, Ala	525
Total	48,593

Concessions of free transportation for cars and messengers, and every facility for the convenience and expedition of the work of distribution, have been afforded by sixteen roads. The aggregate number of miles of free t'ansportation received was 26,212.

List of railroads that moved cars, and messengers to the number of five accompanying, free of charge during the year 1885.

	Miles.
Atchison, Topeka and Santa Fé Railroad; Topeka, Kans	4, 134
Atlantic and Pacific Railroad; Albuquerque, N. Mex	1, 952
Chicago and West Michigan Railway; Muskegon, Mich	54
Detroit, Grand Haven and Milwaukee Railway; Detroit, Mich	288
Flint and Pere Marquette Railroad; East Saginaw, Mich	1, 972
International and Great Northern Railroad; Saint Louis, Mo	932
Lake Shore and Michigan Southern Railway; Cleveland, Ohio	98
Michigan Central Railroad; Detroit, Mich	1, 892
Milwaukee, Lake Shore and Western Railway; Milwaukee, Wis	106
Missouri, Kansas and Texas Railway; Saint Louis, Mo	1, 252
Missouri Pacific Railway; Saint Louis, Mo	2, 034
Northern Pacific Railroad; Saint Paul, Minn	7, 498
Oregon Railway and Navigation Company; Portland, Oreg	916
Saint Louis, Iron Mountain and Southern Railway; Saint Louis, Mo	490
Texas and Pacific Railway, Dallas, Tex	2, 064
Utah Central Railway; Salt Lake City, Utah	530
Total	26, 212

35.—SUMMARY OF FISH DISTRIBUTED TO PUBLIC WATERS FROM 1872 TO 1882, INCLUSIVE, BY THE U. S. FISH COMMISSION.

The following table shows a total of 341,096,971 fish distributed to public waters during the first 11 years of the existence of the Commission:

Waters stocked.	Atlantic salmon.	California salmon.	Landlocked salmon.	Salmon trout.	California trout.
From Saint John River to Merrimac River, inclusive	5, 851, 139	754, 700	2, 849, 412	....	2, 000
Massachusetts Bay to Cape Cod Bay, inclusive	45, 060	138, 000	448, 100	....	....
Buzzard's Bay to Block Island Sonnd, inclusive	704, 597	363, 000	324, 100	....	....
Connecticut River and tributaries	1, 979, 086	740, 000	724, 861	....	....
Long Island Sound, exclusive of Connecticut River	363, 937	410, 186	501, 949	....	....
Hudson River and tributaries	568, 300	193, 500	43, 250	....	....
From Hackensack River to Sandy Hook Bay, inclusive	111, 000	188, 000	48, 150	....	....
From Sandy Hook Point to Cape May, inclusive	....	119, 000	....	....	....
Delaware Bay	906, 822	1, 954, 629	176, 819	2, 000	....
From Cape Henlopen to Cape Charles	....	13, 000	....	....	....
Chesapeake Bay	463, 796	5, 041, 544	178, 175	....	38, 000
Albemarle Sound	....	176, 000	6, 450	....	....
Pamlico Sound	....	10, 200	600	....	....
From Cape Fear River to Altamaha River, inclusive	11, 000	1, 015, 500	28, 525	35, 000	4, 000
Gulf of Mexico east of the Mississippi River	....	89, 500	....	....	....
Mississippi River and tributaries	2, 162, 100	5, 835, 760	444, 650	3, 600	22, 000
Gulf of Mexico west of the Mississippi River	....	92, 600	....	....	....
Pacific coast	....	13, 183, 000	33, 647	....	....
Great Lakes and Saint Lawrence River	987, 100	1, 955, 315	378, 510	....	39, 102
Miscellaneous	265, 950	899, 300	217, 763	....	11, 728
Total	12, 519, 887	33, 172, 734	6, 404, 961	40, 600	116, 830

Waters stocked.	Brook trout.	Shad.	Whitefish.	Herring.	Miscellaneous.
From Saint John River to Merrimac River, inclusive	....	3,123,500	775,000	....	10,000 *Salmo salar* × *S. salar* var. *sebago*.
Massachusetts Bay to Cape Cod Bay, inclusive	....	300,000	....	....	
Buzzard's Bay to Block Island Sound, inclusive	....	2,172,000	....	....	
Connecticut River and tributaries	....	9,661,000	75,000	....	
Long Island Sound, exclusive of Connecticut River	....	190,000	7,000	....	
Hudson River and tributaries	....	1,133,000	45,000	....	
From Hackensack River to Sandy Hook Bay, inclusive	....	....	90,000	....	
From Sandy Hook Point to Cape May, inclusive	....	....	....	....	
Delaware Bay	....	1,538,000	45,000	....	
From Cape Henlopen to Cape Charles	....	50,000	....	....	4,500 Rhine salmon.
Chesapeake Bay	27,200	134,032,850	....	7,833,000	25,000 codfish, 270,000 Spanish mackerel, 5,000 Rangeley trout, and 180,000 white perch.
Albemarle Sound	....	8,778,900	....	....	400,000 rockfish.
Pamlico Sound	....	1,300,000	....	....	
From Cape Fear River to Altamaha River, inclusive	....	7,997,100	....	....	
Gulf of Mexico east of the Mississippi River	....	5,628,000	....	....	
Mississippi River and tributaries	41,000	18,788,400	575,000	....	7,500 Rangeley trout.
Gulf of Mexico west of the Mississippi River	....	2,469,000	....	2,000,000	
Pacific coast	....	619,000	510,000	....	
Great Lakes and Saint Lawrence River	20,000	3,160,400	72,785,000	....	409 moranke.
Miscellaneous	....	5,200	2,165,000	....	
Total	88,200	200,946,350	77,072,000	9,833,000	902,409

36.—CIRCULAR TO PERSONS ENGAGED IN THE COD, HALIBUT, AND OTHER GROUND FISHERIES.

The following circular was widely distributed to fishermen and owners of vessels during November, 1885:

UNITED STATES COMMISSION OF FISH AND FISHERIES,
Washington, D. C., November 1, 1885.

The temporary arrangement made between the Governments of the United States and of Canada, providing for the continuance, in a modified form, of the present international fisheries treaty, makes accurate information in regard to the fisheries of 1885 of very great importance. All persons interested are therefore earnestly requested to render their aid in having ready the necessary data for any future international action. With this object the accompanying blank has been prepared, and will be distributed through Mr. W. A. Wilcox, assistant to the United States Fish Commission, at Gloucester, Mass., from whom any number of copies can be obtained. Any information, when so requested, will be considered strictly confidential, but will be collated in the digest to be made at the close of the fishing season.

The complete record of your port should be sent to Mr. Wilcox immediately.

Any matters of record, prices, &c., not covered by the questions, will add to the value of the return.

SPENCER F. BAIRD,
U. S. Commissioner of Fish and Fisheries.

[Blanks when filled, and other information on the subject, should be sent to W. A. Wilcox, United States Fish Commission, Gloucester, Mass.]

COD, HALIBUT, AND OTHER GROUND FISH.

Port of ———, ———. *Season of* 1885.

	No. of vessels.	Tonnage.	Codfish.	Halibut.	Other ground fish.
			Pounds.	*Pounds.*	*Pounds.*
Number of vessels that fished on Banquereau, Flemish Cap, Grand, La Have, and Western Banks					
Number of vessels that fished on George's and Brown's Banks					
Number of vessels that fished off Nova Scotia shore					
Number of vessels that fished off Greenland and Iceland					
Number of vessels that fished in the Gulf of St. Lawrence					
Number of vessels that fished off New England shore					
Number of vessels, unregistered, that fished off New England shore					
Number of small boats, unregistered, that fished off New England shore					

As some of the above fished on the several grounds, please give total number of registered vessels and tonnage in cod and ground fishing, ———.

Total number of men fishing on vessels and in boats, ———.

Total amount of halibut caught within three miles of provincial shore, and where taken, ———.

Total amount of cod and other ground fish caught within three miles of provincial shore, and where taken, ———.

Kind of bait used, ———.

Quantity and amount paid for bait in the provinces, ———.

Quantity and amount paid for bait in the United States, ———.

Quantity and amount paid for ice in the United States, ———.

Quantity and amount paid for ice in the provinces, ———.

Amount paid for supplies purchased in the provinces, ———.

Amount paid for other expenses in the provinces, with items, ———.

Total value of fishing vessels and boats from your port, ———.

Total value of outfits on vessels from your port, ———.

Number of new vessels for above fishing past year, ———; and tonnage, ———.

Number of vessels for above fishing lost past year, ———.

Number of lives for above fishing lost past year, ———.

Insurance on vessels lost for above fishing past year, ———.

It is important that this should be filled up as near as possible, and returned *at once.* Do not lay it aside, but please give it your *immediate attention.* Any answer or information requiring more space please mention on opposite page.

(Signed)

——— ———.

APPENDIX A.

REPORTS OF STEAMERS AND STATIONS.

I.—REPORT ON THE WORK OF THE UNITED STATES FISH COMMISSION STEAMER ALBATROSS FOR THE YEAR ENDING DECEMBER 31, 1885.

BY LIEUT.-COMMANDER Z. L. TANNER, U. S. N., COMMANDING.

The Albatross was at the navy-yard, Norfolk, Va., at the close of my last annual report, December 31, 1884. All preparations for sea had been completed, and we were waiting the arrival of the naturalists who were to join us for the winter's cruise. They arrived on the morning of January 3, 1885, the party being composed of Messrs. Benedict, Bean, Collins, and Lee.

We left the navy-yard at 2.25 p. m., and proceeded to sea under the following orders:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., December 20, 1884.

Capt. Z. L. TANNER,
Commanding steamer Albatross,
Navy-Yard, Washington, D. C.

SIR: After making the necessary preliminary arrangements, you will start from Washington, in the Albatross, on or about January 5, 1885, and proceed to the Gulf of Mexico, for the purpose of making a careful investigation into the food-fishes and the fisheries of that body of water.

If circumstances favor, you will make a trial of the trawl-line at Cape Hatteras for the tile-fish, selecting the most suitable region known to you.

In proceeding to the Gulf of Mexico, you are at liberty to touch at any of the principal Atlantic or Gulf ports for supplies, or for such other purposes as you may deem expedient. On all such occasions you will report, by telegraph, your arrival, probable length of stay, and time of departure.

Letters will be sent to you at Key West and New Orleans, at which points inquiry should be made for them.

The general plan of the service in question is left to your discretion. When you touch at Pensacola, you will call upon Mr. Silas Stearns, of the fishing firm of Warren & Co., and ask suggestions from him in regard to the best points for exploration. This gentleman has kindly agreed to accompany the vessel on one of its cruises, and you will accordingly make the necessary arrangements.

You will endeavor to ascertain the reasons why the various food-fishes affect particular localities, so as to obtain data for deducing the probable occurrence of certain fishes on grounds ascertained to possess the appropriate food or physical characteristics. You will locate on the charts the known banks where the fish are found, as well as the new ones that may be discovered.

The fullest information as to the habits and characteristics of the fish met with should be gathered and recorded.

You will make New Orleans, in the vicinity of the Exposition building, a special point of resort, coming in from time to time, and landing such of the collections as it is considered expedient to display in the Government building or to send at once to Washington. Arrangements will be made, if possible, for a specialist connected with the Commission to be on hand at New Orleans and take charge of these collections.

Unless for special reasons, it is not desired to have the cruise occupy a longer period than three or three and a half months. Suggestions, however, from you as to curtailing or extending this time will receive attention; much will necessarily depend upon the cost of coal and other elements of maintenance chargeable to the Commission.

The scientific staff for the cruise will consist, as heretofore, of Mr. Benedict as chief naturalist, who will be assisted by Mr. Thomas Lee. Captain Collins will probably start with you and aid in the experiments as to the methods of fishing, and you will ask his advice in such matters, as already intimated. Mr. Silas Stearns, of Pensacola, may be able to accompany you on one or more of your trips, as may be convenient to him and yourself; and it is not impossible that for part of the cruise the services of Dr. Bean may be substituted for those of Captain Collins. This special service will not include, however, more than four persons.

Should there be any other points in regard to which you desire instructions or suggestions, I shall be pleased to have you call attention to them.

Respectfully,

SPENCER F. BAIRD,
Commissioner.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., December 19, 1884.

Capt. Z. L. TANNER,
Commanding steamer Albatross,
Navy-Yard, Washington, D. C.

SIR: If it can be done during any part of your cruise, without in any way interfering with the service or increasing the expense, I should be glad to have you make a special examination of the food-fishes and mollusks in the vicinity of the island of Cozumel, off the coast of Yucatan, and which is said to be very rich in such products.

Should it be convenient to do so, without in any way interfering with the proper service of the vessel, I wish also to have a careful exploration made of the natural history of the island, especially of the birds, mammals, and reptiles, which will probably furnish a field of interesting research.

Respectfully,

SPENCER F. BAIRD,
Commissioner.

The wind was moderate from the eastward, with cloudy weather, clearing during the evening; the barometer was unusually high, touching 31.10 at noon, the highest point I recollect ever having seen it on the

Atlantic coast. It began falling early on the 4th and the wind veered to SE., increasing to a strong wind, moderating, however, during the afternoon, when it veered to the northward and westward. We passed Cape Hatteras at 5 a. m., and entered the Gulf Stream at 7 a. m., intending to set the trawl-line for tile-fish and try the dredge and trawl, but the sea was too rough for boat work, so we hauled inshore out of the Stream and continued our course to the southward until the following morning, when, the wind having moderated, we set a trawl-line in 79 fathoms, latitude 32° 55′ N., longitude 77° 54′ W. No tile-fish were taken—in fact, nothing except an eel and two small hake. Four hauls of the trawl, with wing-nets and mud-bag attached, were made during the day, with good results. We found many familiar species, which seemed to be at home along the whole coast, besides others which were new to us. Large numbers of *Munidas* of a rare species were found, somewhat like those so plentiful on the tile-fish grounds off the New England coast. Several sea-urchins, new to the Albatross, were taken, besides crabs, cephalopods, worms, small sponges, shells, foraminifera, and a variety of fish.

The wind, which was light in the morning, increased steadily during the day, ending with a moderate gale, and, being in the Gulf Stream, an exceedingly uncomfortable sea. We kept on the edge of the Stream with the intention of continuing our work on the 6th, but the gale still held from the southward, making it impracticable. It hauled to the westward on the 7th, still blowing a gale, with every appearance of holding for days, while we were laboring in a regular Gulf Stream sea, which must be experienced to be appreciated, holding on in hopes of getting an opportunity of continuing our work. The prospect, however, was so discouraging that we squared away on the above date, and under steam and sail ran out of the Stream to the southward and eastward, then laid a course for the Straits of Florida, wind and sea moderating.

At 2.50 p. m., January 9, we arrived at Key West and anchored off the naval station, going to the wharf later in the day. While steaming along the Florida reefs from 9 to 10 knots per hour, several kingfish were captured with a trolling-line. The larger fish succeeded in tearing themselves from the hook, those of moderate size only being landed on deck.

At 6.10 a. m. on the 10th we left the wharf, steamed out clear of the reefs, and swung ship under steam, observing azimuths of the sun on every point of the compass to ascertain the local deviation. The work being completed, we returned to port, and at 11.45 a. m. made fast to the wharf. At 1.15 p. m. we commenced coaling and finished the following day, having received 81½ tons. The naturalists were collecting during our stay, giving most of their attention to birds. Captain Collins gained valuable information among the fishermen and took several hauls of the seine with good results.

At 1 p. . on the 15th we cast off from the wharf and steamed out of the main ship channel *en route* for Havana. At 2.15 p. m. we cast the trawl in 37 fathoms, sand and broken coral bottom, latitude 24° 26′ N., longitude 81° 48′ 15″ W. It soon caught on the rough bottom and came up tail first, but there were several good specimens in the folds of the net. The ground was very thickly strewn with coral fragments and dotted with growing coral, making it wholly unfit for trawling; but we used an old net of very little value, and succeeded in making three interesting and successful hauls. Fish were represented by several species, some being new to us, and the invertebrates included many species of crabs, echinoderms, cephalopods, shells, corals, &c., a better variety probably than would be obtained by going over the ground again, as we could not expect to make the same number of hauls without sacrificing the net. After working until dark we started for Havana, arriving at 8.30 a. m. the following morning, making fast to mooring buoy No. 3. We received the usual visits from the authorities on shore, and from the French ram Bouvét, all of which were returned during the day. At 10 a. m. I called on the United States consul-general, Robert Williams, esq., who accompanied me to the office of the captain of the port, he being, in the absence of the admiral, in command of the station. Upon being informed of our mission to Cuba he offered his services and expressed a hope that we would meet with success.

At 6.15 a. m. the following morning, January 17, we left the port and lowered the tangles outside the entrance as near as possible in the spot where we found the *Pentacrinus* last winter. Thirteen hauls were made during the day in from 114 to 230 fathoms, rough coral bottom; the losses amounting to one tangle, 50 fathoms of dredge-rope, and two sounding-shot used as tangle-weights. The result of the day's work was 85 specimens of *Pentacrinus* in good condition, and a large number of small crabs, echinoderms, shrimp, sponges, small fish, &c. We returned to port and made fast to the buoy at 6.15 p. m. The next day, being Sunday, we remained in port receiving visits from the United States consul-general, captain of the port, Capt. J. Romero y Moreno, Spanish navy, and others.

We were under way again the following morning, making thirteen hauls during the day without loss, taking 187 sea-lilies in good condition, and a single specimen of what was said to be a new genus.

Preparations for our final departure were made Tuesday morning, and we left the harbor at noon. Six hauls were made during the afternoon; five with the tangles resulting in the capture of 106 sea-lilies, and one, the last, with the small beam-trawl over the same ground. We hardly expected to see the net again, although thinking it worth the trial. Strange to say, there was not a single specimen of *Pentacrinus* brought up; in other respects the haul was an excellent one. Among the many things in the net were a variety of cup sponges, ophiurans, corals, and a rare fish, a fine specimen of Astrophyton, and several remarkable sea-urchins having very long spines. Many of the specimens were unique, and had daylight permitted we would have made another attempt with the trawl. The result of the 32 hauls was 379 sea-lilies in good condition, besides other specimens too numerous to mention.

At 5.20 p. m. we started ahead for the island of Cozumel, off the east coast of Yucatan. The engines were slowed for half an hour soon after dark for surface towing, but to our surprise very little life was found.

At 9.02 a. m., January 21, we cast the trawl in 426 fathoms, white coral sand, latitude 22° 41′ N., longitude 84° 16′ 30″ W., and again at 11.13 a. m., in 463 fathoms, same character of bottom, latitude 22° 35′ N., longitude 84° 23′ W. Coral patches were encountered both times and caught the net; but we succeeded in getting it on board with a few good specimens of ophiurans, sponges, corals, fish, &c. The weather was squally during the day with frequent showers, clearing during the evening. Our course for many hours lay parallel with the Colorado reefs, on which we saw two wrecks, one of them being a Spanish man-of-war.

Shortly after dark the engines were slowed half an hour for surface towing, and, although a few good specimens were obtained, we found comparatively little life.

Cape San Antonio light was sighted at dark and passed out of sight at 9 p. m. At 9.38 a. m. the following morning we put the tangles over in 167 fathoms, sand, sponge, and coral bottom, latitude 20°. 59′ N., longitude 86° 23′ W., off the eastern edge of Arrowsmith Banks. A few free crinoids, crabs, sponges, &c., were taken, and finding the bottom smoother than was anticipated the small beam-trawl was put over in 130 fathoms, near the first position, making an excellent haul. Among the various forms were some fine gorgonian corals, an echinoderm, sponges, corals, &c. This success induced us to make another trial, when we fouled the bottom and lost the trawl-net.

We sighted the island of Cozumel at 3.10 p. m., January 22, and anchored on the bank at 4.55 p. m. in 5½ fathoms, sandy bottom. The situation was exposed to northerly winds and the holding ground was not good; but we passed a comfortable night, and at 6.10 a. m., on the following day, we got under way and steamed along the western side of the island to the anchorage off the village of San Miguel, about 4 miles from the northwest end, where we anchored in 4½ fathoms, sandy bottom, about one-fourth of a mile from the beach.

Visits were received from the authorities on shore and returned; our object in visiting the island was made known, and in the afternoon a hunting party was sent on shore to commence collecting, giving their attention principally to birds. They were very successful, returning before dark with large numbers, many more than they were able to skin during the night. Those that could not be otherwise cared for were, however, preserved in alcohol, so that none were lost.

The 24th was a busy day with the naturalists, some of whom were traversing the jungle in search of birds, and others, assisted by a working party from the crew, hauling the seine along the beach. Both were successful, bringing in many valuable specimens. Seining, however, can be carried on to a limited extent only, owing to the character of the bottom, which, if not rocky, is usually dotted with coral patches or fragments of dead coral washed up by the sea. The lot of the hunter is not altogether a happy one, for the moment he penetrates the dense undergrowth he is literally covered with wood-ticks, which are unpleasant at all times, and often prove a serious nuisance.

We remained at our anchorage off San Miguel until the morning of January 29, the work of collecting being carried on vigorously by the naturalists, assisted by the officers and working parties detailed from the crew. Large numbers of birds and fishes were obtained, besides some fine specimens of mammals.

The photographer succeeded in taking views of two of the principal ruins, one an old church near San Miguel, and the other a large building near the southern end of the island. The following interesting report of his trip is submitted:

"I left the ship on the 24th of January, with Mr. J. B. Anduze, in the steam-launch for a trip to his plantation, located on the southern end of the island, about 12 miles distant. In passing down the coast we stopped off the mouth of a small creek, which empties into the sea about 5 miles from the village of San Miguel, and took a photograph of the entrance. I learned that this creek is about 60 feet wide at its mouth, which has high rocks on each side, and has an average of 6 feet of water on the bar. On the inside there is a basin of about 300 yards in circumference, the banks of which are perpendicular rocks about 6 feet in height. The water in this basin is so deep that vessels of 80 tons can lay alongside the shore and take in their cargo. From this place to the landing the shore was very low, except one point which was quite rocky; all the rest presented the appearance of being fine sandy beaches and good places for hauling seine. When we reached the landing the surf was so heavy that we were landed from the boat on the backs of natives. The plantation being about three miles in the interior, we were compelled to make the rest of our journey on small ponies that are used in all tropical countries. The road, or rather a narrow bridle-path, led through a dense forest of small twisted knotty trees whose trunks and limbs were covered with creeping vines, so that it was almost impossible to distinguish the leaves of the tree from those of the vine. Many of these vines bore some remarkably beautiful flowers which made a very pretty scene; the foliage meeting overhead completely shut out the rays of the sun, and the total absence of buzzing insects made the ride a very pleasant one. I saw a large number of birds both large and small, some of which were very beautiful, also butterflies of every color imaginable.

"We reached the plantation at 5 o'clock in the evening, too late to take photographs. This plantation consists of a farm of half a league square, around which is a high stone wall, the fields being divided off by rail fences. There were large fields of bananas, and plantain trees, pineapples, corn, and ginger, with immense groves of orange and lemon trees, but all seemed neglected entirely or very poorly cultivated. Farming implements of the crudest kind, no modern appliances being used, may account for the appearance of the fields. The houses were five large thatched structures arranged in a square. These are used for servants to live in and also to store the products of the plantation as they are gathered. In the center of this square is a large stone building with a thatched roof, which is the residence of Mr. Anduze. This must have been a beautiful place once, but is now sadly out of repair. While waiting for supper we went to an Indian village which is located on this plantation. Here I found a collection of about fifty houses occupied by thirty families. They were much neater in their general appearance and more intelligent than the Indians of San Miguel. Our appearance excited so much curiosity that the entire village turned out, so that I had a good view of them. I found their complexion to be that of a bright mulatto, very dark eyes, and with long, straight, coarse, black hair. The men had scanty black beards, and were in height about 5 feet 4 inches, with features blunt and short. I entered several of their houses, which were huts made of poles, with thatched roofs, the floors being made of cement, raised a foot or more above the ground, and kept very clean. In each case I found but one room in a hut where the entire family lived, cooked, and slept, their hammocks being triced up to the rafters during the day. But everything was very clean, all the women were dressed in loose, comfortable white gowns and the children the same—those that had anything on. Some were engaged in making cigars, some curing tobacco, and others making baskets. The occupation of the men at this time is that of wood-chopping, all being engaged in cutting cross-ties for railroad companies in Yucatan.

"Unlike the other villages of the island, the cattle here are not al lowed to run at large about the houses, but are kept in big pens with high stone walls around them. I saw some old Indians that were unable to converse in Spanish, and who knew no language but the original Indian tongue. They all speak the Indian language somewhat. They have a small Catholic church in the village, but there having occurred several remarkable spiritualistic exhibitions among the inhabitants on the island, they have in consequence all turned spiritualists, and their church is neglected and about to fall down. Just on the edge of the village is an old ruin, which, these Indians say, was here at the time of the Spanish conquest, but they know nothing definite about it. The next morning we went out to the ruins on the other side of the plantation, and the undergrowth, having been cut away the evening before from around them, gave us a good view. I found what had once been a very large temple, covering about half an acre of ground, the walls of which had fallen in such a way as to form a large mound, on which grass, trees, and undergrowth had grown so thick that it was only with careful search that we could make out the size of the building. The central tower, or part of it, is the only thing left standing. There is but one entrance to this tower, which opens into a very narrow vaulted room. On the left of the entrance I found some markings on the wall. I detached the plaster on which they were and brought it to the ship. I also found what at first appeared to be iron staples driven into the wall on each side of the entrance, but by a blow of the hand they were broken off and proved to be made of stone and cemented to the wall. These were also brought to the ship. I found within a radius of half a mile of this tower the ruins of a large number of stone arches, beneath which, the Indians say, are buried all kinds of beautiful pottery; but they will not dig for it as they have a belief that at one time the island of Cozumel was one vast cemetery for the inhabitants of the main land. Both Indians and Spaniards claim that these ruins were here at the time of the conquest of Mexico, and that Cortez landed on this island in 1519 before going to the main land. I took three views of this ruin, and then went back to the Indian village and made two photographs of the ruin there, two of the village and its inhabitants, one of the interior of a dwelling, two of Mr. Anduze's plantation, and in the evening returned to the ship.

"A few days later I went ashore at San Miguel and made a photograph of the center of the town, including an old Spanish church, now used as a guard-house. I then went to the ruins of an old Indian church, about a mile north of the village of San Miguel, of which there was so little left standing that it was only here and there that a small portion of the walls could be seen. I had the undergrowth cut away, and took three views of the graves and parts of the wall that were visible. I found that around the church, under the soil, was a pavement of flat, smooth stones, regularly laid down with cement. I was told that it extended for half a mile around the church, and that there was a broad pavement leading from the front of the church to the water's edge, a mile away. I traced the pavement a short distance towards the water by digging up the loose earth with a pointed stick."

At 7.35 a. m. on the 29th we got under way and steamed to the southwestern extremity of the island. A gunning party was sent ashore for birds and a seining party for fish. The Albatross, standing a little off shore, in the mean time made two hauls with the tangles and two with the small beam-trawl. The depth was from 137 fathoms to 231 fathoms, coral sand and occasional coral patches, which made it rough work for a trawl. We were not successful with the tangles, but the trawl brought up some valuable specimens, a portion of which were new to us. We stood in shore a little before sunset and picked up the collecting parties, who reported nothing new in this locality.

Mr. Benedict thought we could not spend more time here advantageously. We had, he said, a large number of every species of bird seen on the island, besides other specimens, and, although we might get a few more species by remaining, he thought the chances too remote to compensate us for the delay. Being of the same opinion myself, we started for the Campeche banks, with the intention of making an examination of the character of the bottom, its fauna, &c.

At 7.42 the following morning we sounded and put the tangles over in 26 fathoms, sand and coral, on the Campeche banks, in latitude 22° 08′ 30″ N., longitude 86° 49′ W. Fishing with hand-lines was also tried, but without success. Seven hauls of the beam-trawl were made at various intervals during the day, resulting in the capture of a large number of specimens, many of them new to us, besides quite a number of red groupers with hook and line, some of them very large. The bottom where fish were taken was covered with live coral, sponges, a vegetable growth resembling sea-lettuce (*Ulva lactuca*), and was of course swarming with life.

It was our intention to spend several days in the examination of this region, particularly as to its fish products, and then proceed to New Orleans; but it became necessary to change the program. One of our seamen was very sick with typhoid fever, which took an unfavorable turn during the day, the patient failing very rapidly. The surgeon finally stated that the only chance of saving his life was to get him into a hospital as soon as possible; and as Pensacola was our nearest port, we made the best of our way there, arriving at the navy-yard at 2.30 p. m. on February 2, when the patient was transferred to the hospital for treatment.

We went to the coal-wharf on the morning of the 3d and made preparations for coaling; the fires were hauled, boilers blown down, and the water-line painted where it had been scraped off by the ice when leaving Washington. Coaling was commenced on the morning of the 4th and finished a little before dark on the 5th. The boilers were filled with rain-water from the yard tanks and fires started under the starboard boiler for heating and lighting the vessel.

At 4.10 p. m. we left the yard for the fishing banks off Cape San Blas, purposing to investigate the character of the bottom, the marine fauna, and the methods of taking the red snapper. A resident fisherman was engaged for the trip. While steaming out of the harbor, near Fort Pickens, we found the three-masted schooner Fanny Whitmore, of Rockland, Me., on shore in a dangerous position, with signals of distress flying. We went to her assistance, got her afloat, and proceeded on our course.

At 8.11 a. m. on the 7th we sounded in 27 fathoms, gray and black sand and broken shells, about latitude 29° 15′ N., longitude 85° 32′ W., put over the fishing lines, and took 117 red snappers, the largest weighing 27½ pounds, 4 groupers, 3 gags, and 32 porgies. All the fish taken were examined externally and internally for parasites, and the contents of their stomachs were noted. Many of the fish were females with partially developed roe, none being ripe.

Having taken as many fish as desirable, we commenced an investigation of the character of the bottom with tangles and trawl. Eight hauls were made during the day with very satisfactory results. The chart gives the bottom as gray sand and broken shells, but the trawl developed the fact that where fish were found live coral, sponges, &c., were very abundant, and living among them were vast numbers of shell-fish, crabs, annelids, and various minute forms which furnish unlimited food supplies to the fish.

We continued work until dark, then started for Pensacola, arriving at 11.10 a. m. the following day. Preparations were made for sea on the 9th, and at 4 p. m. on the 10th we left for New Orleans, intending to investigate a reported bank *en route*. All sail was made after leaving the channel. At 12.35 the next morning we sounded in 43 fathoms, coarse gray sand, latitude 29° 27′ N., longitude 87° 44′ W., and ran a line SSW. to latitude 28° 54′ N., longitude 88° 02′ W., in 698 fathoms, sounding every five miles. We then ran lines in various directions both east and west of the position given without developing anything that would lead us to expect the existence of a bank in that locality; in fact our soundings corresponded closely with those on the Coast Survey chart. Three hauls were made with the trawl in from 68 to 324 fathoms, in about latitude 29° 10′ N., longitude 88° 15′ W., with excellent results; many specimens were obtained which we were unable to identify, and others exceedingly rare. The last haul was made a little after dark, and another line of soundings run which occupied the time until 9 p. m., when we started for Pass à Loutre light, in order to verify our position, making it at 11.50 p. m.; then stood for South Pass, making it at 1 a. m. It was blowing a moderate gale from SE. at the time and soon shut in very thick, so that we did not succeed in passing inside the jetties until 11.40 a. m. Forts Jackson and Saint Philip were passed at 3.45 p. m., and at 8.45 we anchored below Poverty Point for the night, the weather being too thick to run with safety. We were under way again at 5.25 a. m. on the 13th, and anchored off Algiers at 9.45. I then took the pilot with me as a guide and called on the chief harbor-master, who assigned us a berth at a wharf where we would not be molested by vessels coming alongside. Returning to the ship, we got under way again at 1.15 p. m. and reached the berth assigned us at 1.55 p. m.

I telegraphed Mr. Earll at once and met him the following morning, when the subject of placing the vessel on exhibition was discussed. We visited the grounds, examined the wharf, and attempted to see Major Burke, the director-general; but failing in this, the following letter was written:

[United States Commission of Fish and Fisheries, steamer Albatross, wharf foot of Terpsichore street.]

NEW ORLEANS, LA., *February* 14, 1885.

Maj. E. A. BURKE,
235 Camp Street, City.

DEAR SIR: I have the honor to inform you that the United States Fish Commission steamer Albatross, under my command, is in port, and by direction of Prof. Spencer F. Baird, U. S. Commissioner of Fish and

Fisheries, I take this means of placing myself in communication with you, and beg leave to say that I will place the vessel and her scientific appliances on exhibition for one week from Wednesday next, as part of the U. S. Fish Commission exhibit, if you will furnish wharfage. I have examined your wharf to-day, and would say that from 75 to 100 feet at either end (the upper preferred) would give this vessel a practicable berth.

Very respectfully,

Z. L. TANNER,
Lieut.-Commander, U. S. N., Commanding.

The following letter was received in reply:

[The World's Industrial and Cotton Centennial Exposition, Office of the Director-General.]

NEW ORLEANS, *February* 14, 1885.

Captain TANNER,
Commanding Steamer Albatross,
(Care Pim, Forwood & Co.).

DEAR SIR: Thanking you for your kind offer to place your ship and contents on exhibition, we find that we can give you 75 or more feet of the lower end of the wharf, though we fear that the six steamers running constantly between the city and this wharf might subject your ship to some injury; of this you must be the judge.

Please command us if you need our assistance in this matter.

Very respectfully,

S. H. BUCK,
Director-General pro tem.

Upon my expressing a preference for a berth at the upper end of the wharf, as being more out of the way of the steamers which were constantly coming and going, I received the following letter:

[The World's Industrial and Cotton Centennial Exposition, Office of the Director-General.]

NEW ORLEANS, *February* 18, 1885.

Z. L. TANNER,
Lieutenant-Commander, commanding F. C. Steamer Albatross,
(Care Pim, Forwood & Co., New Orleans, La.).

DEAR SIR: Your communication of the 14th received. Please accept thanks of the management, and beg to state that I have instructed Captain Harrison, wharf-master, to allow you 75 feet at the upper end of the wharf for your purpose.

When located I shall do myself the pleasure of paying you a visit.

Respectfully,

S. H. BUCK,
Director-General pro tem.

We cleaned and painted ship, and, in fact, did everything we could in the few days at our command to improve the appearance of the vessel. We dressed ship on the 18th and 19th in honor of the Mardi-Gras festival. On the morning of the 20th we went to the Exposition wharf, had everything prepared as for work at sea, and at meridian opened the vessel to visitors. A detail of officers and men was on duty during visiting hours to show them over the vessel, one naturalist, at least, being in the laboratory.

We remained at the wharf until March 1. Many thousands of people from all parts of the country visited and examined the vessel, her scientific appliances, and such specimens of marine fauna as we could exhibit, with evident wonder and interest. All were received with courtesy, and it is worthy of remark that the officers took particular pleasure in explaining the various appliances in use for deep-sea exploration, the object of that work, and the operations of the U. S. Fish Commission in general. The crew also entered into the matter with commendable spirit, and were of great service. Our visitors almost invariably expressed great interest in what they saw and appreciation of the courtesy shown them.

At 9.15 a. m., March 1, we left the Exhibition wharf and steamed down the river, passing Fort Jackson at 3 p. m. We entered the South Pass at 4.20 p. m., left the jetties at 5.20, and laid a course to the southward and eastward for the night. The surface temperature of the water, which had been 40° in the river, rose to 68° soon after leaving the jetties.

At 5.30 a. m., March 2, we sounded in 1,467 fathoms, yellow ooze, latitude 28° 00′ 15″ N., longitude 87° 42′ W., and at 6.27 lowered the trawl, with wing-nets and mud-bag attached, and veered 2,300 fathoms on the dredge-rope. It was landed on deck at 10.06 a. m. with several species of bottom fish, shrimp, sea-anemones, holothurians, ophiurans, annelids, echinoderms, sponges, &c. The bottom was very slimy, and the numbers of the various species were much smaller than would have been found in the same depth in the Atlantic.

Another haul was made in 1,430 fathoms, brown mud, latitude 28° 02′ 30″ N., longitude 87° 43′ 45″ W., and a third one in 1,330 fathoms, light brown mud, latitude 28° 05′ N., longitude 87° 56′ 15″ W. The general character of the specimens taken in the last two hauls was much the same as that of the first. A feature of all the hauls was the predominance of soft jelly-like forms.

At 5.35 a. m., March 3, we sounded in 1,255 fathoms, gray mud, latitude 28° 19′ 45″ N., longitude 88° 01′ 30″ W., and at 6.09 lowered the trawl. It was landed on deck at 9.30—being a mere "water haul." It was lowered again at 10.51 a. m. in 1,181 fathoms, brown and green mud, latitude 28° 32′ N., longitude 88° 06′ W., and landed on deck at 2.08 p. m. with a heavy load of mud, which yielded considerable foraminifera, but little else. Another cast was made at 3.24 in 940 fathoms, gray and brown mud, latitude 28° 45′ N., longitude 88° 15′ 30″ W. A heavy load of mud was brought up as before, with several bottom fish, one of which we did not recognize. The last haul of the day was made at 7 p. m. in 730 fathoms, gray mud, latitude 28° 51′ N., longitude 88°

18′ W. The trawl was landed on deck at 8.45 p. m., and contained a number of fine fish, as well as a variety of other specimens, among them being an enormous isopod, $8\frac{1}{2}$ inches in length and about 4 inches broad—a remarkable specimen.

At 5.36 a. m., March 4, we cast the trawl in 60 fathoms, blue mud, latitude 29° 15′ N., longitude 88° 06′ W., and while heaving in it caught on some obstruction, probably a coral patch, parting the bridle stops and rending the net. The trawl-frame and wing-nets were lost. Six hauls were made during the day between the position given above and 25 fathoms, latitude 29° 32′ N., longitude 87° 45′ W., and a large number of shoal-water specimens taken. Fishing lines were put over at each dredging station; also at six stations when the trawl was not lowered, trying for fish, but with no success, although we crossed the inner edge of what was at one time a favorite fishing ground.

The weather, which had been moderately good since leaving the jetties, changed for the worse during the day, and at night, when we ceased work, there was a moderate sea from NE. We made Pensacola light at 10.50 p. m., and hove to for the night, as we did not wish to enter before the following morning. At 6.58 a. m., March 5, we arrived at the navy-yard coal wharf, and commenced coaling at 1 p. m. Mr. Silas Stearns, of Pensacola, visited the ship, and arrangements were made with him to go with us to the snapper banks, in the vicinity of Cape San Blas.

We finished coaling at 4.50 p. m., March 6, having taken on board $117\frac{1}{4}$ tons, and at 5.15 cast off from the wharf and proceeded to sea. At [illegible].48 the following morning we tried for fish in 30 fathoms of water, gray sand, black specks, and broken shells, latitude 29° 16′ 19″ N., longitude 85° 49′ 30″ W., a single red grouper being the only fish taken. We made trials in thirty stations during the day, in from 25 to 33 fathoms, and succeeded in taking fish in the following:

Latitude N.	Longitude W.	Fathoms.	Kinds of fish taken.
° ′ ″	° ′ ″		
29 16 00	85 47 30	29	9 red snappers, 10 others.
29 16 45	85 39 30	28	5 red snappers, 6 red groupers, 1 porgie.
29 16 00	85 33 45	31	2 red snappers, 5 red groupers, 1 porgie.
29 19 00	85 43 15	28	11 red snappers, 8 red groupers, 2 black groupers.

The last station was occupied just before dark, and, keeping as near it as possible, we set two gill-nets, but failed to take any fish. They are found on narrow ridges, and it is probable that in setting the nets we missed the ground.

The submarine electric light was used with good results for surface collecting while the fishing party was away, large numbers of minute forms being taken. The fishermen returned at 12.15 a. m., March 8, and at daylight we resumed the examination of the grounds in the vicinity. Eight stations were occupied, fish being taken at the following:

Latitude N.	Longitude W.	Fathoms.	Kinds of fish taken.
° ′ ″	° ′ ″		
29 16 45	85 41 00	29	1 red snapper, 10 other fish.
29 15 30	85 40 15	29	1 red snapper, 4 red groupers.
29 20 15	85 45 40	29	2 red snappers, 6 red groupers.

We met with such poor success that we concluded to change ground to the southward and eastward about 45 miles. Here we made four trials, finding fish finally in latitude 28° 54′ N., longitude 85° 08′ W., in 28 fathoms. Forty-two red snappers and two black groupers were taken in a few minutes. Thinking this would be the most favorable opportunity for trying the trawl-line, which had been baited for the purpose, it was set as nearly as possible on the spot where the fish were taken, but without success. The ridges on which snappers are taken are so narrow that it is difficult to set the line in exactly the right spot, particularly in the strong currents prevalent in this region. The breeze was quite fresh also, which served to drift the fishermen off the ridge.

At 5.45 p. m. we started for port, the wind then blowing a moderate gale from NNW., continuing until the following morning, when it gradually died out. We reached Pensacola navy-yard at 3.15 p. m. on March 9, and made fast to the wharf. On March 12, preparations having been completed for our final departure from Pensacola, we cast off from the wharf at 5.10 p. m., and proceeded to sea.

We had already made extensive explorations in the western [illegible] about the meridian of Mobile and as far south as latitude 28° N. [illegible] in 1,467 fathoms of water we commenced a line of dredgings, whic[illegible] carried into a depth of 25 fathoms off Pensacola. In order to co[illegible]e the exploration we stood to the southward during the night, and a[illegible] 28 the following morning cast the trawl in 724 fathoms, brown and [illegible]ray mud, latitude 28° 47′ 30″ N., longitude 87° 27′ W. Five hauls were [illegible]ade during the day between the above position and latitude 28° 34′ N., longitude 86° 48′ W., in 335 fathoms, in a direction about E. by S., and at nearly equal intervals.

The hauls were all successful, bringing up a great variety of specimens: many holothurians, several species of mollusca, a naked mollusk which was remarkable for its size, a large red crab (*Geryon quinquedens*), several species of shrimp and deep-sea fish, two or three of which we did not recognize. There were also several very large tubes of the worm *Hyalinacea artifex* (?), compound ascidians, cup-corals, *Acanella*, a variety of starfish, sponges, sea-anemones, and the usual number of minute crustacea, many of them being taken in the wing-nets.

A set of serial temperatures and specific gravities was taken during the forenoon to a depth of 500 fathoms, latitude 28° 43′ N., longitude

87° 14′ 30″ W. The new water-bottle, intended to retain the gases in water specimens, was tried at 500 fathoms, but the upper valve failed to close, and when a slight pressure was subsequently put on it the joints were found to leak so badly that it was of no use for the purpose for which it was designed. We did what we could to repair the fault when further experiments were made.

At 5.30 a. m., March 14, we cast the trawl in 280 fathoms, gray mud, latitude 28° 42′ N., longitude 86° 36′ W., making five hauls during the day from the above position to latitude 28° 36′ N., longitude 85° 33′ 30″ W., in 111 fathoms. The general features of the catch were much the same as on the preceding day, with the addition of shoal-water forms.

A curious parasitic worm, genus *Nothria*, was found on a holothurian. Several gallons of foraminifera were washed from the contents of the mud-bag and saved, and during the evening a live paper nautilus (*Argonauta argo*) was taken in a large surface towing-net and secured in perfect condition.

The submarine electric light was used for surface collecting as usual when the ship is hove to at night. Trial lines were put over for fish at the last two stations, but without success.

At 5.30 the following morning the trawl was lowered in 88 fathoms, latitude 28° 42′ 30″ N., longitude 85° 29′ W. The bottom indicated by the lead was gray mud, but the trawl brought up a large quantity of shells, mostly dead. There were also several varieties of fish, shrimp, and crabs. Four other hauls were made between the above position and latitude 28° 48′ 30″ N., longitude 84° 37′ W., in 24 fathoms, with practically the same results, with the addition of sponges, bryozoa, starfish, cephalopods, worms, &c. Trials were made with hand-lines at each station before the trawl was lowered, and the remainder of the day was given up entirely to that work, 15 stations being occupied between latitude 28° 48′ N., longitude 84° 36′ W., and latitude 28° 44′ N., longitude 84° 26′ W., in from 27 to 21 fathoms. Although we crossed a recently-discovered bank, we caught but one red snapper and six groupers during the day.

The sky was overcast with drizzling rain in the morning, and in the afternoon there was constant heavy rain, with occasional distant thunder. March 16 was also overcast, the sun appearing only at intervals and for a few moments. It was entirely obscured during the eclipse.

Work was resumed at daylight the next day, and five stations occupied at intervals of five miles without taking any fish. The trawl was lowered in 21 fathoms, coral and sponge bottom, latitude 28° 28′ N., longitude 84° 25′ W., and brought up several sponges—one being a sponge of commerce—several sea-urchins, hydroids, one gastropod shell (*Murex*), and a variety of small fish. Ten snappers and one grouper were taken at this station. The search for fish was continued without success until the fourth station was reached, in latitude 28° 15′ 45″ N., longitude 84° 02′ 35″ W., in 21 fathoms, when two snappers and ten groupers were taken. The next five stations were occupied without finding fish, and it now being too dark for that work, we steamed toward Tampa Bay, continuing the line of soundings for hydrographic purposes, filling a blank on the chart, until within the range of Egmont Key light, where we hove to until daylight.

At 9.30 a. m., March 17, we anchored in Tampa Bay, and sent the steam-cutter to town with the mail and for provisions, and the dinghy with a seining party to the Little Manatee River. The fishermen returned before dark, having met with good success. Among the edible fish taken were sheepshead, mullet, sea-trout, big-eyed herring, crevalle, and several other species.

March 18 opened clear and pleasant, with a light to moderate breeze from the northward and westward. We were under way at 5.30 a. m., crossed the bar at 8.15, and stood to the southward and westward. A small boat was seen adrift about 11 a. m. and picked up. It proved to be a sharpie, with the remnant of a painter hanging over the bow. It had no oars or rowlocks, but lying on the bottom in the water which filled it nearly to the thwarts were several large live clams, and a few conch and clam shells. While taking up the skiff we sounded in 18 fathoms, trying for fish, without success.

At 12.32 p. m., latitude 27° 08′ 30″ N., longitude 83° 19′ 30″ W., in 25 fathoms, coarse gray and black sand, we commenced sounding and trying for fish at intervals of five miles in a S. by W. direction. The trawl was put over at the second trial (station 2409) and brought up a quantity of cup sponges (the largest being a foot in diameter), which were valuable for the annelids and crustaceans they contained. Several species of fish were taken, as well as shells, crabs, bryozoa, &c. A haul of the Chester rake dredge was made at station 2410 with small results, only a few shells and sponges being taken. Another haul of the trawl was made at station 2411, bringing up a heavy load of sponges, some of them 18 inches in diameter, and filled with worms and crustaceans. Several large holothurians were also taken, besides the usual variety of small forms occurring in this region. It might be called a sponge bottom. The trawl was lowered again and towed at the rate of 5 knots, just clear of the bottom, for the purpose of catching fish, but without results. It was after dark, but the net "fired" so much that it was quite as visible as though it had been broad daylight.

Nine stations were occupied during the day, and fish were taken at the following:

Latitude N.	Longitude W.	Fathoms.	Kinds of fish taken.
° ′ ″	° ′ ″		
27 04 00	83 21 15	25	1 red snapper, 1 porgie, 2 red groupers.
26 58 00	83 22 30	25	2 red snappers, 1 black grouper, 4 red groupers.
26 33 30	83 15 30	27	1 red snapper.

A trial was made during the evening with a hook and line, having a submarine electric light attached a few fathoms from the end. The water was illuminated for at least 20 yards in every direction, but we failed to get a bite.

The vessel was hove to during the night and resumed work at daylight the following morning in 26 fathoms, latitude 26° 28′ 15″ N., longitude 83° 11′ W. Eighteen stations, at intervals of five miles, were occupied, three of them, Nos. 2412, 2413, and 2414, being dredging stations, at which were taken many sponges, some of them very large, a variety of small fish, crustacea, and other shoal-water forms found along these shores.

Fish were taken at the following stations:

Latitude N.	Longitude W.	Fathoms.	Kinds of fish taken.
° ′ ″	° ′ ″		
26 18 30	83 04 45	27	12 red snappers, 1 red grouper.
26 12 30	83 06 30	27	1 red grouper.
26 08 30	83 03 45	25	1 scamp, 1 porgie, 3 red groupers.
25 44 30	83 02 30	27	3 red snappers.
25 39 30	83 01 30	27	3 red snappers, 1 black grouper.

We ceased work at 6.40 p. m., and started for Key West, arriving and making fast to the Government wharf at 8.25 a. m., March 20.

A peculiar atmospheric condition was observed while passing the Tortugas, which, although not particularly rare, is worthy of mention as illustrative of the cause leading to the grounding of the American steamer Alamo on that shoal during the night of March 7. We knew the position of the ship within a mile when we reached the ordinary limit of visibility of the light, but steamed on mile after mile without seeing it, although the stars were shining brightly and the atmosphere was apparently clear. We did not see it, in fact, until we were eight miles within its ordinary range, and even then only with the aid of a glass. Just at this moment the setting moon disappeared in a low-lying mist, which had not been observed before. Had we been doubtful of our position before making the light, and had we made it before detecting the presence of the mist, we should, without doubt, have considered ourselves nineteen miles distant, whereas we were only eleven miles from it.

We began coaling at 9.30 a. m., all preparations having been made before our arrival. We finished the following day, having received on board 97¾ tons. A few necessary repairs in the engineer's department were made by our own people.

At 5.45 a. m. on March 30, we got under way and proceeded to sea. The weather was partly cloudy during the day, with light northerly winds and smooth sea. In the evening it became squally, with frequent lightning to the northward and eastward, a heavy rain-squall passing over us during the last hour. At daylight the following morning it was blowing a moderate gale from NE., with rough sea, and at 9 a. m. the engines were slowed to half-speed, not only for the purpose of easing the vessel, but to avoid passing ground on which we wished to try the trawl. Many flying-fish, a large school of porpoises, and a couple of huge sharks were seen during the day. Well-defined brown streaks in the water were noticed by the officer of the deck during the evening, which, upon examination, proved to be masses of small medusæ.

The wind and sea moderated during the night, and on the following morning, April 1, two hauls of the trawl were made: No. 2415 in 440 fathoms, sand, shells, and foraminifera; and No. 2416 in 276 fathoms, coral and broken shells. A large quantity of coral was brought up in the first haul, enough to fill the table-sieve. Although there were many gorgonians, the bulk was true corals. Sponges, ophiurans, sea-anemones, annelids, living shells, and small crustacea were found in abundance. There were also a few starfish and several deep-sea fish. A notable feature of the haul was a portion of a stalked crinoid, which we did not recognize. There was also a bright-red fish, somewhat resembling the Norway haddock, which was not recognized, although it may be a well-known species. The second haul brought up a large number of glass sponges, from which some fine specimens were obtained, a number of gorgonian corals, small crustacea, fish, and a few starfish.

Later in the day we stood inshore, and at 6 p. m. sounded in 86 fathoms, gray sand and broken shells, latitude 31° 54′ 45″ N., longitude 79° 17′ W., and tried the hand-lines, baited with salt mackerel, for tilefish, but without success. Serial temperatures were taken, and at 6.45 p. m. we steamed ahead on our course to the eastward.

The following day was clear and pleasant, with moderate easterly winds and smooth sea. We cast the trawl at 12.13 p. m., station 2417, in 95 fathoms, fine gray sand, but it came up empty. It was lowered again immediately in 90 fathoms, gray sand, station 2418, and brought up a few skates and flounders, several flat sea-urchins, crabs, small fish, starfish, &c. It was our intention to try the hand-lines for tilefish, but the bottom was so barren that we did not consider it worth while. We stood on until 5.25 p. m., when we lowered the trawl in 107 fathoms, fine gray sand and black specks, station 2419. It brought up several sea-urchins, starfish, small crustacea, and three species of fish. Trial lines were put over for tilefish, but none were taken. We hardly expected to find fish of large size on a bottom so barren, but made the trial, as we had steamed so far out of our course for the purpose.

At 6.30 p. m. we stood to the eastward, keeping in the Gulf Stream, and at 10 p. m., April 3, sounded in 2340 fathoms, blue ooze, latitude 36° 30′ N., longitude 73° 14′ W., and took serial temperatures. At 11.45 p. m. we started ahead, steaming to the westward. The wind, which was moderate in the morning, increased during the night, the barometer falling steadily. At 2 a. m., April 4, sounding and serial temperatures were taken in 1646 fathoms, No. 703, latitude 36° 45′ N., longitude 73° 28′ W., and another at 5.40 a. m., in 1436 fathoms, No. 704, latitude 36° 57′ 30″ N., longitude 73° 47′ W. A water specimen was taken at 1,000 fathoms, in a new water-bottle, intended to retain the free gases in sea-water, and, as far as we could judge, with complete success. The specimen was retained in the bottle for transportation to the Smithsonian Institution.

Wind and sea increased rapidly during the forenoon, making the temperature work exceedingly difficult. Another sounding and serial temperatures were taken at 10.25 a. m. in 1208 fathoms, latitude 37° 01′ 08″ N., longitude 74° 10′ W., and at 12.25 p. m. the course to the westward was resumed until 2.30 p. m., when the vessel was hove to under steam, head to wind, which at the time was blowing a fresh westerly gale, with rough sea. At 6.20 p. m. a sounding was taken with serial temperatures in 336 fathoms, latitude 37° 09′ 23″ N., longitude 74° 30′ 30″ W., and at 10.40 p. m. the engines were stopped and the vessel allowed to drift, as we were near our intended working ground.

At 6.20 a. m., April 5, we cast the trawl in 104 fathoms, sand, mud, and gravel, latitude 37° 03′ 20″ N., longitude 74° 31′ 40″ W., and took large numbers of *Munidas*, several species of fish, ophiurans, starfish, &c. After the haul was finished, we made an unsuccessful trial with hand-lines for tile-fish. Dogfish were plentiful, however, and several were taken. A change of position brought no better success, dogfish only being taken. We made the trial in this particular spot from the fact that it corresponded more nearly with the region off Martha's Vineyard, where tile-fish have been taken, than any other locality on the Atlantic coast. The fauna is much the same, the character of the bottom is similar, and the temperature of the water corresponds with that off the New England coast later in the season. This trial, though failing to show any indications of the presence of these fish, should not be considered conclusive. They may be migratory in their habits, and as none were ever taken earlier than August, they may not as yet have reached that locality; even if they were there it is not at all certain that they would take a hook so early in the season. The presence of dogfish in such large numbers would of itself account to fishermen for their failure to take other fish.

Having finished the trials above mentioned, we started for Washington, continuing the line of soundings and serial temperatures to the Capes, up Chesapeake Bay, and to Piney Point in the Potomac, observations being made at intervals of 20 miles or less.

This series of temperatures from the middle of the Gulf Stream to the coast, taken at this particular season of the year, when so many of the migratory fishes are making their appearance in our waters, will prove of great value in the study of the movements of these fish. The question of water temperatures must enter largely into the investigation of this important subject, and, although its influence has to a certain extent been recognized, it seems probable that it will be given greater consideration by future investigators.

A lookout was kept for mackerel and other schooling fish between the Gulf Stream and the Capes, but none except porpoises were seen. We passed Cape Henry at 6 p. m.; Smith's Point, at 1.20 a. m., April 6, Mount Vernon at meridian, and arrived at the navy-yard at 1.40 p. m.

The late cruise of this vessel was made without accident or loss, except a couple of trawls, and one or two deep-sea thermometers. The vessel has, as usual, inspired confidence in her sea-worthy qualities, which have frequently been put to the test by boisterous weather encountered during nearly every trip. The engines have worked satisfactorily, but the boilers have, as usual, been a source of anxiety, although we have been delayed but little on their account, and repairs have been made by our own people. The sounding and dredging apparatus has worked admirably; so well, in fact, that no improvements have suggested themselves. The new water-bottle designed to retain the free gases in sea-water will require some modifications to make it thoroughly reliable.

We remained at the navy-yard engaged in overhauling and refitting the vessel until May 25 at 10 a. m., when we left for Baltimore, where we arrived at 8 a. m. the following day. At 1.30 p. m. we began hauling the vessel out on Skinner & Son's marine railway to scrape and paint her bottom. She was out of water at 3.40 p. m., and the scrapers commenced work.

There was a noticeable absence of barnacles on the ship's bottom, and very little grass or other growth which would tend to retard her speed, a casual inspection leaving the impression that the bottom was in excellent condition. A critical examination revealed the fact, however, that serious oxidation had taken place on several parts of the submerged surface, particularly wherever the dredge-rope had come in contact with it, where the paint had been scraped off by ice, and on the exposed surfaces of the propeller shafts.

The vessel was last docked at the Norfolk navy-yard, July 14, 1884, about ten and one-half months since, and went immediately on her summer's cruise, when she was at sea most of the time. The steel-wire dredge-rope was in constant use until October 23, when she entered the fresh waters of the Potomac, where she remained for two months, long enough to kill the barnacles and other marine growths that might have formed during the cruise. We left Washington on December 24, 1884, and were obliged to force our way through from 2½ to 3 inches of ice in the Eastern Branch, and encountered more or less of it in the Potomac, scraping the paint off the bottom from the water-line to 3 or 4 feet bebelow it, leaving the surface of the metal entirely exposed.

Leaving the Capes of the Chesapeake on the 3d of January, 1885, we went to the Gulf of Mexico and Western Caribbean Sea, where we spent almost a month, nearly half of the time at anchor. We had an opportunity in the mean time of renewing the paint on the water-line and about 18 inches below it, but there was still left a belt of 2 feet or more in width entirely exposed to the corroding influence of sea-water.

The vessel then spent two weeks in the Mississippi River, thus for a second time removing the barnacles, grass, &c., from the bottom. Leaving the Mississippi, she was about six weeks in the waters of the Gulf and Atlantic, when she again reached the Potomac, where she remained for seven weeks, removing all marine growths from the bottom for a third time since docking.

Had the paint remained unbroken on the wetted surface, the condition of the bottom would have been remarkably good; but unfortunately there was quite a large surface almost entirely devoid of paint, on which oxidation was taking place very rapidly, notably so on surfaces which have been in contact with the dredge-rope. Contact of the sounding-wire with the ship's bottom produced results hardly to be contemplated from a surface so minute. In fact, the contact of these hardened steel surfaces with the softer metal of the ship's bottom not only removed the paint, but actually abraded the surface to a small extent, leaving it in the most favorable condition for rapid corrosion.

The excessive oxidation on the exposed surfaces of the propeller shafts is doubtless due to the friction incident to their rapid revolution in addition to the ordinary friction of progression, to which other portions of the submerged body are subject, all combining to wear quickly the paint from their surfaces, leaving them exposed to the corroding influence of salt water.

In view of the peculiar character of the work in which the vessel is engaged, I consider it absolutely essential to scrape and paint her bottom twice a year.

We were delayed by rainy weather, and did not finish painting until Friday, May 29. A priming coat of red lead was put on, and a coat of white zinc (one-tenth red lead) put on over it. The ship was put into the water at 10 a. m. on the 30th, and left for Norfolk at 2 p. m., arriving at the navy-yard at 8 a. m. the following morning. We forwarded requisitions for coal from Baltimore, and on our arrival found a portion of it on the wharf ready for us. We commenced taking it on board at 8 a. m. on Monday, June 1, and finished at 7 p. m. the same day, having taken $134\frac{545}{2240}$ tons. This is a fact worthy of notice, considering that it was shoveled from the wharf into baskets, passed on board over the rail, put into the bunkers, and stowed by our own small crew.

Mr. James E. Benedict arrived on the morning of June 2, and at 1 p. m. everything was ready for sea, with the exception of fresh bait, which we had been unable to procure in Norfolk or the vicinity, notwithstanding our vigorous efforts in that direction. Our only remaining resource being the fishermen of the Chesapeake, or the fish factories on its shores, we left the navy-yard at 1.20 p. m. and at 4 p. m. anchored off Back River, and sent the steam-cutter in for menhaden, but they had none at the factory and had seen none for several days.

On her way out, however, a sloop was boarded which had made a haul during the day, and 2,500 menhaden in fine condition were procured from her. They were iced as soon as we received them on board. The boat returned at 6 p. m., and at 6.15 we got under way and proceeded to sea. The weather was clear and pleasant, with a smooth sea.

Two trawl-lines were baited during the night and preparations made for prosecuting our investigations in the morning, and at 5.53 a. m., June 3, we lowered the trawl in latitude 37° 07′ N., longitude 74° 34′ 30″ W., in 64 fathoms, fine gray sand and pebbles, bottom temperature 54°. It came up at 6.33 a. m. with large numbers of *Munidas*, many crabs, hermit-crabs, starfish, and several small fish, among them four pole-flounders. It was emphatically a "live bottom," where tile-fish should be found, if they inhabit this region. As soon as the trawl was landed on deck, and the favorable nature of its contents observed, the trawl-line, having 1,000 baited hooks, was set on the same ground over which the trawl had passed, the weather buoy being planted in 61 fathoms, coarse gray sand and pebbles, latitude 37° 08′ N., longitude 74° 34′ 45″ W., bottom temperature 54°. The line was taken up at 9.25 a. m. without a single fish, and, what was more remarkable, none of the baits had been touched. Even the hake, skate, and dogfish seemed to have abandoned the ground. It will be remembered that on April 5 this locality was swarming with dogfish, which took the hooks as fast as they could be put over.

We stood off shore a little to deepen the water, and put the beam-trawl over again at 9.55 a. m. in 82 fathoms, the same character of bottom, latitude 37° 08′ 30″ N., longitude 74° 33′ 30″ W., and the catch was practically the same, with the addition of four small spotted sharks. The trawl-line was set again as soon as the beam-trawl was up in 75 fathoms, same character of bottom, and the bottom temperature 52.5°, agreeing very nearly with the so-called tile-fish ground off Martha's Vineyard. There were no fish of any kind taken on this set, but the baits were nearly all gone, having been eaten probably by crabs.

Another haul of the beam-trawl was made at 3.04 p. m. in 143 fathoms, green mud and fine sand, latitude 37° 10′ 15″ N., longitude 74° 32′ W., bottom temperature 51.5°. Large numbers of *Munidas*, crabs, worm-tubes, hermit-crabs, pole-flounders, corals, sea-anemones, &c., were taken, marking the locality as an excellent feeding ground for fish. We trawled inshore to 103 fathoms, green mud, sand, and black specks, latitude 37° 11′ 30″ N., longitude 74° 32′ 30″ W., when we commenced laying out the trawl line again, standing in the direction of the position given for the last trawling station and in fact covering practically the same ground. Four hake were caught on the line during this set, the baits being nearly all taken as before.

Two large sharks were taken with a hook during the day; one of them measured 10 feet 4 inches in length, and weighed 400 pounds. They were both preserved, one skinned and the hide salted, and the other placed on ice.

Just at dusk we sent a boat for what we supposed was a huge turtle asleep on the water, but it turned out to be a large sunfish, which the men succeeded in striking, but the iron drew out and the fish sunk.

We steamed slowly to the southward during the night, and at 4.37 a. m. the following day cast the trawl in 85 fathoms, black mud, bottom temperature 52.5°, latitude 36° 41′ 37″ N., longitude 74° 42′ 15″ W. A variety of crustaceans were brought up, also a few minor forms of mollusca, fish, &c.; but a marked decrease in numbers and variety was observable as we went to the southward.

At 5.15 the trawl line was set between 135 and 160 fathoms, black mud, the weather buoy being in latitude 36° 43′ N., longitude 74° 41′ W., bottom temperature 48.8°. No fish of any kind were taken on the line, although the baits were many of them gone.

An unsuccessful trial was made with hand-lines in 78 fathoms, latitude 36° 43′ N., longitude 74° 42′ 20″ W., after which we ran to the southward until 11.49 a. m., when we set the trawl line in 119 fathoms, green mud and fine sand, bottom temperature 51.5°, latitude 36° 20′ 24″ N., longitude 74° 46′ 30″ W. As soon as the fishing party was clear of the ship we put the trawl over, taking a large number of crabs, a few *Munidas* and a variety of other crustaceans, a few sponges, hydroids, echinoderms, annelids, mollusca, and four common species of fish. Judging from the fauna captured it would be considered good feeding ground for many species of fish, yet the trawlers returned with only half a dozen hake and one large skate. As the ground here promised nothing we changed our location again and at 4.49 p. m. set the trawl line in 93 fathoms, coarse gray sand, black specks, and broken shells, bottom temperature 52°, latitude 36° 01′ 30″ N., longitude 74° 47′ 30″ W. As soon as the trawlers were away the beam-trawl was put over at the same station, taking large numbers of crabs, a few shrimp, eight specimens of *Octopus Bairdii*, several starfish, and four common species of fish. There were no fish taken on the trawl line, although most of the baits were gone from the hooks.

Three porpoises were taken with the harpoon during the day. Two of them were placed on ice and the skin of the other salted. Three blackfish with large rectangular white spots on their bodies were seen about the ship for a few minutes, but left before any attempt could be made to capture one. They were all marked alike, and as well as I can recollect had four spots each, although I may be mistaken in the number. This peculiar marking may be common, but I never before saw anything of the kind myself. The large surface tow-net was dragged for two hours or more during the evening with very satisfactory results; many minute forms, including several species of small fish, were taken, also one perfect specimen of *Argonauta argo* alive and in its shell.

The tow-net referred to has a ring four feet in diameter, the net itself being about 10 feet in length, made of strong netting and lined with cheese-cloth for 2 feet or more from the tail. Towing this net at the rate of 3 knots or more an hour, either partially or wholly submerged, as occasion requires, we secure many specimens that would elude the ordinary surface towing-net and are too minute to be captured in the trawl. We have seen no birds thus far except petrels, which have been quite numerous about the ship. We heard the cries of a sea-bird at night, but did not see the bird itself.

Having finished the surface towing referred to, we steamed to the southward slowly to change our ground, and at 6.27 a. m. the following day, June 5, set the trawl line in 69 fathoms, black mud, surface temperature 74°, bottom 54°, latitude 35° 27′ 15″ N., longitude 74° 47′ 30″ W., on the northern verge of the Gulf Stream, meeting with the usual results, although a large proportion of the baits were gone. A school of porpoises passed the vessel during the morning, having among them a large number with their bodies thickly dotted with white spots. They were reported to me as "spotted porpoises." They are certainly not common on the Atlantic coast; in fact I do not recollect ever having seen any before. Every effort was made to capture one, but they kept out of reach of the harpoon. We lowered a boat and sent it out among the school, but they gave it a wide berth. We tried also to shoot one with heavy rifles, but failed again, much to our surprise, for we have some excellent shots on board.

A curious accident happened while laying out the trawl line, which might have resulted in the loss of a portion of our gear. After planting the weather buoy they proceeded to pay out the line and plant the lee buoy in the usual manner, but when they attempted to find the weather one it was nowhere to be seen, neither could we see it from the vessel, so we concluded it had sunk. On taking up the lee one, however, we found the trawl line had parted while being laid out, and the boat had drifted out of sight of the weather buoy. Calling the boat alongside we hoisted it on board, and the vessel steamed SSW. 3 miles, where we found the other buoy and recovered it with the anchor and line attached.

The wind, which was light during the morning, increased rapidly, getting up an uncomfortable sea, too heavy for boat work, so we were obliged to resort to hand-lines. An unsuccessful trial was made at 2.11 p. m., in 50 fathoms, fine gray and black sand, broken shells, surface temperature 76°, bottom 63°, latitude 35° 12′ 15″ N., longitude 75° 05′ W. Another trial at 2.36 p. m. in 72 fathoms, coarse gray sand, broken shells, surface temperature 76°, bottom 60°, latitude 35° 12′ 30″ N., longitude 75° 03′ 30″ W., resulted in taking one sea-bass. The next trial at 2.46 p. m., in 68 fathoms, coral, temperatures the same, latitude 35° 12′ 45″ N., longitude 75° 02′ W., was more successful; two sea-bass, two large red groupers, and two specimens of *Caulolatilus chrysops* Gill, were taken, the latter being more nearly related to the tile-fish than anything we have seen during the trip. Specimens of each species were preserved for examination.

An unsuccessful attempt was made at 4.03 p. m. in 123 fathoms, gray sand, black specks, and broken shells, surface temperature 76°, bottom 60°, latitude 35° 13′ N., longitude 75° 01′ W.; and still another at 6.42 p. m. in 52 fathoms, coarse gray sand and broken shells, surface temperature 75°, bottom 65°, latitude 35° 11′ N., longitude 75° 01′ W. We then stood inshore and sighted Hatteras light, keeping it in sight until 3 a. m. on the 6th, when we stood off shore again, and at 5.38 a. m. tried the hand-lines in 66 fathoms, fine gray sand, black specks, surface temperature 75°, bottom 58°, latitude 34° 58′ N., longitude 75° 12′ W., but found no indications of fish. Another unsuccessful trial was made at 6.15 a. m. in 54 fathoms, same character of bottom and the same surface temperature, the bottom temperature being 61°, latitude 34° 59′ N., longitude 75° 13′ W. The wind was blowing strong from the northward at this time, with a heavy swell, making it impracticable to carry on the work satisfactorily, and as we had almost reached the limit of time set apart for this cruise, the vessel was headed for the Chesapeake.

The information gained, although negative as far as the main object of the cruise was concerned, is valuable as demonstrating the total absence of tile-fish in the region examined. We procured valuable specimens of various kinds, which were sent to the Smithsonian Institution for examination.

We arrived at the navy-yard, Washington, D. C., at 3.55 p. m. on June 7, without incident worthy of remark, and moored to the coal wharf.

We remained at the navy-yard making preparations for the summer cruise until noon of June 13, when we sailed for the Newfoundland Banks, *via* Newport, R. I., under the following orders:

U. S. Commission of Fish and Fisheries,
Washington, D. C., June 8, 1885.

Lieutenant Commander Z. L. Tanner,
Commanding steamer Albatross, Navy-Yard, Washington.

Sir: As soon as you have completed any necessary repairs, and have taken coal and other supplies on board, which I understand will probably be on Saturday, June 13, you will proceed to Newport for the purpose of taking on board the torpedo apparatus which the Chief of Ordnance has promised to have ready for you. You will also receive there, as scientific members of the corps, Capt. J. W. Collins, Mr. Sanderson Smith, and Mr. Willard Nye, jr., and extend to them such courtesies as may be in your power. Their mess account will be charged to, and be paid by, the Commission.

As soon as you are ready, you will leave Newport for a survey of the fishing banks to the eastward, if possible extending your researches to the Grand Banks. You will visit as many of the known fishing banks as practicable in the period of your cruise, and will take the usual soundings, dredgings, trawlings, temperature records, &c., in sufficient quantity to determine the physical and biological condition of the grounds. It may be better to proceed to the most distant locality first, so as to make sure of satisfactory investigation. Those nearest to the United States can be left for the last, or for a subsequent exploration.

You will oblige me by conferring with Captain Collins in regard to the points to be visited, and accept his suggestions as far as you may consider proper.

I am desirous of obtaining as nearly as I can the contour lines, as well as the outlines, of the fishing banks, and the maximum depths of water between them, so as to furnish the data for a relief model of the fishery sea bottom. Should there be any suggestions of available localities for fishing not yet examined, it will be well to investigate these as far as convenient.

The determination of the depths off the slopes of the banks will be of interest both in a scientific and practical point of view.

You will obtain at Newport and carry with you a sufficient supply of bait to use the trawl line to a convenient extent, purchasing such quantity of ice as may be necessary to keep it in the best condition.

As stated, the period of time for this survey is left to your discretion; it may occupy a month if you think proper. You will take in your supplies of coal at the most convenient points. It is suggested that three or four hauls of the trawl be made on the slope between the banks and the Gulf Stream, somewhere between hauls 2,076 and 2,084.

Respectfully yours,

SPENCER F. BAIRD,
Commissioner.

P. S.—I am in receipt of a letter from the Bureau of Navigation asking that if not interfering with the work of the Fish Commission, the commander of the Albatross be instructed to make an examination of Hope Bank and Watson's Rock. You will do what you can to carry out this request so far as it may be done without seriously interfering with the program above indicated.

S. F. B.

We arrived at Newport at 9.50 p. m. on the 15th, and spent the following day adjusting compasses in Narragansett Bay. On the 17th we took on board $42\frac{1646}{2240}$ tons of coal, two Cape Ann dories with fittings, and a number of torpedoes from the torpedo station. These torpedoes were taken on board for the purpose of experimenting on the banks as to the effect the explosion would have on marine life. At 3.50 p. m. we got under way and proceeded to sea. Numerous menhaden steamers and mackerel schooners were seen between Beaver Tail, Block Island, and No Man's Land. Several schools of small mackerel were observed the following day south of George's Bank.

On the morning of the 19th we commenced a line of soundings to the westward of Hope Bank, and continued it over and to the eastward of its position as given on H. O. chart 21*a*, finding from 1,915 to 2,995 fathoms, demonstrating beyond doubt that no bank exists in that immediate locality.

We then stood in the direction of Watson's Rock, sounding at intervals, and when we were in the vicinity of the reported danger sounded every few miles, finding depths between 2,863 and 3,103 fathoms. The depth found at the position of the rock as given on the chart was 2,882 fathoms. As the weather was clear during this time and the observations reliable, it was proved beyond all question that there is no such danger in that locality.

Leaving the reported position of Watson's Rock, we stood for the southern end of the Newfoundland Banks, taking soundings at intervals, and on the morning of the 23d, a few miles to the southward of the banks, we found 1,070, 523, 826, 970, and 471 fathoms, respectively, thus developing a ridge. The trawl was put over at each of these soundings, but failed to reach the bottom on account of the water unexpectedly deepening. Eleven hauls of the trawl were made during the 23d, the principal results being numerous specimens of Ophioglypha, Pentacta, and Bryozoa. Haul No. 2434 contained several specimens of the Norway haddock and 26 pole-flounders, their aggregate weight reaching 106 pounds.

We then stood to the northward and eastward with the intention of examining the slough in the Grand Banks, reported* by the schooner Augusta H. Johnson, of Gloucester, Mass., and also to verify the existence or non-existence of the Nile Rocks, reported as a little north of the slough above-mentioned. Arriving in the supposed vicinity of Nile Rocks on the morning of the 24th, we took a number of hauls with the trawl, but a dense fog prevailed, making it impossible to ascertain the ship's position with sufficient accuracy for hydrographic purposes. A strong wind then springing up, followed by a heavy bank swell, obliged us to cease trawling, and being unable to afford the time to wait for clear weather, we stood to the northward under low speed, and at daylight on the 25th began trawling again.

Ten hauls were made during the day, the results being mainly numerous sea-urchins, sand-dollars, starfish, hermit-crabs, and dead shells. We communicated with two fishing schooners during the day—the Garland, of St. John's, Newfoundland, and the Keewatim, of Lockport, Nova Scotia, both reporting good fishing. In the afternoon we sounded and trawled over the position assigned to Jesse Ryder Rock, H. O. chart 21*a*. We found 40 fathoms, which corresponded with the depth marked for the vicinity on the chart, and dragged the trawl over the reported position. The weather being clear and the observations reliable, we do not hesitate to say that there is nothing of the kind existing in that locality. Fishermen who had their trawl lines laid around the position said they knew nothing of such a rock. Five hauls of the trawl were made the following morning, June 26, the results obtained being about the same as on the previous day. At 8.40 a. m., August Peterssen, seaman, fell overboard while taking in the trawl, and was drowned; the ship was stopped, a life-buoy thrown within a few feet of him, and the dinghy and whale-boat lowered, the former reaching the spot in less than two minutes from the time he fell overboard, but being unable to swim, he sunk before it reached him.

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* See F. C. Bulletin, 1885, p. 291.

At 1 p. m. we started for St. John's, Newfoundland, arriving there at 6.20 the same evening. Several icebergs were passed outside the harbor, a few of which were photographed. A boat was sent ashore with an officer to call on the American consul, who returned with the boat and paid an official visit to the ship.

Several Norway haddock taken in haul No. 2434, on June 23, contained large numbers of young about three-eighths of an inch in length.

Unsuccessful attempts were made to catch cod with the menhaden bait procured in Newport, R. I. The Grand Banks fishermen use capelin at this season of the year, followed by squid a month later. A few of the former were procured from the Keewatim on June 25, and the results were all that could be desired.

During the 29th and 30th we coaled ship, taking on board 100 tons of anthracite. On July 1 we procured two barrels of capelin bait, and at 5.35 a. m., July 2, got under way and steamed out of St. John's, Newfoundland, in a dense fog.

But four hauls were made during the day, the results obtained being numerous starfish, hermit-crabs, and shells. A line of soundings and dredgings was run along the deeper waters between the Grand Banks and the Newfoundland coast. It was continued across Green Bank, the southern end of St. Peter's Bank, and the gully between St. Peter's and the southern end of Banquereau. An extended examination at the east end of the latter bank was made for coral, but we were able to procure only a few small fragments with the apparatus we had on board. The line was then carried the whole length of Misaine Bank, across the gully between the latter and the west end of Banquereau, thence across the Middle Ground, the Northwest Prong, and then to Halifax, Nova Scotia, where we arrived at 4 p. m., July 8. We encountered dense fogs during the entire trip, with the exception of a few hours' sunshine on two or three occasions.

Trials were made for cod on the various banks. None were taken on Green Bank, but they were caught plentifully on the south end of St. Peter's, east end of Banquereau, along the entire length of Misaine, the west end of Banquereau, the Middle Ground, and on the Northwest Prong. Capelin bait was used.

On July 3 nine hauls were made, with results about the same as on the 2d. Nine hauls were also made on the 4th, one containing 19 pole-flounders. During the day 11 specimens of Goode's cup-coral, 1 large and 30 or 40 small *Macrurus Bairdii* were obtained. On the 5th twelve hauls were made, with results about the same as on the two previous days. We tried hand-lines in the evening, using capelin bait, taking 33 cod and 4 flounders. On the 6th we made ten hauls, containing numerous sea-urchins, hermit-crabs, sea-anemones, starfish, and shells. Twenty-six cod were caught with hand-lines during the day, capelin bait being used, as before. Six hauls were made on the 7th, with practically the same results, with the addition of several shrimp. Two 8-

pound torpedoes were exploded during the forenoon on the Middle Ground. The first explosion resulted in floating to the surface 1 cod and 1 haddock; the second, 1 haddock only. These results show that the explosion sends nothing to the surface except fish with large swimming bladders, and that flat-fish, squid, and other marine forms with small bladders remain on the bottom if killed.

During the forenoon of the 8th four hauls were made, containing numerous starfish, sea-anemones, sea-urchins, and shells, and in one 15 Norway haddock, 6 flounders, 1 goose-fish, and a number of sponges.

An officer was sent ashore to visit the United States consul-general, M. H. Phelan, immediately upon our arrival at Halifax. Arrangements for coaling were completed on the 9th, and 50 tons of anthracite coal were taken on board on the 10th, at a cost of $6 per ton delivered on the rail, the vessel being at the wharf.

We left Halifax at 8 a. m. on July 11, and at 10.51 a. m. put the dredge over in 68 fathoms on Sambro Ledge. The lead indicated a bottom of black mud and broken shells, but the dredge encountered a rocky bottom, in which it became entangled and was lost, with about 80 fathoms of rope. But four hauls were made during the remainder of the day, two with the dredge and two with the small beam-trawl. The dredge contained a few worms and dead shells. The trawl brought up numerous specimens of *Schizaster fragilis*, sea-anemones, shrimp, shells, ten Norway haddock, and four hake.

The following day eight hauls were made, seven with the dredge and one with the small beam-trawl. At 5.35 a. m. the dredge was lowered, remaining on the bottom but five minutes, when, the bridle parting, it was lost. The results of the day were mainly small quantities of starfish, sea-anemones, shells, and worms. At 12.15 p. m. one 10-pound torpedo was exploded in about 60 fathoms of water, but no fish floated to the surface. During the 13th five hauls were made, one at 6.29 p. m., which contained several pole-flounders, a rare species of sea-anemone, a few sprays of gold-banded coral, and a large quantity of *Primnoa*. At 1.30 p. m. we lowered the dories and engaged in dragging for coral with grapnels. The boats returned at 4.30 p. m. with a few small sprays. Numerous schools of finback whales, swordfish, and porpoises were passed continually during the day feeding in the strong current between George's and Brown's Banks.

On the 14th there were but four hauls taken, containing numerous holothurians, ophiurans, shells, and a few pole-flounders. At 11.30 a. m., on reaching the surface, the net of the large beam-trawl began parting from the frame, occasioned by the heavy weight of mud and stones with which it was loaded. It was finally secured and hoisted on board without loss. Several schools of finback whales were seen during the day.

Three hauls of the large beam-trawl were made on the 15th in 828, 1,234, and 1,149 fathoms, respectively, with about the same results as on the previous day. At 3.45 p. m. the experimental water-bottle was lowered to 500 fathoms and a water specimen procured for analysis.

We started for Wood's Holl, Mass., at 4.30 p. m., and arrived at 12.45 p. m. on July 16.

The details of the scientific explorations during the cruise are left to the various specialists; this report aiming simply to record the movements of the vessel, and general mention of the work performed.

We were detained until August 6, making necessary repairs to machinery, coaling ship, &c. At 6.25 p. m. on that day we left port with the intention of visiting the grounds where tile-fish were formerly found, and to secure, if possible, specimens of that fish, having obtained a quantity of fresh menhaden bait for the purpose. Messrs. W. Libbey, jr., Sanderson Smith, and L. A. Lee came on board as naturalists for the trip, in addition to Mr. James E. Benedict, resident naturalist, and Mr. Thomas Lee, assistant.

The weather was clear and pleasant during the night with light southerly breeze and smooth sea. We arrived on the ground at daylight the following morning and cast the trawl in order to find a favorable "live" bottom. At 8.30 the trawl lines were set in 133 fathoms, green mud and sand, latitude 39° 59′ 45″ N., longitude 70° 53′ W.; 49 hake, 7 whiting, and 5 skate were taken, but no tile-fish. The lines were set again at 3 p. m. in 129 fathoms, sand and broken shells, latitude 40° 00′ 15″ N., longitude 70° 42′ 20″ W.; 34 hake, 9 whiting, and 1 haddock were taken, but, as before, no tile-fish. Eight hauls of the beam-trawl were made during the 7th, near where the trawl lines were set, the results being mainly large numbers of sea-anemones, sea-pens, starfish, shells, and fish. There was a noticeable absence of specimens which were found abundantly in the same locality during the summers of 1880 and 1881. The large surface tow-net was successfully used during the evening and several squid were taken with the aid of the electric light. A porpoise was caught, the brain taken out and preserved, and the remainder thrown overboard.

At 6.15 on the morning of the 8th the trawl lines were set in 131, fathoms, green sand, black specks, latitude 40° 01′ 45″ N., longitude 70° 24′ W. Thirty-seven hake, 6 whiting, 2 skate, and 5 *Sebastes* were taken, but no tile-fish. A brisk easterly breeze and heavy swell prevented our resetting the trawl lines, and the day was passed in dredging. Six hauls of the trawl were made in from 130 to 570 fathoms. The results of the day's work were numerous starfish, sea-pens, shells, a few shrimp and sponges, 8 large spider-crabs, and a quantity of *Acanella*. Several cephalopods (*Alloposus mollis*) were seen on the surface, two of which were captured, one being quite perfect. A few porpoises, one shark, and occasionally a petrel were the only life seen during the day.

The easterly wind continued during the night, making the sea too rough the following morning to set the trawl lines. Five hauls of the trawl were made during the day in from 445 to 1,081 fathoms. Numerous starfish, brittle-stars, crabs, shrimp, shells, and a small quantity of *Acanella* were the results. During the second haul the trawl buried, parting the rope at 1,510 fathoms. The trawl with everything attached was lost. The rope parted at the engine, an unusual occurrence, the kinks in the working end usually insuring its parting near the trawl, thus resulting in the loss of but little rope. A set of serial temperatures to 300 fathoms was taken in the evening; the large surface townet used with excellent results, and the submarine electric light was brought into requisition to aid in the capture of squid.

At 6 a. m. on the 10th, the wind and sea having moderated, the trawl lines were set in 136 fathoms, green mud and sand, latitude 39° 53′ N., longitude 71° 32′ W. Twelve hake and 6 skate were taken. The lines were again set at 1.05 p. m in 120 fathoms, brown mud and sand, latitude 39° 48′ N., longitude 71° 48′ 30″ W. Six hake, 1 goose-fish, and 4 skate were taken, but no tile-fish. Seven hauls of the trawl were made during the day in from 143 to 500 fathoms, numerous starfish, shrimp, and shells being taken. A set of serial temperatures was taken in the evening to 300 fathoms. The surface tow-net and the submarine electric light were used with good results. An enormous school of porpoises passed near the ship during the evening, and a couple of dolphins were seen swimming about at intervals through the day. As our bait was exhausted we stood into deeper water, and at 5.50 a. m. on the morning of the 11th cast the trawl in 1,434 fathoms, gray ooze, latitude 39° 15′ 30″ N., longitude 71° 25′ W. Three hauls were made during the day in about the same locality, the results being numerous starfish, shrimp, shells, and a great quantity of *Benthodytes*. A fine dolphin was caught with hook and line, and an unsuccessful attempt made to strike a porpoise. In the evening a set of serial temperatures was taken to 1,000 fathoms. The second haul brought up a quantity of diatomaceous earth, nearly white in color.

At 9 p. m. we started for Wood's Holl, and on the morning of the 12th stopped on Cox's Ledge and tried for codfish without success. At 4.10 p. m. we arrived and moored to the Fish Commission wharf.

We reeled 1,500 fathoms of new dredge-rope on the drum, making the total length of the rope 4,610 fathoms. At 6.50 a. m. on the 17th we commenced to coal, taking on board 53 tons. We remained in port taking in laboratory stores, fitting trawl nets, and making general repairs until 1.10 p. m. on August 27, when we cast off from the Fish Commission wharf and stood out to sea. The weather was clear and pleasant, with a light NW. breeze. At 12.19 p. m. on the 28th we sounded in 2,069 fathoms, latitude 38° 19′ 20″ N., longitude 69° 02′ 30″ W., and put over the large beam-trawl. It came up comparatively empty, containing only shrimp and small fish, it probably having skipped along the bottom, touching only now and then, owing to the current of the Gulf Stream. Serial temperatures were taken in the evening to 1,000 fathoms, and the large surface tow-net was used with good results. The submarine electric light was also used, quite a number of flying squid being captured.

A gull and a swallow were the only birds seen, even the petrels having disappeared for the day. The officer of the deck reported a large fish on the surface early in the morning, which he failed to recognize. According to his report, it had barnacles on its back, was propelled by side fins, and seemed to have a pouch under its mouth. This unrecognized fish was undoubtedly a large turtle floating on the surface, not an unusual sight in the Atlantic.

At 4 a. m. the following day we sounded in 2,620 fathoms, latitude 37° 23′ N., longitude 68° 08′ W., and put over the large beam-trawl, several starfish, shells, shrimp, hermit-crabs, and foraminifera being taken. We took serial temperatures to 1,000 fathoms, and, as on the previous day, the large surface tow-net and submarine electric light were advantageously used. Two dolphins (*Coryphæna*) were caught during the day, one with a hook and line, the other with the grains.

At 5.27 a. m. on the 30th, the large beam-trawl was cast in 2,721 fathoms, latitude 37° 45′ N., longitude 66° 56′ W., and while heaving in, the dredge-rope parted, losing the trawl and its appurtenances, beside 3,030 fathoms of rope. The fracture occurred at a splice where the experimental rope was attached to the standard dredge-rope, the tension being between 3,500 and 4,000 pounds. It should have stood twice that strain with safety. The experimental rope referred to was 1,000 fathoms, having a lower tensile strength and greater pliability than the standard rope. It was supposed to be less likely to kink, therefore more reliable than a rope of higher tensile strength in which kinks cannot be avoided, particularly near the end. We reeled on 1,500 fathoms of new rope, this being all we had, and as we were then left with only 3,000 fathoms on the drum, the remainder of the cruise was necessarily confined to depths under 2,000 fathoms. The vessel was at once headed to the northward and eastward to reach the desired locality. The weather remained clear and pleasant during the forenoon with light to moderate breeze from the southward and eastward, becoming overcast with frequent rain-squalls in the afternoon, falling calm at 8.45 p. m. At 9.45 p. m. the wind came out suddenly from northeast, blowing a moderate gale, which increased to a fresh gale at midnight. It gradually decreased to a light breeze at meridian on the 31st, and was cloudy and rainy the whole day. Two hauls of the beam-trawl were made, one in 1,781 fathoms, latitude 39° 15′ N., longitude 68° 08′ W., and the other in 1,782 fathoms, latitude 39° 26′ N., longitude 68° 03′ 30″ W. Numerous starfish, shrimp, hermit-crabs, 15 species of shells, several species of coral, and a quantity of foraminifera were the results.

On September 1st two hauls were made with the beam-trawl, the first in 1,813 fathoms latitude 39° 54′ N., longitude 67° 05′ 30″ W.; the second in 1,356 fathoms, latitude 40° 09′ 30″ N., longitude 67° 09′ W. Large numbers of grenadiers, starfish, sea-urchins, *Acanella*, a few small nautilus, several shrimp, and a quantity of foraminifera were procured. Serial temperatures were taken to 1,000 fathoms in the evening, and the large surface tow-net and submarine electric light used, as usual, with excellent results. The weather continued overcast and rainy during the forenoon, but cleared later in the day.

During the morning of the 2d instant the large beam-trawl was put over in 1,769 fathoms, latitude 40° 29′ N., longitude 66° 04′ W., and on being landed on deck it was found to be badly torn. A few shrimp, a lump of red clay, some heavy stones, and a large amount of foraminiferous ooze were found in the net. The small beam-trawl was put over in the afternoon in 1,742 fathoms, latitude 40° 34′ 18″ N., longitude 66° 09′ W., and a number of starfish, sea-urchins, sponges, and a quantity of foraminifera were brought up. We took a set of serial temperatures to 1,000 fathoms in the evening, and the large surface tow-net and submarine electric light were used with good results.

At 7.19 a. m., on the 3d, we put the large beam-trawl over in 1,791 fathoms, latitude 41° 02′ 30″ N., longitude 65° 08′ 15″ W. While dragging on the bottom it caught on some obstruction and parted the rope near the end, the trawl and its appurtenances being lost. The small beam-trawl was lowered at 1.43 p. m. in 1,710 fathoms, latitude 41° 07′ N., longitude 65° 26′ 20″ W., and brought up several grenadiers, brittle-stars, holothurians, one large red shrimp, and a few specimens of coral. Serial temperatures were then taken to 1,000 fathoms. The large surface tow-net and the electric light were used during the evening. Three large steamers were seen during the day, two bound to the eastward and one to the westward. We exchanged colors with one of the former, a German.

We worked well within the limits of the Gulf Stream after the 28th, and it is worthy of remark that with the exception of the haul made on that date, we experienced no easterly current. On the contrary we at times observed a slight set to the southward and westward. The Stream was probably affected by the cyclone of the 25th and 26th of August.

Five hauls of the small beam-trawl were made during the afternoon of September 4, in from 18 to 85 fathoms, along the southern and western part of George's Bank, numerous starfish, a large quantity of bryozoa, shells, scallops, sand-dollars, shrimp, sea-anemones, sea-urchins, pole-flounders, and sculpins being the result.

At 10 p. m. we started for Wood's Holl, where we arrived at 9.05 a. m., September 5th, and made fast to the Fish Commission wharf. The specimens procured during the trip were transferred to the laboratory. We coaled ship on the 7th, taking on board $92\frac{800}{2240}$ tons, and were engaged in overhauling rigging, making trawl-nets, renewing splices on the dredge-rope, and making general preparations for a trip, until 4 p. m., September 17th, when we cast off from the wharf and proceeded to sea.

We were to search for tile-fish in the vicinity of 39° N. latitude, and 72° W. longitude, in from 100 to 600 fathoms, and were provided with 3 barrels of fresh menhaden bait for the purpose.

The weather was clear and pleasant during the night, with moderate SW. breeze and smooth sea. At 7.10 a. m. on the 18th, we cast the trawl in 394 fathoms, green mud, latitude 39° 43′ N., longitude 71° 34′ W. A fishing party left the ship and set a trawl line in the position above indicated. Three hauls of the beam-trawl were made during the day between this position and latitude 39° 50′ 45″ N., longitude 71° 43′ W., in 131 fathoms, green mud and sand, and although the bottom was not particularly rich, many ophiurans, archasters, and worm-tubes were taken, besides hermit-crabs, *Epizoanthus americanus*, shells, sea-anemones, *Salpæ*, and single specimens of *Geryon quinquedens*, *Lophius piscatorius*, and *Octopus Bairdii.*

The fishermen returned at noon, having taken but 1 hake, 1 skate, 1 dogfish, 1 whiting, and 3 eels. The trawl line was set again at 2.15 p. m. in 137 fathoms, green mud, latitude 39° 50′ N., longitude 71° 43′ W., and taken up at 6.25 p. m., with 26 hake and 6 skate. Chester's fish-trap was set near the trawl line, taking a single specimen of eel (*Myxine glutinosa*). This trap does not differ in principle from the ordinary lobster-pot, except that it is made of wire gauze instead of wood, and is intended for use in deep water. The large surface net and submarine electric light were used during the evening with fair success.

At 7 a. m., the following morning, the trawl was lowered in 541 fathoms, gray mud, latitude 39° 05′ 30″ N., longitude 72° 23′ 20″ W. A few ophiurans, archasters, shells, a large number of deep-sea fish, and a squid being taken. The trawl line was set at 10 a. m. in 519 fathoms, green mud, latitude 39° 05′ 30″ N., longitude 72° 25′ 30″ W., and was taken up at 4.20 p. m. with no fish. But few of the baits had been disturbed, although fish of various kinds were plentiful on the bottom, as indicated by the number taken in the beam-trawl.

Chester's fish-trap was set soon after the fishermen left in the morning, and was not recovered, the buoy having sunk. At 4.29 p. m. we cast the trawl in 542 fathoms, gray mud, latitude 39° 08′ 30″ N., longitude 72° 17′ W. The rope parted at 321 fathoms while heaving in, the trawl and its appurtenances being lost. The rope broke at an indicated strain of 1,700 pounds, which we always consider well within the limit of safety; in fact, the bridle-stops are intended to part at nothing less than 3,000 pounds.

Three sharks were taken with hook and line, two of them unusually large, and one of moderate size. The latter had been feeding on squid, nearly two deck-buckets full being found in its stomach.

The large surface net and the submarine electric light were used successfully during the evening and just before daybreak the following day. The trawl line was set again at 9.25 a. m. on the 20th, in 328 fathoms, gray mud, latitude 39° 02′ 40″ N., longitude 72° 40′ W., and taken up at 2.55 p. m. There were no fish caught and most of the baits remained untouched. Three hauls of the trawl were made between the above position and latitude 39° 02′ N., longitude 72° 36′ W., in 479 fathoms, green mud, and, although the forms were generally well known, some were exceedingly rare and a few new to us. Among the invertebrates starfish, sea-anemones, shrimp, &c., were the most abundant; several kinds of shells were found also, and sixteen species of fish, the most numerous being *Macrurus Bairdii*, *Glyptocephalus cynoglossus*, and *Phycis Chesteri*. During the last haul the trawl buried, and the net was torn from the frame before it could be released from the bottom. It was blowing a fresh breeze at the time with considerable swell, but the vessel rode for over an hour by the dredge rope after it was hove short, without parting it or breaking out the trawl.

The surface net and submarine light were used during the evening and before daylight on the morning of the 21st. At 8.37 a. m. the trawl line was set in 231 fathoms, green mud, latitude 38° 55′ N., longitude 72° 50′ 30″ W. It was taken up at 3.20 p. m. with one wry-mouth, eight hake, four skate, and one whiting. Three hauls of the trawl were made during the day between the above position and latitude 38° 53′ 30″ N., longitude 72° 52′ W., in 138 fathoms, green mud and sand. Life was found more abundant and the hauls were all successful. Among the many forms taken may be mentioned *Ophioglypha Sarsii*, *Octopus Bairdii*, *Asterias Tanneri*, archasters, sea-anemones, shrimp, *Calistoma Bairdii*, hermit-crabs, &c., beside fourteen species of fish.

At 3.25 p. m. we started ahead S. ½ E. (p. c.) to change our working ground. The barometer was falling steadily with every appearance of bad weather. At 8 p. m. the engines were slowed and the surface net and submarine light used till 10 p. m., when the course was resumed. We entered the Gulf Stream at 4 a. m. on the 22d, in latitude 37° 40′ N., longitude 72° 40′ W., and hove to until 8 a. m., when, the wind having increased to a moderate gale, we ran to the northward about 16 miles to avoid the confused sea of the Stream, and hove to under the fore storm-staysail, bringing the wind and sea a little abaft the starboard beam. The barometer fell to 29.58 about 2 p. m., then began to rise slowly, the wind backing to the northward and increasing to a fresh gale. The ship rode very comfortably until 9 a. m. on the 23d, when we wore to the northward and started ahead about 5 knots per hour to increase our distance from the Gulf Stream, which had been driven to the northward by the gale of the previous days. We had a moderate to fresh gale during the 23d from NW., increasing to a strong gale in the evening with a very heavy sea, which began to come on board in the weather gangway, doing no damage, however, except breaking a pane of glass in the pilot-house and another in the wardroom skylight. At 7 p. m. we slowed to 2½ knots and passed a very comfortable night. The wind and sea moderated during the morning of the 24th, and as we had reached the limit of time assigned for the trip, the speed was increased and the ship headed for Wood's Holl, under steam and sail.

The surface net and submarine light were used during the gale until the naturalists became discouraged by their failure to procure specimens. All of the various forms usually taken in vast numbers on the surface, particularly in the mornings and evenings, seemed to have disappeared; even the Gulf weed sunk below the surface, being seen a few fathoms under water. We have always noted a marked diminution in the surface forms taken in rough weather, but in this instance there was almost a total disappearance.

We arrived in port at 6.30 a. m., September 25, and moored to the Fish Commission wharf. The specimens were sent to the laboratory during the day.

The boilers required some slight repairs, which were completed about October 1, when preparations were made for leaving the station for the season, and all articles of equipment and scientific outfit which were not to be left at Wood's Holl for the winter were taken on board. Ninety tons of coal were taken in on the 6th, and at 9.30 a. m., October 8, we cast off from the wharf and started for Newport, R. I., where we arrived at 3.20 p. m., and anchored in the inner harbor. The electric torpedo apparatus borrowed from the torpedo station for use on our Newfoundland trip was returned and proper acknowledgments made to the commandant.

At 7.30 a. m. on the 9th we got under way and steamed out of the harbor bound for New York *via* Long Island Sound. Fresh northerly winds were encountered during the day with cool weather. We anchored off Great Captain's Island at 9 p. m., got under way at daylight the following morning, and anchored off 23d street, North River, at 10.25 a. m. The Albatross was among the last vessels to pass through Hell Gate previous to the explosion of Flood Rock, which occurred at 11.14 a. m. The explosion was not noticed on board, and we did not know that it had taken place until information to that effect was received from shore.

An officer came on board from the French flagship Floré soon after we anchored, with the admiral's compliments, and tendered the usual civilities. The call was returned on the 12th.

We called at New York for stores and various articles of equipment which could be procured to better advantage there than in Washington. An ample supply of fresh menhaden bait was taken on board for use in our search for tile-fish, which was to be extended to the southward of Cape Hatteras.

We remained at our anchorage until 11.10 a. m. on the 15th, when we got under way and proceeded to sea. The weather was pleasant, with moderate westerly winds. We were under steam and sail till the following morning, when the engines were slowed down to allow of surface towing, which has recently been a marked feature in our investigations, the improvements in towing-nets having practically opened a new field to us. The surface-nets were put over again in the evening, with gratifying results.

At 10.54 a. m. on the 17th we set the trawl line in 120 fathoms, fine gray sand, latitude 35° 02′ 20″ N., longitude 75° 12′ W., and after the fishermen left the ship the trawl was lowered, taking a few fish, dead shells, worms, a single hydroid, &c., the bottom being exceedingly barren. The trawl line was taken up at 3.30 p. m., a single dogfish being the only catch. The weather buoy sunk, and while hauling in from the leeward the line parted, the weather buoy, anchor, and line, and a portion of the trawl line being lost.

Five hauls of the trawl were made in the vicinity during the day, resulting in the capture of many starfish, crustacea, fish, corals, and a great variety of shells, mostly minute forms. Surface towing was carried on both in the morning and evening with excellent results.

At 6 a. m. on the following day, we cast the trawl in 15 fathoms, gray sand, latitude 34° 57′ N., longitude 75° 43′ 30″ W., and ran a line of dredgings off shore until 11.40 a. m., when the trawl line was set in 124 fathoms, sand and rock, latitude 34° 38′ 30″ N., longitude 75° 33′ 30″ W. When taken up at 4 p. m., there were only two small sharks found on the hooks, although many of the baits were gone. The strong current of the Gulf Stream towed the weather buoy under, and the line parting while heaving in, the remaining portion of the gear was lost.

The rock referred to was a sandstone, fragments of which, from a few inches to 2 feet in diameter, and from 2 to 4 inches in thickness, came up in the trawl. It was perforated in all directions with holes, from half an inch to an inch in diameter, and closely resembled the clay or rottenstone formation referred to in previous reports found off the capes of the Delaware.

After the fishermen returned we continued the line of dredgings, ten hauls being made during the day, and many interesting specimens taken. The bottom was, as a rule, clean sand, washed by the sea during every gale, and a portion of it swept by the action of the Gulf Stream, which in that locality extends to the bottom. Among the many forms taken were several varieties of starfish, brittle-stars, shrimp, sea-anemones, small squid, holothurians, rare and beautiful sea-urchins, a few Cephalopods, Astrophytons, sand-dollars, *Munidas*, and a variety of shells, both large and small, the minute forms in particular being taken in great numbers. There were also a variety of fish taken, among them large numbers of young scup, which were subsequently used for bait, a few file-fish, and a number of shoal-water species. A large spotted porpoise was harpooned during the evening, and preserved for examination. It is a rare species in the Atlantic, and was first seen by us off Cape Hatteras in June last. The large surface-nets were used in the morning and evening, and at intervals during the day, with excellent results.

After finishing work in the evening we stood slowly to the westward, and at 6 a. m. on the 19th the trawl was cast in 18 fathoms, fine gray sand, latitude 34° 38′ N., longitude 76° 12′ W. Eight hauls were made during the day between the above position and latitude 34° 09′ N., longitude 76° 02′ W., the results being practically the same as on the previous day.

A trawl line was set at 1.10 p. m. in 168 fathoms, gray sand and black specks, latitude 34° 09′ N., longitude 76° 02′ W., and was taken up at 5.50 p. m. with no fish. The surface tow-nets were used with good results both in the morning and evening. At 6.17 a. m. on the 20th we cast the trawl in 18 fathoms, gray sand, latitude 33° 45′ N., longitude 77° 25′ W., and made nine hauls during the day between the above position and latitude 33° 37′ 15″ N., longitude 77° 35′ 30″ W., on the northeast extremity of Frying-Pan Shoals, where numerous coral patches were found abounding in marine life. Several species of coral and shells, both dead and alive, were taken, besides sponges, hydroids, crustacea of many forms, and a variety of shoal-water fish.

A trawl line was set at 3 p. m. in 15 fathoms, gray sand and broken coral, latitude 33° 38′ N., longitude 77° 36′ W., and taken up at 5.20 p. m., with 12 black bass, 2 scup, 1 dogfish, 1 grunt, and 1 bluefish. Hand-lines were used at intervals during the day, taking 138 black bass, 1 scup, 1 dogfish, and 1 grunt. The vessel was not anchored, but allowed to drift, the fish being taken while passing over coral patches or *live bottom*. The surface-net was used in the evening with good success, and the submarine electric light was tried, but contrary to our usual experience we obtained very few specimens.

We steamed off shore during the night, and at 6.27 a. m. on the 21st cast the trawl in 258 fathoms, gray sand and black specks, latitude 32° 36′ N., longitude 77° 29′ 15″ W. Five hauls were made during the day between the above position and latitude 32° 21′ 30″ N., longitude 76° 55′ 30″ W., in 528 fathoms, yellow mud. We were within the limits of the Gulf Stream, but experienced little or no current during the first two hauls; a light but perceptible drift during the third, and the last two were made in the full strength of the Stream. The results of the day's work were very satisfactory, many rare and valuable specimens being taken, some entirely new to us. Among the numerous forms were many soft sea-urchins, hermit-crabs, long-spined sea-urchins, corals, cephalopods, crabs, and a variety of fish. The surface-nets were used in the early morning, and after the last haul serial temperatures were taken. The weather changed during the night of the 20th, and rain-squalls with variable winds were encountered on the 21st, the wind increasing until at dark we had quite a heavy sea.

Our supply of alcohol being exhausted, we started for port at 7.14 p. m., as soon as the work of the day was finished. The wind continued fresh from northeast during the night, and being in the Stream a heavy head sea was encountered. Cape Hatteras light was sighted at 5.19 p. m. on the 22d, and at 6 a. m. on the 23d we made Cape Henry light, passing it at 7 a. m. The wind moderated as we approached the coast, and after entering the Chesapeake we had a light northerly breeze and clear weather.

At 2.30 p. m., off Point Lookout, we swung ship under steam to ascertain compass errors, and at 4.35 p. m. resumed our course up the river, anchoring off Blakistone's Island for the night. We were under way again at 6.15 a. m. on the 24th, and arrived at the navy-yard, Washington, D. C., at 3.10 p. m., mooring at our usual berth off the east ship-house.

The specimens on board were transferred to the Smithsonian Institution, and the work of refitting commenced. The vessel was painted, the rigging refitted, holds and store-rooms broken out, whitewashed or painted, and restowed, and the bilges cleaned. The dredging apparatus was overhauled, and 2,000 fathoms of new dredge-rope procured. New trawl and dredge frames were provided, the dredging-block repaired, and a cast-brass hood added to prevent the rope from flying out of the score when, from any cause, it is slackened.

We have taken a new departure in surface collecting, and instead of the old form of net, with a hoop 1 foot in diameter, we have enlarged it to 4 feet, and strengthened the parts so that it can be towed at the rate of 5 knots an hour. It has a pocket similar to the trawl, which prevents the escape of fish. This development of the surface net has opened a new and interesting field of investigation, in which we have made many additions to the surface fauna.

The table of fishing stations appended to this report shows the extent to which we have prosecuted the search for tile-fish. They were discovered by Captain Kirby, in May, 1879, in latitude 40° 04′ N., longitude 70° 59′ W., at a depth of 80 fathoms, and were taken again, in July, 1879, by Captain Dempsey, in 87 fathoms, latitude 40° 02′ N., longitude 70° 07′ W. We took them in considerable numbers during the seasons of 1880 and 1881, previous to the unprecedented destruction of the species in March and April of the following year. As they were a fish of great commercial value, we have made diligent search for them from year to year since 1882 in the region where they were first found, extending the search as far as the coast of North Carolina in 1883 and 1884, and to Newfoundland and the Gulf of Mexico in 1885, without discovering the least trace of their existence.

Our experience seems to confirm the belief that they were entirely exterminated or that the survivors abandoned our coast. The table referred to shows also the investigations carried on with reference to other edible fish in widely separated localities.

Two attempts further to investigate the tile-fish grounds by means of chartered fishing schooners should be mentioned as properly belonging to the records of search by the U. S. Fish Commission. The first in 1880, in which the vessel failed to reach the grounds, and the second in 1882, after the destruction and disappearance of the fish from their former haunts. The vessel reached the grounds and carried on the investigations for several days, but failed to find any trace of tile-fish.

In the engineer's department the principal work was on the boilers, which required several new patches, renewal of old ones, &c. Counterbalances were put on the main engines, which make them run more smoothly and enables us to turn them over much slower while dredging, thus bringing the speed of the vessel down to the desired limit for deep-water work.

The most important improvement in the engineer's department during the year was the introduction of "Baird's annunciators," which are fully described in his report. They are designed to show the action of the engines to the officer on the bridge or the quartermaster in the pilothouse. It is desirable at all times to know whether engine signals have been rightly understood and answered, but doubly so when sounding or dredging. The annunciators show at a glance what the engines are doing.

Personnel.—Many changes have occurred among the officers during the year. Ensigns R. H. Miner and L. M. Garrett were detached on the 22d of April; Lieut. H. S. Waring reported for duty October 11; Ensign Franklin Swift was detached on November 4; Lieut. A. C. Baker on November 10; Lieut. C. J. Boush on December 12; and Lieut. B. O. Scott reported for duty on December 21.

At the close of this report, December 31, the Albatross was practically ready for sea.

The following officers were attached to the vessel at the end of the year:

Z. L. Tanner, lieutenant-commander, U. S. N., commanding.

Seaton Schroeder, lieutenant, U. S. N., executive officer and navigator.

H. S. Waring, lieutenant, U. S. N.

Bernard O. Scott, lieutenant, U. S. N.

J. M. Flint, surgeon, U. S. N.

C. D. Mansfield, paymaster, U. S. N.

G. W. Baird, passed assistant engineer, U. S. N.

NAVIGATION REPORT OF LIEUT. SEATON SCHROEDER, U. S. N., NAVIGATOR.

During the year 1885 the cruising of the Albatross has been comprised between the parallels of 20° and 48° north latitude, and the meridians of 49° and 90° 30′ west longitude.

The following table gives the number of days under way, together with the distances run and the object of each trip:

Date.	Object.	Distance.
		Miles.
January 4 to 10	Sounding and dredging	1,069.6
January 12	Swinging ship	30.0
January 16	Key West, Fla., to Havana, Cuba	114.0
January 17 to 20	Sounding and dredging	80.0
January 21 to 23	do	393.0
January 29 to February 3	do	774.4
February 7 to 8	Sounding, dredging, and fishing	267.0
February 11 to 14	Sounding and dredging	329.0
February 20	Shifting berth	4.0
March 1 to 5	Sounding and dredging	404.0
March 7 to 9	Sounding, dredging, and fishing	347.0
March 13 to 18	do	521.0
March 19 to 20	do	233.1
March 30 to April 7	do	1,109.3
May 25 to 26	Washington, D. C., to Baltimore, Md	180.0
May 31	Baltimore, Md., to Norfolk, Va	163.0
June 3 to 8	Sounding, dredging, and fishing	658.2
June 14 to 16	Washington, D. C., to Narragansett Bay	527.6
June 17	Swinging ship	25.0
June 18 to 27	Sounding, dredging, and fishing	1,433.5
July 2 to 9	do	746.0
July 11 to 17	do	653.0
August 7 to 13	do	495.0
August 28 to September 5	Sounding and dredging	1,014.0
September 18 to 25	Sounding, dredging, and fishing	713.3
October 8 to 10	Wood's Holl, Mass., to New York	172.0
October 15 to 25	Sounding, dredging, and fishing	1,249.4
Total, 130 days		13,705.4

During the year 625 sounding stations have been occupied, of which 318 were also dredging stations. A large number were located with sufficient accuracy to be of hydrographic value, and lists of such were sent to the Bureau of Navigation, Navy Department. Lists of those near the United States coasts were also sent to the Coast Survey Office, Treasury Department.

Following is a table of reported banks and shoals over or near which the depths were found in the positions given:

Name.	Latitude N.	Longitude W.	Depth.
	° ′ ″	° ′ ″	*Fathoms.*
Hope Bank	41 26 15	63 15 00	2,020
Do	41 22 00	63 10 00	2,094
Hamilton Bank	40 24 30	54 24 00	2,957
Watson's Rock	40 18 30	53 39 30	2,863
Do	40 16 00	53 16 30	2,882
Jesse Ryder Rock	46 28 00	49 39 30	40
Do	46 29 00	49 39 30	39
Five Fathoms (Green Bank)	45 45 30	54 20 30	41

Other soundings than those quoted were taken on each side of these dangers, conclusively proving their non-existence. The trawl-net was also dragged over the vicinity of the Jesse Ryder Rock without discovering any sign of an elevation of the bottom.

While at anchor off the village of San Miguel, island of Cozumel, Yucatan, a reconnaissance was made of the bay, and forwarded to the Bureau of Navigation, Navy Department. The longitude of the plaza, established by equal altitudes of the sun with sextant, artificial horizon, and four chronometers, was found to be 86° 57′ 59.6″ W.; the latitude was found by thirteen ex-meridian altitudes of the sun, with artificial horizon, to be 20° 30′ 46″ N., and the compass variation 6° 24′ E.

The shore line was run in, and houses and other landmarks located by compass, sextant, and micrometer telescope, a man 6 feet tall serving as staff for the latter. The anchorage was also sounded out and sailing directions prepared.

While working in the Gulf of Mexico the opportunity was taken of furnishing the Navy Department with remarks on the landfall of Pensacola, Fla., steamer beacons in Tampa Bay, the entrance to the South Pass of the Mississippi River, and currents in the Gulf. Special soundings were also taken eastward of the Mississippi delta, which proved the non-existence of a 30 to 40 fathom bank, represented on old charts as extending eastward about 30 miles from longitude 88° 10′ on the parallel of 29° 05′. Fishermen seeking new grounds have sought for this bank and wasted money in the search.

A short line of soundings run out southeastward into the Gulf Stream from between Capes Fear and Romain, South Carolina, showed that the bottom is rather flatter there than is indicated by the negative soundings given on the charts to the northeastward and southwestward.

Opportunity was taken to make a slight examination of the bottom near the 100-fathom line south of Nantucket Island, where indications had been found in 1884 of an inward sweep of the 200 to 600 fathom curves. This was found to be the case, a marked pocket making in on the meridian of 75° 15′ W., latitude 39° 50′ to 40°.

The phenomenon of semi-diurnal tidal currents was again observed in latitude 39° 40′ to 40°, between the meridians of 70° and 71°, where it had been noticed in previous seasons. Their directions seem to be nearly east and west, but it was not practicable while dredging to ascertain with any accuracy the time of turning.

The position, as given on the charts, of the southeast end of Banquereau was found to be erroneous. With favorable circumstances for accurate work, the 100-fathom curve was found to be 10 miles farther to WNW. than represented.

While sounding in the vicinity of Watson's Rock and farther west, the northern edge of the Gulf Stream was found to be in about latitude 40° 20′ between the meridians of 53° and 60°; and while running along that line, on the 19th to 21st of June, on an easterly course (true), the vessel would alternately be in water of 76° and of 63°, and frequent observations, under favorable circumstances, day and night, showed that when in the warm water a moderate ENE. set was experienced; on emerging into cooler water the ship was immediately set to the southward, the wind being east to northeast, and on reaching warmer water again the same easterly current was found.

The table of hydrographic soundings and record of dredgings and trawlings give the position and depth of all soundings taken during the year. The numbers above 2,000 indicate dredging stations.

The ship was swung for deviations in different latitudes three times during the year. At Key West, Fla., latitude 23° 30′, in January; in Narragansett Bay, latitude 41° 30′, in June; and at the mouth of the Potomac River, latitude 38°, in October. In each case the ship was swung on even keel once with starboard and once with port helm, the object observed being the sun. From the mean deviation curves thus obtained, the accompanying steering-cards were constructed, in which the points of the inner circle represent the magnetic courses to be made, the radial lines from them showing on the outer circle the corresponding courses to be steered by the standard compass.

The deviations are nearly the same now as in the spring of 1883 for the same latitude. At the time of swinging ship in the Chesapeake then, there were three spare pieces of iron railing lashed fore and aft to the hand-rail on the port side abreast of the compass, and 8 feet from it; these were removed shortly afterwards, and the change in the magnetic conditions affected the compass somewhat, the greatest westerly deviations (on the ESE. course) becoming ¼ point greater than the greatest easterly deviation on the west course, while previously they had been practically equal. All subsequent swingings were performed under the same circumstances, mutually, as regards movable metal masses.

There has been observed a noticeable illustration of the well-known reciprocally inductive influences of magnetic needles and masses of iron in certain positions relative to each other and to the magnetic meridian. Immediately abreast of the center of the standard compass, 12 feet 7 inches from it on the starboard side, is the forward vertical iron davit of the seine boat. When swung in, the head of this curved davit is 7 feet 9 inches laterally and 4 feet vertically from the center of the card; when rigged out it is 17 feet 5 inches off laterally and 4 feet vertically, the body of the davit remaining stationary. It has been noticed for a long time that the compass is markedly affected by the latter position of the davit, but it is usually kept rigged in when at sea, in the same position as when the ship is being swung on even beam. There has been neither occasion nor opportunity to prepare a separate curve of deviations with it rigged out. Isolated observations show that the greatest disturbance occurs on the northerly and southerly courses. In latitude 35° to 40°, swinging the davits out changes the deviation about one point to the westward on a N. by E. course, and about the same amount to the eastward on a S. by W. course, the disturbance decreasing eastward and westward from those points to nothing at east and west, where the needle points to or from the disturbing element, and when the two are in approximately the plane of the same magnetic meridian.

The davit in question is in metallic connection with the hull of the ship, and through it with the earth. The upper part, beginning about on a level with the compass card, curves with a radius of about five feet, and when swung outboard has a general direction pointing exactly from the compass; when rigged in its general trend is not far from normal to the line of shortest distance to the compass. In the latter position, although so much nearer to the needle, it has apparently no special influence upon it, the deviations making a fair curve.

The methods employed in navigating were as described and illustrated in preceding reports.

REPORT OF PASSED ASSISTANT ENGINEER G. W. BAIRD, U. S. N.

MAIN ENGINES.

During the year the ship has steamed 13,240.26 miles on her course, besides the time the engines have been worked for sounding and dredging. The ship has been at sea one hundred and thirty days, and has not been detained in port through any mishap or accident to steam machinery. The casualties have been few. The out-board blow-valve chamber was found to be corroded through in April; we put a pine plug

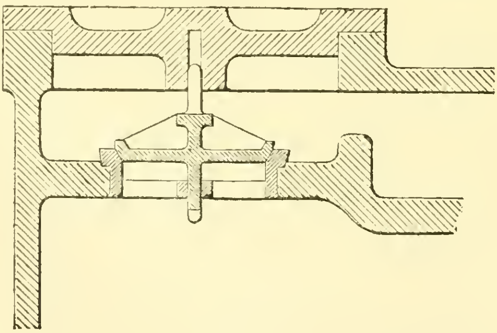

FIG. 1.

in the opening while at Key West, and after our return to Washington we listed the ship to bring the valve above water, when we put in a new valve. To prevent further corrosion, we placed a zinc ferrule in the neck. The soft-rubber valves in the air-pump were found to curl up from great heat in the water discharged into the hot-well from the heaters; they have been replaced by vulcanized hard-rubber valves. The feed-pump valves, from faulty design and excessive weight, used to batter out their stops and would cockbill and stick up in their seats. I therefore designed a set of valves with better guides (Fig. 1), having greater diameter and less lift and containing much less metal. They were made and fitted at the Washington navy-yard. During the year we have overhauled the valve-gear, and have set out the piston-springs twice. While the ship was in dry-dock in May we examined that portion of the line shafts which we had covered with Edison's tape a year before, and found the metal bright and clean, the corrosion having been completely arrested. These corroded places are directly behind the bronze covering of the shaft which is placed there for a bearing. We have had new set-screws fitted to the nuts on themain valve-stems; the original ones were not tight enough, and have sometimes backed out. We have always found great difficulty in moving the engines by hand, owing to the great lack of counterbalancing, as well as to the inaccessibility of the jacking-wheels.

I therefore designed a pair of counterbalances (Fig. 2) for the low pressure cranks, which are being built at the Washington navy-yard. By

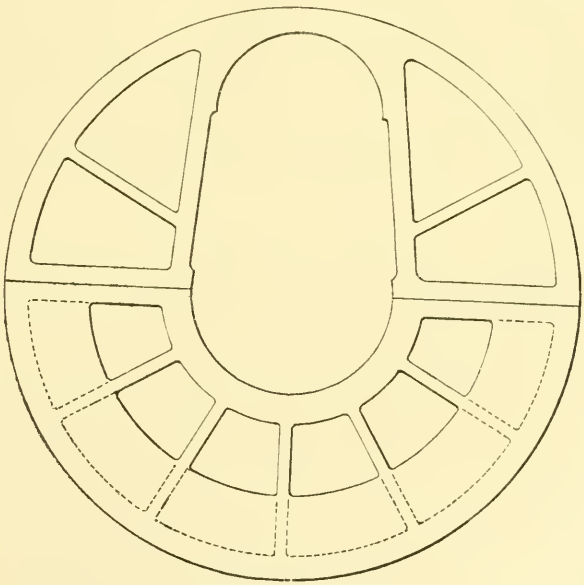

FIG. 2.

making them in halves they can be put on without disturbing the crank-shafts, and by providing teeth in their peripheries they can be utilized as auxiliary pinching-wheels.

Synopsis of the steam log of the U. S. Fish Commission steamer Albatross during the year 1885, the vessel during that period being employed in deep-sea exploration.

[KIND OF ENGINE.—Twin screw, compound engine, surface condenser; inclined.]

Number of cylinders:	
High pressure	2
Low pressure	2
Diameter of cylinders, in inches:	
High pressure	18
Low pressure	34
Stroke of pistons, in feet	$2\frac{1}{2}$
Mean point of cutting off the steam, from commencement of stroke of pistons, in inches:	
High pressure	18.34
Low pressure	16.45
Mean number of holes of throttle-valve open	2.9
Mean vacuum in condenser, in inches of mercury	23.07
Mean steam pressure per square inch, above the atmosphere:	
Boiler pressure ... pounds	48.17
Receiver pressure ... do	8.37
Mean temperature, in degrees, Fahrenheit:	
Engine room	100.8
On deck	65.1
Injection-water	67.68
Discharge-water	96.91
Feed-water	74.15
Total time the fires were lighted ... hours	8,514
Total time the engines were in operation, the ship being on her course, in free route ... hours	$1,584\frac{26}{60}$
Total number of revolutions:	
Starboard engine	6,213,850
Port engine	6,199,567
Mean number of revolutions per minute:	
Starboard engine	65.37
Port engine	65.23
Total number of knots	13,240.26
Mean number of knots per hour	8.35
Total coal consumed ... tons	$1,531\frac{1756}{2240}$
Total weight of refuse from coal ... do	$329\frac{1257}{2240}$
Total weight of coal consumed while the engines were in operation ... tons	$836\frac{484}{2240}$
Mean quantity of coal consumed per hour while the engines were in operation ... pounds	1,182
Total oil consumed:	
Red M engine oil ... gallons	442
600 W. cylinder oil ... do	169
Electric oil ... do	36
Lard oil ... do	350
Tallow consumed ... pounds	69
Wiping stuff consumed ... do	419
Greatest draught forward and aft ... feet	$11\frac{1}{4}$ & $13\frac{7}{12}$
Least draught forward and aft ... do	$9\frac{1}{3}$ & $10\frac{11}{12}$
Average draught for the whole steaming ... do	$10\frac{19}{48}$ & $12\frac{5}{32}$
Helicoidal area of each screw ... square feet	42.02
Diameter ... feet	9
Pitch (mean) ... do	$14\frac{10}{12}$

BOILERS.

The boilers continue to give trouble, and have reached that point where the loss of speed and length of voyage of the ship, and the cost of repairs make it a matter of economy to build new boilers of a proper design. A boiler built from the design already submitted by the writer will enable the ship to carry 80 tons more coal, which will enable the ship to cross the Atlantic Ocean at the rate of 10 knots per hour, uninfluenced by wind or wave. As the proposed boilers will carry a higher pressure, a greater economy will be insured. In the present boilers the flues cannot be swept unless the fires be hauled, and it would be impossible to replace a flue without cutting a hole through the end of the boiler. To accomplish this renewal of a flue, it would be necessary either to cut a hole through a bulkhead to pass the flue through, or else to tear up the deck and take the boilers out for the purpose. Though we never exceed a pressure of 50 pounds, we have repeated leaks around seams and socket-bolts, and are kept making soft patches, calking seams, and replacing leaky socket-bolts and rivets whenever we have a chance. Fires have been kept in the boilers 295¼ days during the year, so our chances to repair the boilers have been limited. The crown sheets are so inaccessible—from close bracing—that the men cannot reach all parts of them with their scaling tools; the steel of which these crowns are made tempers and cracks and is sometimes so hard that chisels require the hardest temper to cut them. We have renewed the hard patches on crown sheets of Nos. 1, 2, and 3 furnaces; have put a new hard patch on side of No. 3 furnace, and one on the side of No. 4 furnace; we have renewed eighteen socket-bolts and six soft patches during the year.

To get at the hard patches we were obliged to cut from the boilers 18 stays (Fig. 3), 24 sockets (Fig. 4), and 36 braces (Fig. 5), all of which had to be replaced. We took advantage of this to cram our smallest man into the boilers to scale them as much as possible. We cut one 1⅜-inch hole in the port and six in the starboard boiler, through which we scaled the hitherto inaccessible parts, and afterwards closed the holes with 1½-inch pipe plugs; these holes are better than hand-holes, in that they do not cut so much iron out of the boilers. We tested the boilers by cold-water pressure (after replacing the braces) to 64 pounds.

In repairing at the Washington yard we have been permitted to select their best two boiler makers, and have utilized our firemen as helpers; at New Bedford, the contractors, for some reason, refused to do this, and, in order to get our repairs made, we were obliged to employ a helper with each skilled boiler-maker. The quality of the repairs done by the navy-yard was better, and, by utilizing our men as helpers, was also cheaper. I beg to recommend that new boilers be built at the Washington navy-yard, from the plans I have already submitted, and estimate $20,000 as the sum necessary to build and connect the boilers, and make the necessary alteration in the bunkers and deck-house, as indicated in the drawings already submitted.

FIG. 3.

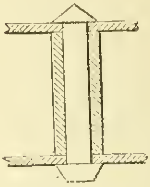

FIG. 4.

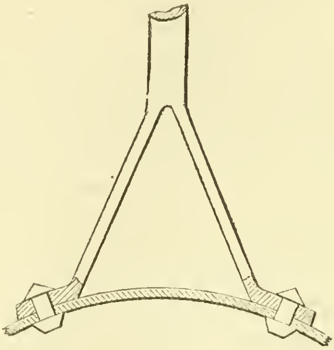

FIG. 5.

MARINE GOVERNORS.

The Svedberg governors continue to work admirably. Stormy weather on the 7th, 15th, and 16th of January, the 12th of February, the 9th and 31st of March compelled the use of the governors, on all of which occasions they worked very well. I consider them indispensable. Experience has demonstrated that the relative direction and force of the gale requires a different height of mercury in the cups; I have therefore tapped iron cocks into the bottoms of the mercury-cups for diminishing the height of mercury.

DREDGING ENGINE.

This engine continues to do its work well, giving but little trouble. We have reset the steam-valves, and the engine now runs more smoothly than formerly. On one occasion the cast-iron chamber of the throttle-valve was broken, probably from water in the pipe; the engine was not in motion at the time. To prevent detaining the ship in port we substituted a smaller valve, which was used during one dredging voyage in the Gulf Stream, and when the ship returned to port we put in a duplicate of the original valve. We have overhauled this engine during the year, adjusted the bearings, lined up the roller-guide, &c., and have polished some of the rough, unfinished parts.

REELING ENGINE.

We have overhauled this engine and have had the lower journals of the connecting-rods turned down and brasses refitted; they were $\frac{1}{32}$ of an inch "out of round." We have stopped the leaks under the valve-bonnets, adjusted the bearings, &c.

SOUNDING ENGINE.

We have put a new piston-ring in this engine, to replace a broken one, and we have draw-filed the trunk to make its sides parallel, since which time the engine has worked better. I recommend that the cylinder be rebored and that a new and much lighter piston and trunk be made, with a view to increasing the speed of the engine. The steam-hose which has been used on this engine for the past three years is much deteriorated and must soon be replaced.

STEERING ENGINE.

This engine continues to do its work well, and gives no trouble except to diminish the vacuum by its air-leaks.

STEAM WINDLASS.

This machine continues to give great satisfaction; its convenience in enabling us to hoist, cat, and fish the anchors, or to veer one while hoisting the other, merits a special mention. It is also used to hoist boats, and, in reeling off wire rope, the capstan is utilized as a drum.

We have put a new key in the rock shaft to replace a loose one; we have reset the valves, and have divided the lead equally. On examination we find the cylinders, valve faces, and journals all wearing smoothly.

STEAM PUMPS.

The cast-iron piston in the water end of the circulating pump has corroded considerably, and we have been obliged to have the hole for the rod counterbored, and have a composition collar let in, for the shoulder of the rod to press squarely against. This piston is heavy, and the two leather collars (packing) wear away quite fast. We will ask for a bronze piston, with hemp packing, during the coming year.

We have put a new set of rubber valves in the boiler feed-pump, and have put a safety feed-valve on that pump. The hydrant pump has required no further attention than repacking and cleaning during the year.

STEAM ASH HOIST.

The engine and chute continue to give satisfaction. The engine has not been overhauled during the year, and does not appear to need it. It is in a hot, dark, and dusty place, and does not receive much attention, and does not require much.

STEAM CUTTERS.

The steam cutter and steam gig continue to give great satisfaction. During the year we have taken out the boilers twice, and have overhauled the machinery. We have put a new high-pressure steam-valve in the cutter, to replace one worn away to a knife-edge on one side. We have had the line-shafts out, and have lined them up; we straightened that of the cutter; it had been bent by the screw striking something. We have fitted a new follower to the piston of the low-pressure cylinder of the cutter. We have provided new air-pump rods for both boats, which has resulted in better vacuum. We have put new steel bushings in the air-pump connections of the cutter, and provided a new casing for the smoke-pipe. We have provided the gig with a new smoke-pipe with brass casing; it replaced the old one, which was burned out. We have put a new feed-pump rod and a new plunger on the hand bilge-pump of the cutter.

While the engine was out of the cutter, a man, in getting into the boat, jumped on and broke the flange off the bottom blow connection; this was the only break that occurred to the boat during the year that would have detained her an hour from her work. We replaced the flange at the Washington yard.

SIGNALS.

The number of signals struck upon our engine-room gongs during the process of sounding and dredging is so great that mistakes both in striking and answering must be expected; when such a mistake occurs, great mischief sometimes follows before it is discovered. To obviate this I have devised an annunciator, which has been built and attached, and which has worked quite well. I append a copy of the report of a board of U. S. naval engineer officers, which describes the machine. The Navy Department has adopted this machine for their new ships.

FRESH-WATER DISTILLING APPARATUS.

During the year we have distilled 51,320½ gallons of water, which has been used for drinking, cooking, and washing, and sometimes for the steam cutter and steam gig. A leak occurred in a coil, during the summer months, which caused brackish water; this was promptly stopped with soft solder. Organic matter was found in the water in September, but this was traced to the dirty tanks. With these two exceptions the water has been clean, sweet, sharp, and pure. The tanks are now cleaned as soon as empty, and are whitewashed inside before refilling.

ELECTRIC LIGHT.

The Edison incandescent light continues satisfactory, and still excites admiration. The dynamo (Fig. 6) has run three years without failure, and though the commutator has worn considerably I think it will last a year yet. The set-screw in the pulley on the armature had a habit

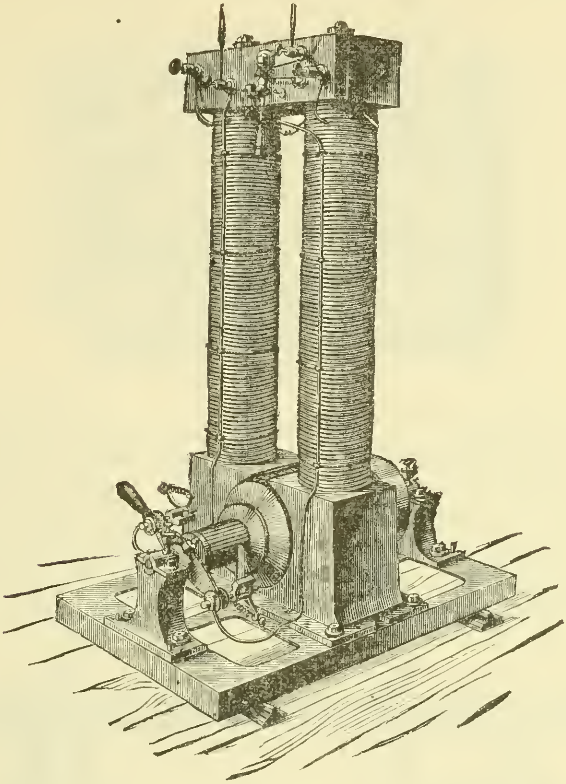

FIG. 6.

of slipping at times, causing annoyance; we had a "feather" fitted to the shaft at Washington, which obviates that trouble. Occasional breaks in the flexible cords, branch wires, lamp-sockets, &c., have occurred; they have been due partly to short circuits through sea-water which leaked through the decks, and partly to accidents; they have always been repaired by men in the engineer's department. But two breaks have occurred in the main wires. As an additional safety we have put large double-pole cut-out blocks (Fig. 7) in the forward circuit, next the dynamo. We have placed switches in the upper laboratory, by which four lamps on each side—overhead—in the lower laboratory are lighted, which is an additional convenience to the naturalists. We have placed a portable state-room sliding lamp-fixture in the chart-room for the convenience of the navigator, and a similar one in the laboratory over the microscope table of the surgeon. We have provided two 25-foot cables and fitted submarine lamps and attachment plugs to them for the use of the naturalists; these cables are made up of seven strands (double circuit) of small wire, equal in aggregate area of cross-section to a single No. 16 wire, and are well insulated in gutta-percha; they have been much used and are more convenient than the old ones.

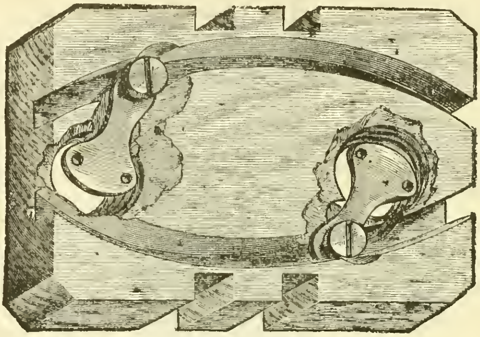

FIG. 7.

The two 3-light pendant lamps and their cables have also proved very useful and convenient; in fact, they have enabled us to dispense with the use of the arc lamps entirely. We have been obliged to dispense with the switches I improvised for these pendant cables, and to substitute Edison's standard switches for them. The engine which drives the dynamo still requires considerable care; the pressure-regulating valve (Fig. 8.) has sometimes stuck in its seat, and, on one occasion, delayed

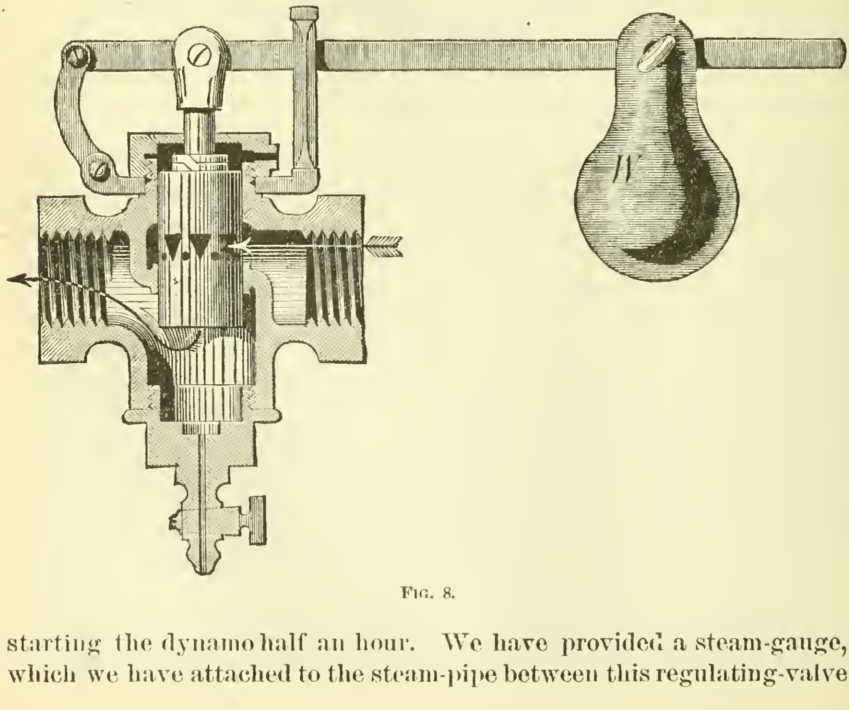

FIG. 8.

starting the dynamo half an hour. We have provided a steam-gauge, which we have attached to the steam-pipe between this regulating-valve key to the fly-wheel of the dynamo engine, the old one having worked loose. We have had the commutator turned down and polished. We have removed the submarine lamp from the deep-sea cable to make place and the engine, in order that we may set the pressure at pleasure, and also know if the valve is working properly. We have been obliged to substitute a copper for an iron steam-pipe on the dynamo engine; as the continuous jarring caused leaks in the iron fittings. We have fitted a new for the photometer. In a gale of wind the guys of the cabin chandelier broke, and as the lamp swung it sheared off the electric wires. We restored the wires and replaced the rope guys with proper brass ones.

The dynamo has been in operation 1,623 hours during the year, during which time a mean of about 47½ lamps have been burning, aggregating the following cost:

Essential expenses of illumination.

$15\frac{563}{2240}$ tons of coal, at $5.02	$76 56
192 lamps, at 61.8 cents*	118 65
36 gallons of oil, at 60 cents	21 60
3 brushes, at 60 cents	1 80
3 cut-out blocks, at 32 cents	96
32 3-light safety-plugs, at 8 cents	2 56
25 6-light safety-plugs, at 8 cents	2 00
7 key-sockets, at 90 cents	6 30
Refitting cross-head journal of dynamo engine	8 00
2 plain sockets, at 46 cents	92
Shortening dynamo belt	3 95
1 pound No. 12 insulated wire, at 40 cents	40
50 feet of flexible cord, at 15 cents	7 50
1 pound No. 18 insulated wire, at 40 cents	40
2 cigar-lighter plugs, at 55 cents	1 10

Additional expenses.

4 double-pole cut out blocks, at $1.10	4 40
5 80-light safety-plugs, at 17 cents	85
5 plain sockets, at 46 cents	2 30
2 pounds of insulation compound	24
5 attachment plugs, at 25 cents	1 25
50 feet of submarine cable, at 12 cents	6 00
2 P. B. sliding fixtures, at $6.50	13 00
2 P. B. standard switches, at $3.75	7 50
2 P. B. standard switches, at $2.35	4 70
Total expenses	292 94

Deducting the cost of the fixtures added to the plant during the year, and of the submarine cables, sockets, and attachment plugs used in building and repairing the submarine cables, there remains an expenditure of $252.80 for the legitimate illumination of the ship.

* The price of lamps during 1885 has been 85 cents apiece, but the Edison company, finding they had delivered us a bad lot of lamps, gave us an equal number of good ones without charge. This brought the price of lamps to 61.8 cents.

In calculating the number of lamp-hours I estimate a 16 candle-power lamp as taking a current double that of an 8 candle-power lamp. It then appears that the mean cost per candle power per hour is $(\frac{25280}{1623 \times 47.5 \times 8} =)$ 0.041 cents.

The coal-gas company of Washington supplies gas of 17 candle-power used from a 4-foot bat-wing burner, at $1.75 per 1,000 cubic feet. The cost of such a jet becomes $(\frac{175}{1000} \times \frac{4}{17} =)$ 0.041176 cents per candle-power per hour, or somewhat more than our light is costing us on board this ship.

I have purposely omitted the cost of labor, as the dynamo is run by a coal-heaver, who performs other than this duty.

VENTILATION.

The quantity of air induced by the fan remains practically constant, *ceteris paribus*, and the efficiency is the same as recorded in my last report. We have put new throttles on the motor, and have led the drain-pipe to the ash-pans. Owing to the humming of the fan somewhat resembling the sound of a large steam-whistle, its speed was purposely limited during our cruise in the foggy latitudes of the Grand Banks last summer. The fan has been used only a few hours during each night, as the enormous inefficiency of the Wise motor (which drives it) causes an expenditure of about 50 pounds of coal per hour. We manage, however, to keep the sleeping apartments tolerably free of bad air during the night.

STEAM HEATERS.

The steam radiators appear to be deficient in surface in very cold weather. The drainage of the cabin heaters, and also the lower labora-

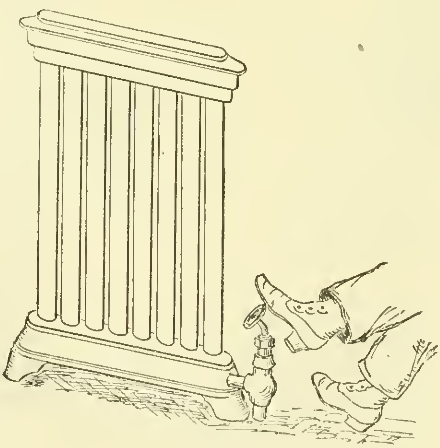

FIG. 9.

tory heater, has been improved by substituting three-fourths for one-half inch pipe. The number of leaks in the heater pipes has diminished since we began to put in the ground unions. There continues to be trouble with leaky valves, due to bent stems. We have replaced several during the year. We have put new soapstone floats in the heater traps, and have provided an additional blow-through for the forward trap.

One of the two heaters on the berth-deck was removed in December by order of the commanding officer.

COAL.

All the coal consumed (excepting a small amount of semi-bituminous coal for the gig) during the year has been Pennsylvania anthracite, mostly from the Lackawamna mine, but partly from Scranton and the Lehigh Valley. The quality has been generally good, except that obtained from the navy-yard, Norfolk, which had deteriorated from absorption of moisture from exposure. The following are the amounts charged to different purposes, as nearly as I am able to divide them:

Coal consumed to propel the ship while on her course, to warm the ship, pump bilges, wash decks, and hoist ashes while the main engines were in operation .... tons..	$836\frac{488}{2240}$
Coal consumed for lighting the ship by electricity .... do...	$16\frac{563}{2240}$
Coal consumed for ventilating the ship .... do...	$23\frac{2129}{2240}$
Coal consumed for distilling water .... do...	$23\frac{800}{2240}$
Coal consumed by the steam cutters .... do...	$9\frac{1530}{2240}$
Coal consumed for driving the hoisting engine, reeling engine, steam windlass, washing decks, warming the ship, and keeping fires banked when the main engines were not in operation .... tons..	$622\frac{726}{2240}$
Total number of tons of coal used for and by the engineer's department. do...	$1,531\frac{1756}{2240}$
Coal used for the equipment department (cooking) .... do...	$37\frac{197}{2240}$

CASUALTIES.

We have put additional cement in the bottoms of the shaft alleys, in order to give the floors a pitch and to improve the drainage, and have cleaned and painted the iron part of the hull in the alleys above the cement. We have substituted a $\frac{1}{2}$-inch for a $\frac{3}{8}$-inch drain-pipe from the main escape pipe; we have soldered a new nipple on the water-tank in the cabin; drilled a broken bolt out of a hawse-pipe shutter; cut threads on dredging shackle-pins; repaired a broken photometer spring; riveted up a lot of brackets for specimen bottles in the laboratory. We have provided a bronze shoe and have fitted it under the bottom of the sheave in the heel of the dredging-boom; the object of this shoe is to prevent the wire from jamming between the sheave and its frame when the wire rope is slacked, runs off, or breaks. We have provided a bushing for the guide-stem of the dredge-rope governor to make it work smoothly. We have cleaned and painted the floor frames under the boilers. We have straightened awning stanchions; put new screws in guide of accumulator on the foremast; riveted a new hinge to a port-shutter on the side of the ship; forged new iron work for foremast-head; and have done such other mechanical work about the ship as was required.

APPENDIX.

CHIEF ENGINEER'S OFFICE, U. S. NAVY-YARD,
Washington, D. C., December 19, 1885.

SIR: In compliance with instructions of the Bureau of Steam Engineering, dated the 15th, and your order dated the 16th instant, the Board appointed to examine the device described as "Baird's Annunciator," have examined the apparatus, observed its operation, and beg leave to report as follows:

The object of the device is to indicate upon deck, to the easy inspection of the officer in charge of the deck or his assistants, the direction of the movement of the engines, whether ahead or aback.

While the engines are working ahead an index revolves in the direction in which an arrow, on its free extremity, points; upon reversing the engines the motion of the index is reversed.

The mechanism immediately employed in producing these movements is inclosed in a case, of which the dial over which the index revolves is the face. The index is mounted upon a shaft or spindle, which carries a toothed wheel.

The wheel and spindle are turned by the revolutions of a second spindle placed at right angles with the first, carrying a worm or endless screw, the threads of which mesh with the teeth of the wheel. The second spindle carries also a series of fans, arranged like the blades of a screw propeller, or like the vanes of the common anemometer.

By means of an air current, which flows in one direction when the ship's engines are going ahead and in the opposite direction when they are backing, the fans and their spindle are rapidly revolved, and the proper motion transmitted through the spiral gearing to the index. The movement of the index is moderate in speed, but the speed is variable with the speed of the engine, and incidentally affords a means of estimating, by the eye, the speed as well as the direction of the movement of the engines and the ship.

The air current is derived from a small rotary blower placed near the engine shaft, and turned by it through the operation of belts. When turned in one direction the blower draws the air from the vanes of the annunciator through a pipe, in one enlarged extremity of which, forming a mouth, the vanes revolve. When turned in the opposite direction the air is driven through the connecting pipe to the vanes, and the direction of the movement of the latter, upon the instant, reversed.

It is a very great advantage to the person maneuvering the ship to know, without the delay attending inquiry or observation of the movement of the ship herself, exactly what the latter is to be. Should mistake be made it will be apparent before it is too late to correct it.

The apparatus is simple and elegant, the power consumed by it is inconsiderable, and it is not at all likely to get out of order.

Its first cost needs never to be great, and the cost of maintenance trifling. Drawings of it are hereto appended.

The Board recommends it for purchase and use for purposes under cognizance of the Bureau of Steam Engineering.

We are, sir, very respectfully, your obedient servants,

CHARLES H. BAKER,
Chief Engineer, U. S. N.
R. D. TAYLOR,
Passed Assistant Engineer, U. S. N.
R. R. LEITCH,
Passed Assistant Engineer, U. S. N.

Commodore W. W. QUEEN, U. S. N.,
Commandant.

UNITED STATES NAVY-YARD, WASHINGTON,
Commandant's Office, December 24, 1885.

Respectfully referred to the Bureau of Steam Engineering.

W. W. QUEEN,
Commodore, Commandant.

REPORT OF THE MEDICAL DEPARTMENT, BY JAMES M. FLINT, SURGEON, U. S. N.

The general health of the officers and men during the year has been good. There have been no deaths from disease, and only one serious accident, whereby the victim lost his life by drowning, having fallen overboard at sea. One severe case of typhoid fever occurred in the early part of the year, but there is no reason to attribute the disease to any cause existing on board the ship, as the man had been enlisted but a short time before the appearance of his illness, and his was the only case of the kind that occurred. He was temporarily removed to the naval hospital at Pensacola, until convalescence was assured, when he returned to the ship and has since entirely regained his health.

It is perhaps worthy of note that of 65 vaccinations during the year 41 were successful. All of the 65 claimed to have been vaccinated previously, and 42 of them showed good evidence thereof in well-marked cicatrices. Among these latter presenting good evidence of previous vaccination, revaccination was effective in 26 cases. Fresh bovine virus was used and introduced by scarification.

No changes affecting the sanitary condition of the ship have been made during the year, and reference is made to former annual reports from this department for statistics and descriptions of all that pertains to the arrangements for the accommodation of the crew, for ventilation, lighting, heating, &c.

The following ports were visited: Washington, D. C.; Norfolk, Va.; Key West, Fla.; Havana, Cuba; Cozumel Island, Yucatan; Pensacola, Fla.; New Orleans, La.; Tampa, Fla.; Baltimore, Md.; Newport, R.I.; St. John's, N. F.; Halifax, N. S.; Wood's Holl, Mass.; New York, N. Y.

Specific gravity observations were continued except in those portions of the Atlantic covered by previous cruises. The results are appended. Of especial interest is the series of date March 1, 5.30 o'clock, to March 2, 3 o'clock. This series of observations commences at the jetties of the South Pass of the Mississippi River and extends directly out into the Gulf of Mexico for the distance of about 75 nautical miles. The course of the ship from the jetties was SE. ¼ E.; average speed a little over 8 knots; wind light from the NE. The 5.30 specimen of water was taken from the river just inside the mouth of the jetties; at 6 o'clock the ship was about 5 miles out; after that, 8 miles may be added to the distance for each hour. It will be seen that at 50 miles from its mouth the river is practically lost in the Gulf, and at 75 miles all influence upon the density of the Gulf water has disappeared.

REPORT OF THE NATURALIST, MR. JAMES E. BENEDICT.

The first cruise of the Albatross in 1885 began on the 3d of January, when the ship sailed from Norfolk, Va., for the Gulf of Mexico. Dredging began on the 5th, when four hauls were made with the beam trawl, resulting in the capture of many invertebrates and fish. Captain Collins set a large trawl line in the morning, but succeeded in taking only three fish. Surface collecting was carried on with vigor. We arrived in Key West on the 9th, where some of us collected birds for the practice in skinning. Dr. Bean and Captain Collins made several hauls along shore with the capelin seine. The bottom was too rough to accomplish much in this way.

On the 15th of January the ship sailed for Havana, making several good hauls on the way. Several days were spent off Havana using the tangles for sea-lilies and other echinoderms, corals, and hydroids. In this work we were very successful, the tangles usually coming up so well filled with specimens that it was necessary to put on a clean tangle while the one from the bottom was being picked over. The work in this locality is interesting, as it is on a fishing ground frequented by small fishing craft from Havana, which have from time to time brought in some of the rare invertebrates and fish. The bottom is so rough that it was no uncommon thing for the tangles to catch, and it required careful maneuvering of the ship to free them without loss of the outfit. After leaving this place the ship cruised to the westward through the southern portion of the Gulf, dredging and doing surface work when there was any occasion for it. From one haul a barrel of siliceous sponges was saved; also very many specimens of a small worm belonging to the family Eunicidæ.

On the 23d of January the Albatross dropped anchor off the town of San Miguel, island of Cozumel. After arrangements had been made by Captain Tanner with the magistrate of the island the naturalists were allowed to go ashore and collect. During the stay of about six days nearly two hundred bird-skins were made, and more than that number of birds preserved in alcohol. From this collection of birds Mr. Ridgway has described sixteen new species and several sub-species. Dr. Bean and Captain Collins made several hauls with the seine and captured several new species of fish, and also some very desirable known species. The reptiles are said by Professor E. D. Cope to be interesting and to indicate a rich fauna. Only three species of mammals were taken.

On the evening of the 29th we steamed away from Cozumel, and on the 30th made seven hauls on Campeche Bank in water from 21 to 27 fathoms in depth. Some of the hauls showed good food bottom and added some fine invertebrates to our collection. A number of good-sized fish were caught with hook and line, after which we left the bank and steamed straight to Pensacola, Fla., where we remained several days.

A short cruise was made to the red-snapper fishing grounds off Pensacola on the 7th of February. Eight hauls were made, which will, I think, show the relative abundance of the different invertebrates at this locality. From Mr. Silas Stearns, a prominent correspondent of the Fish Commission, living in Pensacola, we learned that while the red snapper was not in danger of extermination, as some think, the limited extent of its range along the Gulf coast of Florida makes it possible to over-fish, and so deplete the waters that it can no longer be sought with profit. Already the Pensacola fishermen are obliged to go farther south than formerly. Shortly after this, the Albatross sailed for New Orleans, where the vessel remained until March 1.

During the latter part of March large collections were made on the more southern red-snapper banks of Florida. At Key West Captain Collins made a careful study of the fisheries which supply that city and export fish to Cuba. On the way to Washington an unsuccessful effort was made to take tile-fish on ground where, from the nature of the bottom, depth, &c., we thought it possible that they might live. We arrived at the Washington navy yard on the 6th of April.

The second cruise began on the 2d of June at Norfolk, Va., and ended at Washington on the 8th. The object of this cruise was to make trials with the trawl line from Cape Charles to Cape Hatteras in water of suitable depth for tile-fish. Early in the morning of the 3d the ship was 70 miles east of Cape Charles. Here the first hauls were made with the beam-trawl, which brought up a large number of *Munidæ*. The trawl line, which had been baited the night before, was then set in the same place, but without result, not even a dogfish being taken. From this station we gradually worked south toward Cape Hatteras. Life was found to be less and less abundant as we proceeded. *Cancer borealis* and *Eupagurus politus*, the latter in the shells of Neptunea, were common. The bottom in this region to a depth of 100 fathoms seems to be a drift unsuitable for sponges, corals, and other things which afford hiding-places for small fish and the invertebrates, upon which they feed. The bottom is composed of sand and mud mixed with many broken shells and a few living ones. Worms belonging principally to the Nephthydidæ and Lumbricuneridæ are not uncommon. A few of the larger forms of foraminifera are also found. Hand-lines were used in the afternoon of the 5th. Two specimens of *Caulolatilus chrysops* Gill, an *Epinephelus*, and several specimens of *Serranus* were caught. Among the surface animals taken was *Argonauta argo*. An effort was made to keep this alive, but did not succeed. The ship arrived in Washington on the 8th.

The Albatross left Washington on its third cruise on the 13th of June. After taking in bait at Newport, R. I., it cruised to the eastward and then north, putting in to St. John's, Newfoundland, making various soundings and dredgings on the way. After a stay of a few days at St. John's the ship cruised about the Banks, dredging when possible. Very often the nets of the trawls and dredges came from the bottom so badly torn that it was necessary to replace them before more work could be done. In many places the bottom was covered with bowlders of different sizes; in others it was smooth and sandy; in such places *Echinarachnius parma* were taken in large numbers, with now and then a hermit-crab, small flounders, and sculpins. During this cruise one hundred and nine hauls were made. The invertebrates were for the most part well known. The notes on the fish and the fishermen were made by Captain Collins, and are to be written out at some future day. The Albatross reached Wood's Holl on the 16th of July.

The Albatross put to sea from Wood's Holl for a short cruise on the tile-fish ground in the evening of August 6th, and returned on the 12th, having made twenty-eight hauls with the trawl, and having set the long trawl-line five times. Collecting on the surface was carried on with good result. Squid and flying-fishes were taken with the aid of the electric light. A dolphin (*Delphinus delphis*) was harpooned by Mr. G. A. Miller. This being a common species it was turned over to Dr. Libbey for histological purposes.

The cruise of the Albatross beginning August 27 and ending September 5 is of especial interest on account of the great depth of water in which the principal dredging was done. The average depth of water at the first eleven stations was $1,923\frac{6}{11}$ fathoms. At eight of these stations numerous bottom specimens were obtained. The success of the surface collecting was unusual. As heretofore much assistance was given by the crew, some of whom were nearly always at hand with scoop-nets ready to capture anything coming within reach.

The large surface net was used after dark with the best results. In the day-time it was not so successful. Some of the more interesting surface fish were placed in the aquarium and brought into Wood's Holl alive. Three specimens of *Argonauta argo* were placed in jars, and the water was kept running through in the hope of keeping them alive. One lived for three days, and was killed not unlikely by the change in the temperature of the water from 75° to 60° F. Early in the evening of September 2 a petrel flew on board, blinded, no doubt, by the electric light. As soon as convenient the bird was skinned; and upon the arrival of the ship in Wood's Holl it was sent to Mr. Ridgway, curator of the department of birds, National Museum. Mr. Ridgway found the bird to be the *Pelagodroma marina* (Lath.) of Australia, and never before found in the North Atlantic and but twice in the South Atlantic. The position of the ship when the bird was taken was latitude N. 43° 34′ 18″, longitude W. 66° 09′.

The sixth cruise was from Wood's Holl, and lasted from the 17th to the 25th of September. Ten hauls were made with the beam-trawl, and more than the usual time was spent in surface collecting. Our large surface nets were used as often as possible, one from each side of the ship. These nets strain water through their meshes at the rate of nearly 12,000 gallons per minute when the ship is moving at the rate of 2 miles an hour. At the rate of 10,000 gallons per net the amount of water strained in an hour would be for both nets 1,200,000 gallons. The use of this net began with the first cruise of the year, and has been very satisfactory, only the very smallest objects escaping through its meshes. As might be expected from the large amount of water passing through it, many rare forms of fish and invertebrates are taken during a cruise.

The last cruise was from New York to Washington, going south as far as the coast of North Carolina. Leaving New York on October 15, the ship sailed southward, stopping to do surface work morning and evening whenever practical. Before daylight on the 16th the large net was put over and towed for an hour, taking hundreds of fish of one species and a few of a dozen others. The invertebrates taken at the same time were numerous and interesting. Among the mollusks were several species of Salpæ, Pteropods, Heteropods, and one small male argonaut. The preservation of the large amount of varied material taken by the net requires the attention of at least one collector the greater part of the time. During the cruise thirty-seven hauls were made, Nos. 2592 to 2628, inclusive. The last five were on very rich ground in water about 250 fathoms in depth. The ship reached Washington on the 24th of October.

The number of hauls made on the various cruises is three hundred and eighteen.

Record of dredgings and trawlings of the U. S. Fish Commission steamer Albatross, during the year ending December 31, 1885.

Serial number.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth.	Character of bottom.	Wind. Direction.	Wind. Force.	Drift. Direction.	Drift. Distance.	Instrument used.
	1885.		° ′ ″	° ′ ″	°	°	°	Fath.					Miles.	
2311	Jan. 5	9.47 a. m	32 55 00	77 54 00	69	72	59.1	79	crs. S. bk. Sp	SE.	3			L. B. T.
2312	Jan. 5	10.48 a. m	32 54 00	77 53 30	69	73	57.8	88	crs. S. bk. Sp	ESE.	3			L. B. T.
2313	Jan. 5	12.17 p. m	32 53 00	77 53 00	69	73	57.2	99	crs. S. bk. Sp. brk. Sh	ESE.	3			L. B. T.
2314	Jan. 5	3.06 p. m	32 43 00	77 51 00	70	69	47.4	159	crs. S. bk. Sp. brk. Sh	SSE.	4			L. B. T.
2315	Jan. 15	2.17 p. m	24 26 00	81 48 15	77	75		37	Co	ESE.	5			L. B. T.
2316	Jan. 15	3.21 p. m	24 25 30	81 47 45	77	75	74	50		ESE.	5			L. B. T.
2317	Jan. 15	4.22 p. m	24 25 45	81 46 45	77	75	75	45	Co	ESE.	5			L. B. T.
2318	Jan. 15	5.00 p. m	24 25 45	81 46 00	77	75	75	45	Co	ESE.	5			L. B. T.
2319	Jan. 17	6.45 a. m	23 10 37	82 20 06	71	76		143	gy. Co	ESE.	1			Tgls.
2320	Jan. 17	7.25 a. m	23 10 39	82 18 48	72	76		130	fne. Co	ESE.	1			Tgls.
2321	Jan. 17	7.58 a. m	23 10 54	82 18 00	74	77		230	fne. gy. S	ESE.	1			Tgls.
2322	Jan. 17	8.53 a. m	23 10 54	82 17 45	75	77		115	Co	ESE.	1			Tgls.
2323	Jan. 17	10.04 a. m	23 10 51	82 19 03	78	78		163	wh. br. Co	ESE.	2			Tgls.
2324	Jan. 17	11.17 a. m	23 10 25	82 20 24	78	78	79.1	33	Co	ESE.	2			Tgls.
2325	Jan. 17	11.39 a. m	23 10 48	82 19 54	78	78		170	lt. br. Co	ESE.	2			Tgls.
2326	Jan. 17	12.15 p. m	23 11 45	82 18 54	79	78	62	194	br. Co	ESE.	2			Tgls.
2327	Jan. 17	12.53 p. m	23 11 45	82 17 54	80	76		182	fne. br. S	SSE.	1			Tgls.
2328	Jan. 17	2.11 p. m	23 11 03	82 19 15	81	75	58	203	fne. gy. Co	W.	1			Tgls.
2329	Jan. 17	2.45 p. m	23 11 03	82 18 45	81	75		118	wh. Co	W.	1			Tgls.
2330	Jan. 17	3.50 p. m	23 10 48	82 19 15	81	75		121	fne. gy. Co	W.	2			Tgls.
2331	Jan. 17	4.35 p. m	23 10 31	82 19 55	80	75		114	Co	W.	1			Tgls.
2332	Jan. 19	6.48 a. m	23 10 38	82 20 06	73	75		156	wh. gy. Co	SSE.	3			Tgls.
2333	Jan. 19	7.20 a. m	23 10 36	82 19 12	73	75		169	fne. wh. Co	SSE.	3			Tgls.
2334	Jan. 19	8.00 a. m	23 10 42	82 18 24	74	75		67	wh. Co	SSE.	3			Tgls.
2335	Jan. 19	9.00 a. m	23 10 39	82 20 21	76	77		204		NE.	3			Tgls.
2336	Jan. 19	9.46 a. m	23 10 48	82 18 52	77	77		157	Co	NE.	3			Tgls.
2337	Jan. 19	11.02 a. m	23 10 39	82 20 21	78	78		199	Co	NE.	3			Tgls.
2338	Jan. 19	11.53 a. m	23 10 40	82 20 15	79	78		189	Co	NE.	3			Tgls.
2339	Jan. 19	12.43 p. m	23 10 40	82 20 15	79	78		191	Co	NE.	3			Tgls.
2340	Jan. 19	1.35 p. m	23 10 47	82 20 06	80	78		234	Co	NE.	3			Tgls.
2341	Jan. 19	2.11 p. m	23 11 00	82 19 06	79	78		143	Co	NE.	3			Tgls.
2342	Jan. 19	2.57 p. m	23 10 39	82 20 21	78	78		201	Co	NE.	3			Tgls.
2343	Jan. 19	3.32 p. m	23 11 35	82 19 25	78	78		279	fne. Co	NE.	3			Tgls.
2344	Jan. 19	4.40 p. m	23 10 39	82 20 21	78	78		199	br. Co	NE.	3			Tgls.
2345	Jan. 20	12.36 p. m	23 10 40	82 20 15	84	78		184	fne. gy. wh. Co	E.	4			Tgls.
2346	Jan. 20	1.24 p. m	23 10 39	82 20 21	83	78		200	Co	E.	4			Tgls.
2347	Jan. 20	2.11 p. m	23 10 39	82 20 21	82	78		216	Co	E.	4			Tgls.

2348	Jan. 20	3.04 p. m	23 10 39	82 20 21	82	78	......	2 1	Co	E.	4			Tgls.
2349	Jan. 20	3.51 p. m	23 10 40	82 20 15	82	78	......	182	Co	E.	4			Tgls.
2350	Jan. 20	4.37 p. m	23 10 39	82 20 21	81	78	......	213	Co	E.	3			S. B. T.
2351	Jan. 21	9.02 a. m	22 41 00	84 16 30	78	77	......	426	......	SSE.	2			L. B. T.
2352	Jan. 21	11.13 a. m	22 35 00	84 23 00	79	77	45	463	wh. Co	Variable.	0-1			L. B. T.
2353	Jan. 22	9.23 a. m	20 59 00	86 23 00	79	79	62.8	167	Co	NE.	1			Tgls.
2354	Jan. 22	10.17 a. m	20 59 30	86 23 45	80	78	......	130	Co	NE.	1			S. B. T.
2355	Jan. 22	11.28 a. m	20 56 48	86 27 00	83	78	......	399	yl. Oz	NE.	2			S. B. T.
2356	Jan. 29	1.29 p. m	20 18 50	87 03 00	84	78	......	137	fne. wh. Co	ESE.	3			Tgls.
2357	Jan. 29	2.07 p. m	20 19 00	87 03 10	81	78	......	178	wh. Co	ESE.	4			Tgls.
2358	Jan. 29	2.57 p. m	20 19 00	87 03 30	82	78	......	222	fne. wh. Co	ESE.	4			S. B. T.
2359	Jan. 29	4.07 p. m	20 19 10	87 03 30	84	78	50.8	231	wh. Co	ESE.	4			S. B. T.
2360	Jan. 30	7.42 a. m	22 08 30	86 49 00	79	78	......	26	wh. Co	SE.	3			Tgls.
2361	Jan. 30	8.45 a. m	22 08 15	86 51 15	80	78	......	25	Co. S	SE.	3			S. B. T.
2362	Jan. 30	9.18 a. m	22 08 30	86 53 30	79	78	......	25	Co. S	SE.	3			S. B. T.
2363	Jan. 30	10.38 a. m	22 07 30	87 06 00	78	77	......	21	wh. R. Co	SE.	3			S. B. T.
2364	Jan. 30	11.37 a. m	22 08 40	87 06 00	79	77	......	22	Co. S	SE.	3			S. B. T.
2365	Jan. 30	3.00 p. m	22 18 00	87 04 00	79	77	......	24	wh. R. Co	SSE.	2			S. B. T.
2366	Jan. 30	4.52 p. m	22 28 00	87 02 00	77	76	......	27	fne. wh. Co	SSE.	2			S. B. T.
2367	Jan. 30	6.32 p. m	22 38 00	87 00 00	75	76	......	124	wh. Co	Calm.	0			S. B. T.
2368	Feb. 7	12.11 p. m	29 15 00	85 32 00	60	64	......	28	crs. gy. S. brk. Sh	SE.	2			Tgls.
2369	Feb. 7	12.46 p. m	29 16 30	85 32 00	60	64	......	26	crs. gy. S. brk. Sh	S.	3			L. B. T.
2370	Feb. 7	1.16 p. m	29 18 15	85 32 00	60	64	......	25	crs. gy. S. brk. Sh	S.	3			L. B. T.
2371	Feb. 7	2.16 p. m	29 17 00	85 30 45	65	66	......	26	gy. S. brk. Sh	S.	3			L. B. T.
2372	Feb. 7	2.47 p. m	29 15 30	85 29 30	64	64	......	27	G	S.	3			L. B. T.
2373	Feb. 7	3.27 p. m	29 14 00	85 29 15	64	64	......	25	Co	S.	3			L. B. T.
2374	Feb. 7	4.27 p. m	29 11 30	85 29 00	63	65	......	26	S. G. brk. Sh	S.	3			L. B. T.
2375	Feb. 7	5.15 p. m	29 10 00	85 31 00	62	65	......	30	S. bk. Sp. brk. Sh	S.	4			L. B. T.
2376	Feb. 11	1.43 p. m	29 03 15	88 16 00	50	62	46.5	324	gy. M	NE.	4			L. B. T.
2377	Feb. 11	3.44 p. m	29 07 30	88 08 00	50	63	67	210	gy. M	E.	4			L. B. T.
2378	Feb. 11	5.40 p. m	29 14 30	88 09 30	50	63	......	68	gy. M	NE.	4			L. B. T.
2379	Mar. 2	5.40 a. m	28 00 15	87 42 00	60	66	......	1,467	yl. Oz	NE.	6			L. B. T.
2380	Mar. 2	10.43 a. m	28 02 30	87 43 45	60	69	40.1	1,430	br. M	NNE.	3			L. B. T.
2381	Mar. 2	3.59 p. m	28 05 00	87 56 15	59	69		1,330	lt. br. M	N.	2			L. B. T.
2382	Mar. 3	5.37 a. m	28 19 45	88 01 30	59	62	39.6	1,255	gy. M	NE.	1			L. B. T.
2383	Mar. 3	10.23 a. m	28 32 00	88 06 00	62	69	39.8	1,181	br. gn. M	NE.	2			L. B. T.
2384	Mar. 3	2.59 p. m	28 45 00	88 15 30	70	67	39.6	940	br. gy. M	E.	2			L. B. T.
2385	Mar. 3	6.37 p. m	28 51 00	88 18 00	63	67	40.1	730	gy. M	E.	2			L. B. T.
2386	Mar. 4	5.36 a. m	29 15 00	88 06 00	62	67	61.8	60	bu. M	NE.	1			L. B. T.
2387	Mar. 4	7.46 a. m	29 24 00	88 04 00	61	61	......	32	S. G. brk. Sh	NE.	2			L. B. T.
2388	Mar. 4	9.45 a. m	29 24 30	88 01 00	61	61	......	35	yl. S. bk. Sp	NE.	2			L. B. T.
2389	Mar. 4	10.56 a. m	29 28 00	87 56 00	64	62	......	27	gy. S. brk. Sh	NE.	2			L. B. T.
2390	Mar. 4	12.48 p. m	29 27 30	87 48 30	62	62	......	30	crs. S. bk. Sp. Sh	NE.	2			L. B. T.
2391	Mar. 4	2.03 p. m	29 32 00	87 45 00	61	59	......	25	gy. S. bk. Sp	ENE.	2			L. B. T.
2392	Mar. 13	5.27 a. m	28 47 30	87 27 00	66	62	40.7	724	br. gy. M	SW.	3			L. B. T.
2393	Mar. 13	9.37 a. m	28 43 00	87 14 30	70	64	41.1	525	lt. gy. M	NE.	1			L. B. T.
2394	Mar. 13	1.35 p. m	28 38 30	87 02 00	70	66	41.8	420	gn. M.	WSW.	2			L. B. T.
2395	Mar. 13	4.31 p. m	28 36 15	86 50 00	72	66	44.1	347	gy. M	WSW.	2			L. B. T.
2396	Mar. 13	6.09 p. m	28 34 00	86 48 00	6-	65		335	gy. M	WSW.	3			L. B. T.
2397	Mar. 14	5.32 a. m	28 42 00	86 36 00	64	65	46.1	280	gy. M	NE.	2			L. B. T.
2398	Mar. 14	8.24 a. m	28 45 00	86 26 00	64	67	45.6	227	gy. M	NE.	2			L. B. T.
2399	Mar. 14	10.52 a. m	28 44 00	86 18 00	70	65	51.6	196	gy. M	NE.	2			L. B. T.

Record of dredgings and trawlings of the U. S. Fish Commission steamer Albatross, &c.—Continued.

Serial number.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth.	Character of bottom.	Wind. Direction.	Wind. Force.	Drift. Direction.	Drift. Distance.	Instrument used.
	1885.		° ′ ″	° ′ ″	°	°	°	Fath.					Miles.	
2400	Mar. 14	1.23 p. m.	28 41 00	86 07 00	71	67	......	169	gy. M	ENE.	1	......	......	L. B. T.
2401	Mar. 14	4.01 p. m.	28 38 30	85 52 30	73	69	......	142	gn. M. brk. Sh	Calm.	0	......	......	L. B. T.
2402	Mar. 14	6.18 p. m.	28 36 00	85 33 30	65	63	......	111	gy. M	Calm.	0	......	......	L. B. T.
2403	Mar. 15	5.30 a. m.	28 42 30	85 29 00	67	65	......	88	gy. M	SW.	2	......	......	L. B. T.
2404	Mar. 15	7.45 a. m.	28 44 00	85 16 00	68	66	......	60	gy. S	SW.	1	......	......	L. B. T.
2405	Mar. 15	9.39 a. m.	28 45 00	85 02 00	68	68	......	30	gy. S. brk. Co	ESE.	1	......	......	L. B T.
2406	Mar. 15	11.21 a. m.	28 46 00	84 49 00	67	64	......	26	crs. S. Co	SE.	2	......	......	L. B. T.
2407	Mar. 15	1.14 p. m.	28 47 30	84 37 00	64	63	......	24	Co. brk. Sh	SE.	2	......	......	L B. T.
2408	Mar. 16	9.22 a. m.	28 28 00	84 25 00	60	64	......	21	Co	NE.	4	......	......	L. B. T.
2409	Mar. 18	1.12 p. m.	27 04 00	83 21 15	67	66	......	26	crs. gy. S. brk. Sh	W.	4	......	......	L. B. T.
2410	Mar. 18	3.52 p. m.	26 47 30	83 25 15	67	66	......	28	fne. wh. S. bk. Sp. brk. Sh	WNW.	4	......	......	Rake dredge.
2411	Mar. 18	6.21 p. m.	26 33 30	83 15 30	69	67	......	27	fne. wh. S. bk. Sp	NW.	4	......	......	L. B. T.
2412	Mar. 19	6.50 a. m.	26 18 30	83 08 45	62	66	......	27	fne. gy. S. bk. Sp. brk. Sh	NW.	3	......	......	L. B. T.
2413	Mar. 19	10.04 a. m.	26 00 00	82 57 30	68	66	......	24	fne. S. bk. Sp. brk. Sh	NNW.	2	......	......	L. B. T.
2414	Mar. 19	6.11 p. m.	25 04 30	82 59 15	67	69	......	26	fne. wh. S. brk. Sh	NW.	2	......	......	L. B. T.
2415	Apr. 1	5.31 a. m.	30 44 00	79 26 00	70	70	45.6	440	Co. crs. S. Sh. For	ENE.	3	......	......	L B. T.
2416	Apr. 1	12.01 p. m.	31 26 00	79 07 00	70	74	53.8	276	Co. brk. Sh	ENE.	5	......	......	L. B. T.
2417	Apr. 2	12.13 p. m.	33 18 30	77 07 00	69	67	65.8	95	fne. gy. S	ESE.	4	......	......	L. B. T.
2418	Apr. 2	12.54 p. m.	33 20 00	77 05 00	69	67	65.8	90	gy. S	ESE.	4	......	......	L. B. T.
2419	Apr. 2	5.25 p. m.	33 34 00	76 40 30	69	72	60.3	107	fne. gy. S. bk. Sp	ESE.	3	......	......	L. B. T.
2420	Apr. 5	6.20 p. m.	37 03 20	74 31 40	50	48	47.7	104	bk. S. M. G	S. by E.	1	......	......	L. B. T.
2421	June 3	5.40 a. m.	37 07 00	74 34 30	61	61	......	64	fne. gy. S. P	NE.	2	......	......	L. B. T.
2422	June 3	9.55 a. m.	37 08 30	74 33 30	66	63	52.5	85	crs. gy. S. bk. Sp. brk. Sh	E.	4	......	......	L. B. T.
2423	June 3	3.11 p. m.	37 10 15	74 32 00	65	67	......	143	gn. M. fne. S	ENE.	3	......	......	L. B. T.
2424	June 4	4.30 a. m.	36 41 37	74 42 15	69	67	52.5	85	bk. M	S.	1	......	......	L. B. T.
2425	June 4	11.30 a. m.	36 20 24	74 46 30	72	69	51.5	119	dk. gy. M. fne. S	SSW.	2	......	......	L. B. T.
2426	June 4	4.49 p. m.	36 01 30	74 47 30	77	71	52.0	93	crs. gy. bk. S. brk. Sh	S.	3	......	......	L. B. T.
2427	June 23	6.00 a. m.	42 46 00	51 00 00	49	47	38.7	523	brd	S.	1	......	......	L. B. T.
2428	June 23	8.18 a. m.	42 48 00	50 55 30	50	48	38.3	826	gn. M	S.	2	......	......	L. B. T.
2429	June 23	12.04 p. m.	42 55 30	50 51 00	51	45	38.7	471	gy. M	S.	3	......	......	L. B. T.
2430	June 23	3.05 p. m.	42 58 30	50 50 00	51	46	......	179	gn. S. P	S.	2	E. by N.	1.50	L. B. T.
2431	June 23	4.24 p. m.	43 00 00	50 47 30	51	46	33.5	129	yl. S. bk. Sp	S.	2	ESE.	1	L. B. T.
2432	June 23	5.28 p. m.	43 04 00	50 45 00	51	47	......	64	fne. gy. S	SSW.	3	ESE.	1	L. B. T.
2433	June 23	6.05 p. m.	43 05 00	50 43 00	52	48	33.0	57	gn. S	SW.	3	E.	1.50	L. B. T.
2434	June 23	7.20 p. m.	43 08 00	50 40 00	54	48	34.0	51	gn. M	SW.	3	E.	1.50	L. B. T.
2435	June 23	8.13 p. m.	43 12 00	50 38 45	54	48	34.0	47	bk. M	SW.	4	E.	1.50	L. B. T.
2436	June 24	4.22 a. m.	43 36 00	50 06 30	53	49	34.0	36	wh. S. bk. Sp. brk. Sh	SW.	4	ESE.	1	L. B. T.

2437	June 24	5.04 a. m	43 36 00	50 05 00	53	49	35.8	37	crs. bk. Sh. brk. St	SW.	4	ESE.	1	L. B. T.
2438	June 24	5.40 a. m	43 36 00	50 03 30	54	48	36.8	37	gn. S. bk. Sp. brk. Sh	SW.	4	ESE.	1	L. B. T.
2439	June 24	6.50 a. m	43 37 00	49 56 30	54	48	37.8	36	wh. S. bk. Sp	SW.	5	ESE.	1	L. B. T.
2440	June 24	7.55 a. m	43 38 00	49 49 30	54	48	38.3	33	fne. wh. S. bk. Sp	SW.	5	ESE.	1	L. B. T.
2441	June 25	5.05 a. m	45 27 00	49 42 00	45	43	33.0	31	wh. S. brk. Sh	W.	2	N. by E.	1.50	L. B. T.
2442	June 25	6.42 a. m	45 33 00	49 43 00	46	44	33.2	36	wh. S. brk. Sh	W.	3	NNE.	1	L. B. T.
2443	June 25	8.47 a. m	45 44 00	49 45 00	50	46	34.9	35	wh. S. brk. Sh	WNW.	2	NNE.	1	L. B. T.
2444	June 25	11.21 a. m	45 59 00	49 45 30	49	45	34.4	39	wh. S. brk. Sh	WNW.	2	NNE.	1	L. B. T.
2445	June 25	12.54 p. m	46 09 30	49 48 30	47	44	33.5	39	brk. Sh	SW.	3	NNE.	1	L. B. T.
2446	June 25	2.21 p. m	46 20 00	49 52 00	48	43	35.3	40	brk. Sh	SW.	3	NNE.	1	L. B. T.
2447	June 25	3.55 p. m	46 26 00	49 42 00	48	43	34.8	39	brk. Sh	WSW.	3	NNE.	1	L. B. T.
2448	June 25	4.40 p. m	46 28 00	49 39 30	48	43	33.9	40	S. G	WSW.	3	NNE.	1	L. B. T.
2449	June 25	7.03 p. m	46 37 00	49 50 30	46	42	33.0	39	brk. Sh	SW.	4	NNW.	1	L. B. T.
2450	June 25	8.33 p. m	46 45 00	50 02 30	45	42	31.0	44	P. brk. Sh	SSW.	4	NNW.	.50	L. B. T.
2451	June 26	4.19 a. m	46 58 00	50 34 00	41	40	29.7	67	S. Sh	SSW.	3	NW. by N.	1	S. B. T.
2452	June 26	6.14 a. m	47 04 00	50 48 00	54	40	29.7	89	fne. gn. S	SW.	3	NNW.	1	L. B. T.
2453	June 26	8.02 a. m	47 10 00	51 02 00	48	41	29.7	82	gn. M. fne. S	WSW.	3	NNW.	1	L. B. T.
2454	June 26	10.17 a. m	47 16 00	51 16 00	46	42	29.7	74	fne. gy. S	SW.	2	NNW.	1	L. B. T.
2455	June 26	12.25 p. m	47 21 00	51 38 30	45	43	30.0	81	br. S	SW.	2	W.	.75	L. B. T.
2456	July 2	8.00 a. m	47 29 00	52 18 00	47	46	......	86	G	SW.	2	S. by E.	1	Bl. Dr.
2457	July 2	10.48 a. m	47 13 00	52 24 00	48	47	29.5	86	gy. S	SW.	2	S. by E.	1	Bl. Dr.
2458	July 2	2.35 p. m	46 48 30	52 34 00	50	48	29.5	89	S. gn. M	SSE.	2	S. by W.	1	Bl. Dr.
2459	July 2	6.10 p. m	46 23 00	52 45 00	50	49	29.5	88	crs. gy. S	SSW.	3	S.	1	Bl. Dr.
2460	July 3	4.45 a. m	45 50 00	54 06 00	50	47	30.0	67	gy. S. Sh	WSW.	1	WSW.	.50	Bl. Dr.
2461	July 3	6.03 a. m	45 47 00	54 13 30	54	48	30.0	59	fne S. bk. Sp	WSW.	1	W.	.50	Sh. Dr.
2462	July 3	7.18 a. m	45 45 30	54 20 30	52	48	30.0	41	wh. S. bk. Sp	WSW.	2	W.	.50	Bl. Dr.
2463	July 3	8.30 a. m	45 44 00	54 27 00	51	50	30.0	45	brk. Sh	WSW.	2	W.	.75	Bl. Dr.
2464	July 3	10.14 a. m	45 40 00	54 41 00	52	47	32.0	42	wh. bk. S. brk. Sh	WSW.	2	W.	.75	Sh. Dr.
2465	July 3	12.15 p. m	45 35 00	55 01 00	52	48	30.0	67	bk. gy. S	WSW.	2	S.	.75	Sh. Dr.
2466	July 3	2.40 p. m	45 29 00	55 24 00	54	53	30.0	67	Co	SW.	2	SSW.	.75	Sh. Dr.
2467	July 3	5.31 p. m	45 23 00	55 41 00	58	52	35.8	38	fne. wh. S. bk. Sp	SW.	2	SSW.	.75	Bl. Dr.
2468	July 3	7.45 p. m	45 11 30	55 51 30	57	52	33.0	42	fne. bk. S	SW.	1	S. by W.	50	Sh. Dr.
2469	July 4	4.29 a. m	44 58 37	56 20 45	55	54	40.5	201	gn. M	SW.	1	ESE.	1	L. B. T.
2470	July 4	7.37 a. m	44 47 00	56 33 45	56	54	40.2	224	gy. M	S.	1	ESE.	1.50	L. B. T.
2471	July 4	10.31 a. m	44 34 00	56 41 45	56	53	40.4	218	gy. M. S	S. by E.	3	SW. by W.	1.50	L. B. T.
2472	July 4	4.30 p. m	44 27 30	57 10 45	59	53	40.0	137	crs. S. G	S.	3	NW.	.50	Tgls. with grapnels.
2473	July 4	5.17 p. m	44 27 15	57 10 00	58	53	40.0	219	crs. S. brk. Sh	SW.	2	NNW.	.50	Tgls. with grapnels.
2474	July 4	6.07 p. m	44 28 30	57 10 45	58	53	40.0	133	hrd	SW.	2	W.	.50	Tgls. with grapnels.
2475	July 4	6.50 p. m	44 28 30	57 10 00	54	53	......	222	yl. S. P	SW₂	3	WNW.	.50	Tgls. with grapnels.
2476	July 4	7.21 p. m	44 28 50	57 10 30	54	53	......	200	yl. S. P	SW.	3	N. by W.	1	Tgls. with grapnels.
2477	July 4	8.05 p. m	44 29 30	57 11 15	54	51	.....	114	crs. wh. S. P	SW.	3	NNW.	.50	L. B. T.
2478	July 5	5.06 a. m	44 05 30	57 16 30	53	52	.....	191	fne. yl. S	WSW.	2	N. by W.	.75	Tgls.
2479	July 5	5.53 a. m	44 05 45	57 16 45	53	52	.....	129	wh. S. P	W.	2	NNW.	.50	Tgls.
2480	July 5	6.54 p. m	44 06 00	57 16 30	54	52	.....	189	wh. S. P	W.	2	NNW.	.75	Sh. Dr.
2481	July 5	7.56 a. m	44 07 30	57 16 45	54	52	.....	116	G	NW.	2	NE.	.75	Sh. Dr.
2482	July 5	8.38 a. m	44 08 00	57 16 15	54	52	.....	265	br. M	NW.	2	N. by W.	.50	Sh. Dr.
2483	July 5	10.18 a. m	44 16 00	57 12 45	58	53	.....	175	crs. G	NW.	2	NE.	.50	Sh. Dr.

Record of dredgings and trawlings of the U. S. Fish Commission steamer Albatross, &c.—Continued.

Serial number.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth.	Character of bottom.	Wind. Direction.	Wind. Force.	Drift. Direction.	Drift. Distance.	Instrument used.
	1885.		° ′ ″	° ′ ″	°	°	°	*Fath.*					*Miles.*	
2484	July 5	11.26 a. m.	44 20 00	57 11 15	59	54	......	204	fne. wh. S	NW.	2	N. by E.	.50	Sh. Dr.
2485	July 5	12.30 p. m.	44 24 00	57 09 50	58	54	......	205	fne. wh. S	NW.	2	N. by W.	.50	Sh. Dr.
2486	July 5	1.38 p. m.	44 26 00	57 11 15	58	54	39.7	190	crs. S. G.	W. byN.	2	NNW.	.75	Sh. Dr.
2487	July 5	3.20 p. m.	44 28 30	57 14 45	57	54	......	39	gy. S. G	W. byN.	2	NNE.	1	Sh. Dr.
2488	July 5	5.02 p. m	44 35 00	57 13 30	56	53	......	150	yl. S.	NW.	2	ESE.	.50	Sh. Dr.
2489	July 5	7.17 p. m.	44 43 00	57 22 45	55	53	......	33	wh. S	NW.	2	ESE.	.75	Sh. Dr.
2490	July 6	4.44 a. m	45 27 30	58 27 45	50	52	......	50	G. P	SSW.	1	WNW.	.50	Sh. Dr.
2491	July 6	6.06 a. m.	45 24 30	58 35 15	51	53	......	59	wh. S	SSW.	1	W.	.50	Sh. Dr.
2492	July 6	7.32 a. m	45 22 00	58 43 45	51	53	33.3	75	wh. S.	SSW.	2	W.	.50	Sh. Dr.
2493	July 6	8.53 a. m.	45 19 00	58 51 15	52	53	32.3	45	wh. S. brk. Sh	SSW.	2	W.	.50	Sh. Dr.
2494	July 6	10.40 a. m.	45 14 30	59 06 45	54	54	32.5	50	S. G	SSW.	1	W.	.25	Tgls.
2495	July 6	12.20 p. m.	45 10 00	59 23 45	54	54	32.5	44	hrd	SSW.	1	W.	.25	Tgls.
2496	July 6	1.30 p. m.	45 07 30	59 27 45	58	56	32.2	44	crs. yl. S. P	S.	1	W.	.25	Tgls.
2497	July 6	3.10 p. m.	45 04 00	59 36 45	58	55	33.0	57	yl. S. brk. Sh. hrd	S.	1	W.	.75	Sh. Dr.
2498	July 6	5.21 p. m.	44 54 00	59 46 45	63	57	......	65	fne. br. S.	SSW.	2	W.	1	L. B. T.
2499	July 6	7.01 p. m	44 46 30	59 55 45	62	57	35.8	130	bk. M	SSW.	2	W. by S.	1	L. B. T.
2500	July 7	7.10 a. m.	44 28 00	60 15 15	59	58	......	36	S. G	S.	2	W.	.50	L. B. T.
2501	July 7	8.02 a. m.	44 27 00	60 20 15	59	58	38.7	26	S. G.	S.	2	W.	.50	L. B. T.
2502	July 7	11.09 a. m.	44 19 00	60 39 15	60	57	34.8	54	yl. S.	S.	1	NNW.	.50	L. B. T.
2503	July 7	1.43 p. m.	44 22 30	61 00 15	63	60	35.0	47	P	SSW.	1	WNW.	.50	L. B. T.
2504	July 7	4.22 p. m.	44 23 00	61 22 45	65	62	40.6	82	bk. M. G	SSW.	1	WNW.	.50	Sh. Dr.
2505	July 7	6.46 p. m.	44 23 30	61 44 15	63	63	42.3	93	dk. br. M	SSW.	1	W. by S.	.50	L. B. T.
2506	July 8	4.15 a. m.	44 26 00	62 10 00	61	61	43.1	127	dk. br. M.	SW.	1	WNW.	.50	L. B. T.
2507	July 8	6.46 a. m.	44 27 30	62 33 30	62	61	41.6	80	hrd	SW.	1	WNW.	.50	Sh. Dr.
2508	July 8	9.13 a. m.	44 28 30	62 56 00	62	61	39.7	72	br. M	Calm.	0	WNW.	.50	L. B. T.
2509	July 8	11.29 a. m.	44 30 00	63 18 00	64	61	34.8	43	crs. S.	Calm.	0	WNW.	.50	Sh. Dr.
2510	July 11	10.45 a. m.	44 16 00	63 23 00	58	53	39.2	68	bk. M. brk. Sh.	(*)		(*)		Dredge.
2511	July 11	12.29 p. m.	44 05 30	63 31 30	60	57	41.6	84	br. M	SW.	1	W. by N.	1	Sh. Dr.
2512	July 11	3.00 p. m.	43 48 00	63 46 30	62	58	42.6	103	br. M	SW.	2	W.	.50	Sh. Dr.
2513	July 11	5.38 p. m	43 34 00	63 56 30	62	58	43.6	134	gv. Oz	SW.	2	SSW.	.50	S. B. T.
2514	July 11	7.16 p. m.	43 28 30	63 57 30	62	59	43.1	126	bk. M	SW.	2	SSW.	.50	S. B. T.
2515	July 12	4.21 a. m	43 18 30	63 51 30	60	58	36.3	57	S. G	N.	2	W.	.50	Sh. Dr.
2516	July 12	5.35 a. m.	43 15 00	63 58 00	59	58	36.3	52	rky	NW.	2	WSW.	.50	Sh. Dr.
2517	July 12	9.02 a. m.	43 10 00	64 18 00	60	60	38.3	55	yl. S. bk. Sp	NNW.	2	W.	.50	Sh. Dr.
2518	July 12	11.16 a. m.	43 05 00	64 40 30	60	59	38.7	60	St	NNW.	2	W.	.50	Sh. Dr.
2519	July 12	2.11 p. m.	42 51 15	64 49 00	61	60	39.2	53	hrd	NW.	2	WSW.	.25	Sh. Dr.
2520	July 12	3.51 p. m.	42 41 00	64 55 30	60	60	40.6	62	rky	WNW.	3	SW. by S.	.25	Sh. Dr.

2521	July 12	5.26 p. m	42 30 30	65 02 00	61	62	42.1	65	S. G	WNW.	3	SW. by S.	.25	Sh. Dr.
2522	July 12	7.05 p. m	42 20 00	65 07 30	62	61	46.7	104	S. G	NW.	2	SW. by S.	.50	S. B. T.
2523	July 13	4.26 a. m	41 48 30	65 44 30	59	60	41.6	111	S. G. St	NNW.	2	W.	.25	Sh. Dr.
2524	July 13	5.14 a. m	41 48 45	65 47 00	60	60	42.6	85	S. G. St	ENE.	1	WSW.	.25	Sh. Dr.
2525	July 13	5.54 a. m	41 49 00	65 49 30	62	69	43.6	72	S. G. brk. Sh	E.	1	E. by N.	.25	Sh. Dr.
2526	July 13	8.49 a. m	41 40 45	65 46 00	65	66	......	121	P	NE.	1	NE. by E.	.50	Sh. Dr.
2527	July 13	1.30 p. m	41 59 00	65 35 30	66	61	......	117	S. G	(†)	....	(†)	......	(†)
2528	July 13	6.29 p. m	41 47 00	65 37 30	78	69	38.7	677	br. S	N.	1	WSW.	1	L. B. T.
2529	July 14	5.08 a. m	41 03 30	66 14 00	66	65	38.7	662	gy. M	SE.	1	SW. by S.	1	L. B. T.
2530	July 14	9.08 a. m	40 53 30	66 24 00	70	67	38.4	956	gy. Oz	SE.	1	SW. by W.	1	L. B. T.
2531	July 14	1.43 p. m	40 42 00	66 33 00	72	67	38.4	852	gy. M	SE.	2	SW. by W.	1	L. B. T.
2532	July 14	5.57 p. m	40 34 30	66 48 00	75	67	38.7	705	gy. M	SE.	2	WSW.	1	L. B. T.
2533	July 15	4.34 a. m	40 16 30	67 26 15	72	68	38.7	828	br. Oz	WNW.	3	NNW.	1	L. B. T.
2534	July 15	9.22 a. m	40 01 00	67 29 15	66	70	37.8	1,234	gy. Oz	NW.	3	NE.	1	L. B. T.
2535	July 15	1.03 p. m	40 03 30	67 27 15	66	70	37.8	1,149	gy. Oz	WNW.	1	NW.	1.50	L. B. T.
2536	Aug. 7	5.46 a. m	39 56 15	70 47 30	69	74	......	157	gn. M. fne. S	N.	1	WNW. / W.	.50 / 1	L. B. T.
2537	Aug. 7	6.53 a. m	39 56 45	70 50 30	71	74	46.2	156	gn. M. fne. S	NE.	1	NW. by N.	1	L. B. T.
2538	Aug. 7	7.48 a. m	39 57 30	70 51 15	71	74	46.2	150	gn. M. fne. S	NE.	1	N.	1	L. B. T.
2539	Aug. 7	8.57 a. m	39 59 45	70 53 00	71	74	47.7	133	gn. S	NE.	1	N.	1	L. B. T.
2540	Aug. 7	11.20 a. m	39 58 20	70 52 00	72	74	46.7	144	gn. S	NE.	1	N.	1	L. B. T.
2541	Aug. 7	12.00 m	39 57 45	70 50 30	73	73	47.7	134	gn. S. brk. Sh	NE.	1	N. by W.	1	L. B. T.
2542	Aug. 7	3.00 p. m	40 00 15	70 42 20	73	76	47.2	129	S. brk. Sh	NE.	2	NNW.	1	L. B. T.
2543	Aug. 7	4.27 p. m	39 58 15	70 42 30	72	76	45.2	166	gn. S. bk. Sp	NE. by E.	2	N.	1	L. B. T.
2544	Aug. 8	6.19 a. m	40 01 45	70 24 00	70	74	47.7	131	gn. S. bk. Sp	ENE.	3	N.	.50	L. B. T.
2545	Aug. 8	7.31 a. m	40 01 00	70 23 45	70	74	46.7	142	gn. S. bk. Sp	ENE.	4	N.	.50	L. B. T.
2546	Aug. 8	12.47 p. m	39 53 30	70 17 30	73	72	39.6	538	gn. M	ENE.	4	NW. by W.	1.50	L. B. T.
2547	Aug. 8	2.25 p. m	39 54 30	70 20 00	70	76	39.6	390	gn. M	ENE.	4	N.	1	L. B. T.
2548	Aug. 8	4.37 p. m	39 56 00	70 14 30	69	76	43.4	200	gn. S. bk. Sp	E.	4	N.	.50	L. B. T.
2549	Aug. 8	6.43 p. m	39 51 30	70 17 00	76	76	39.5	571	gn. M	E.	4	WNW.	1.50	L. B. T.
2550	Aug. 9	5.23 a. m	39 44 30	70 30 45	73	76	38.5	1,081	br. M	E. by N.	3	NW.	2	L. B. T.
2551	Aug. 9	8.47 a. m	39 46 00	70 36 30	77	77	38.7	778	gy. Oz	ENE.	4	....	......	....
2552	Aug. 9	12.33 p. m	39 47 07	70 35 00	77	77	39.6	721	gy. Oz	ENE.	4	NNW.	1.50	L. B. T.
2553	Aug. 9	3.48 p. m	39 48 00	70 36 00	72	77	39.2	551	gn. M	ENE.	3	W. by N.	2	L. B. T.
2554	Aug. 9	5.56 p. m	39 48 30	70 40 30	71	77	39.6	445	gn. M	ENE.	4	N.	.50	L. B. T.
2555	Aug. 10	6.13 a. m	39 53 00	71 32 00	72	75	47.7	136	gn. M. S	E.	1	N.	.50	L. B. T.
2556	Aug. 10	7.39 a. m	39 52 15	71 32 00	72	75	......	180	gn. M. fne. S	E.	2	N.	.50	S. B. T.
2557	Aug. 10	9.00 a. m	39 53 10	71 31 00	76	75	46.7	154	gn. M	SE.	2	WNW.	.50	S. B. T.
2558	Aug. 10	12.16 p. m	39 47 15	71 50 30	76	76	50.3	123	gn. S	SE.	2	NE.	.50	S. B. T.
2559	Aug. 10	1.11 p. m	39 48 00	71 48 30	78	76	......	120	br. M. S	SE.	1	NNE.	1	S. B. T.
2560	Aug. 10	3.13 p. m	39 48 10	71 48 40	78	76	50.7	114	br. M. S	SE.	1	NE.	.50	L. B. T.
2561	Aug. 10	5.53 p. m	39 38 00	71 42 00	89	77	39.2	500	gn. M	SSE.	1	N. by E.	1	L. B. T.
2562	Aug. 11	5.53 a. m	39 15 30	71 25 00	76	76	37.3	1,434	gy. Oz	S.	2	NE. by N.	1	L. B. T.
2563	Aug. 11	10.30 a. m	39 18 30	71 23 30	82	77	37.4	1,422	gy. Oz	S.	1	N.	1	L. B. T.
2564	Aug. 11	3.22 p. m	39 22 00	71 23 30	79	78	37.3	1,390	gy. Oz	SW.	2	NE. by N.	1	L. B. T.
2565	Aug. 28	1.15 p. m	38 19 20	69 02 30	72	77	36.2	2,069	gy. and br. Oz	WSW.	2	E.	3	L. B. T.
2566	Aug. 29	5.39 a. m	37 23 00	68 08 00	75	80	36.4	2,620	gy. Oz	NW.	4	SW. by S.	2	L. B. T.
2567	Aug. 30	5.27 a. m	37 45 00	66 56 00	72	78	36.4	2,721	gy. Oz	ESE.	2	(‡)	......	(‡)

* Dredge rope parted, losing ship's dredge and 79 fathoms of wire rope.
† Dories lowered with trawl grapnels to drag for coral. Several sprays obtained.
‡ Lost trawl.

Record of dredgings and trawlings of the U. S. Fish Commission steamer Albatross, &c.—Continued.

Serial number.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth.	Character of bottom.	Wind. Direction.	Wind. Force.	Drift. Direction.	Drift. Distance.	Instrument used.
	1885.		° ′ ″	° ′ ″	°	°	°	*Fath.*					*Miles.*	
2568	Aug. 31	9.48 a. m.	39 15 00	68 08 00	72	75	36.9	1,781	gy. Oz	ENE.	2	N. by E.	1	L. B. T.
2569	Aug. 31	3.00 p. m.	39 26 00	68 03 30	74	75	37.0	1,782	gy. Oz	W.	1	SSW.	1	L. B. T.
2570	Sept. 1	7.12 a. m.	39 54 00	67 05 30	72	72	36.8	1,813	Glob. Oz	Calm.	....	N.	1	L. B. T.
2571	Sept. 1	1.37 p. m.	40 09 30	67 09 00	75	72	37.8	1,356	gy. Glob. Oz	WSW.	2	N.	1	L. B. T.
2572	Sept. 2	5.00 a. m.	40 29 00	66 04 00	72	72	37.8	1,769	gy. Oz	NW.	3	W.	.50	L. B. T.
2573	Sept. 2	12.12 p. m.	40 34 18	66 09 00	71	71	37.3	1,742	gy. M. S	NW.	5	WNW.	1	S. B. T.
2574	Sept. 3	7.19 a. m.	41 02 30	65 08 15	65	71	36.7	1,791	yl. Glob. Oz	NNW.	3	WNW.	1	(*)
2575	Sept. 3	1.43 p. m.	41 07 00	65 26 30	64	71	37.1	1,710	gy. Oz	NW.	1	W.	1	S. B. T.
2576	Sept. 4	1.58 p. m.	41 15 30	68 15 00	64	61	......	18	crs. wh. S. yl. Sp	SW.	2	NW. by W.	.25	S. B. T.
2577	Sept. 4	2.55 p. m.	41 17 00	68 21 00	64	61	....	32	yl. S. P. hrd	SW.	3	WNW.	.25	S. B. T.
2578	Sept. 4	4.34 p. m.	41 20 30	68 31 30	63	60	54.4	37	fne. wh. S. bk. Sp	S.	2	WNW.	.25	S. B. T.
2579	Sept. 4	6.29 p. m.	41 23 00	68 47 00	62	61	42.2	70	fne. dk. gy. S	S.	2	W.	.25	S. B. T.
2580	Sept. 4	8.10 p. m.	41 25 30	69 01 00	64	62	42.4	83	yl. S. bk. Sp	SSW.	4	W.	.25	S. B. T.
2581	Sept. 18	8.21 a. m.	39 43 00	71 31 00	66	70	......	394	gn. M	SW.	3	S.	......	L. B. T.
2582	Sept. 18	2.53 p. m.	39 50 00	71 43 00	68	70	47.2	137	gn. M	SSW.	4	NE.	......	L. B. T.
2583	Sept. 18	4.18 p. m.	39 50 45	71 43 00	68	70	......	131	gn. M. S	SSW.	4	SSW.	......	L. B. T.
2584	Sept. 19	7.02 a. m.	39 05 30	72 23 20	71	72	39.5	541	gy. M	SW. by W.	4	S.	......	L. B. T.
2585	Sept. 19	4.28 p. m.	39 08 30	72 17 00	74	73	39.0	542	dk. gy. M	W. by S.	1	(†)	......	(†)
2586	Sept. 20	9.33 a. m.	39 02 40	72 40 00	69	71	40.2	328	dk. gy. M	NNE.	3	W.	1	S. B. T.
2587	Sept. 20	11.49 a. m.	39 02 00	72 38 00	70	71	39.7	404	dk. gy. M	NNE.	5	W.	.50	S. B. T.
2588	Sept. 20	3.21 p. m.	39 02 00	72 36 00	70	71	39.5	479	gn. M	NE. by E.	6	W.	.50	S. B. T.
2589	Sept. 21	8.37 a. m.	38 55 00	72 50 30	66	70	44.2	231	gn. M. S	ENE.	3	N. by W.	.50	S. B. T.
2590	Sept. 21	10.28 a. m.	38 53 30	72 52 00	68	71	47.6	190	gn. M. S	ENE.	3	N. by W.	.50	S. B. T.
2591	Sept. 21	12.08 p. m.	38 53 30	72 52 00	67	71	......	188	gn. M. S	ENE.	3	N. by W.	.50	S. B. T.
2592	Oct. 17	11.14 a. m.	35 02 20	75 12 00	70	79	......	120	fne. gy. S	N.	4	S.	.50	L. B. T.
2593	Oct. 17	12.00 m.	35 01 19	75 12 00	70	79	......	143	gy. S. bk. Sp	N.	4	NNE.	1	L. B. T.
2594	Oct. 17	1.25 p. m.	35 01 00	75 12 00	70	78	......	160	crs. gy. S. brk. Sh	N.	3	NNE.	1	L. B. T.
2595	Oct. 17	4.26 p. m.	35 08 00	75 05 30	78	78	......	63	gy. S. brk. Sh	N.	3	S.	.50	L. B. T.
2596	Oct. 17	5.52 p. m.	35 08 30	75 10 00	74	78	......	49	gy. S	N.	3	S.	.50	L. B. T.
2597	Oct. 18	6.07 a. m.	34 57 00	75 43 30	69	76	......	15	crs. gy. S	NE.	2	SE.	.25	L. B. T.
2598	Oct. 18	7.18 a. m.	34 51 00	75 40 15	71	77	....	22	wh. S. brk. Sh	NE.	2	S. by E.	.25	L. B. T.
2599	Oct. 18	8.25 a. m.	34 45 20	75 38 10	72	77	......	25	wh. S. brk. Sh	NE.	2	S. by E.	.25	L. B. T.
2600	Oct. 18	9.39 a. m.	34 39 30	75 35 30	75	78	......	87	fne. gy. S. bk. Sp. brk. Sh	NE.	2	S. by E.	.35	L. B. T.
2601	Oct. 18	11.09 a. m.	34 39 15	75 33 30	71	78	......	107	gy. S. P	NE.	2	S. by E.	.25	L. B. T.
2602	Oct. 18	12.03 p. m.	34 38 30	75 33 30	74	78	....	124	S. R	NE.	2	S. by E.	.25	L. B. T.
2603	Oct. 18	1.33 p. m.	34 38 30	75 33 30	79	77	......	124	S. R	NE	2	S. by E.	.25	L. B. T.
2604	Oct. 18	5.25 p. m.	34 37 30	75 39 45	76	78	......	34	yl. S. brk. Sh	ENE.	1	S. by E.	.25	L. B. T.

2605	Oct. 18	6.43 p. m.	34 35 30	75 45 30	75	78	......	32	wh. S. bk. Sp	Calm.	....	S. by E.	.25	L. B. T.
2606	Oct. 18	7.58 p. m.	34 35 15	75 52 00	73	78	......	25	wh. S. bk. Sp	WNW.	1	S. by W.	.25	L. B. T.
2607	Oct. 19	6.15 a. m.	34 38 00	76 12 00	71	76	......	18	fne. gy. S	ENE.	3	ENE.	.25	L. B. T.
2608	Oct. 19	7.19 a. m.	34 32 00	76 12 00	71	76	......	22	crs. gy. S. bk. Sp	S.	1	SSE.	.25	L. B. T.
2609	Oct. 19	8.24 a. m.	34 26 00	76 12 00	74	78	......	22	fne. gy. S.	S.	2	SSE.	.25	L. B. T.
2610	Oct. 19	9.32 a. m.	34 20 00	76 12 00	74	75	......	22	wh. S. bk. Sp. brk. Sh	S.	3	SSE.	.25	L. B. T.
2611	Oct. 19	10.35 a. m.	34 15 00	76 11 30	76	75	......	31	bk. S. brk. Sh	ESE.	3	SSW.	.25	L. B. T.
2612	Oct. 19	11.45 a. m.	34 11 00	76 10 30	77	78	......	52	crs. wh. S. brk. Sh	ESE.	3	NE. by N.	.25	L. B. T.
2613	Oct. 19	1.45 p. m.	34 09 00	76 02 00	77	78	......	168	gy. S. bk. Sp	SSE.	2	NE.	.50	L. B. T.
2614	Oct. 19	3.00 p. m.	34 09 00	76 02 00	77	78	......	168	gy. S. bk. Sp	SSE.	2	NE.	.50	L. B. T.
2615	Oct. 20	6.17 a. m.	33 45 00	77 25 00	76	75	......	18	gy. S	SSE.	3	SSE.	.25	Dredge.
2616	Oct. 20	7.20 a. m.	33 42 45	77 31 00	76	75	......	17	S. P.	SSE.	3	SSE.	.25	Dredge.
2617	Oct. 20	10.00 a. m.	33 37 30	77 36 30	77	75	......	14	crs. yl. S. brk. Sh	SE.	3	E.	.25	Dredge.
2618	Oct. 20	10.55 a. m.	33 37 15	77 35 30	76	74	......	17	crs. yl. S. brk. Sh	SE. by S.	3	E.	.25	S. B. T.
2619	Oct. 20	11.19 a. m.	33 38 00	77 36 00	76	74	......	15	crs. yl. S. brk. Sp. rot. Co	SE.	3	SE.	.25	Dredge.
2620	Oct. 20	12.13 p. m.	33 37 45	77 36 30	78	75	......	15	gy. S. rot. Co	SE. by S.	3	ESE.	.25	S. B. T.
2621	Oct. 20	1.54 p. m.	33 34 00	77 42 00	76	75	......	9	gy. S. brk. Co	SE. by S.	3	ESE.	.25	S. B. T.
2622	Oct. 20	3.48 p. m.	33 38 00	77 36 00	76	74	......	15	gy. S. brk. Co	SE. by S.	3	ESE.	.25	S. B. T.
2623	Oct. 20	4.09 p. m.	33 38 00	77 36 00	76	74	......	15	gy. S. brk. Co	SE. by S.	3	ESE.	.25	S. B. T.
2624	Oct. 21	6.27 a. m.	32 36 00	77 29 15	71	78	......	*258	gy. S. bk. Sp	WSW.	5	SSW.	.50	L. B. T.
2625	Oct. 21	7.50 a. m.	32 35 00	77 30 00	70	76	......	247	gy. S. bk. Sp	NE.	5	S. by E.	.50	L. B. T.
2626	Oct. 21	10.50 a. m.	32 27 30	77 20 30	69	76	......	353	fne. gy. S	SSW.	2	SE. by S.	.50	L. B. T.
2627	Oct. 21	2.06 p. m.	32 21 30	77 07 00	69	77	......	437	yl. M	SSW.	4	E.	.50	L. B. T.
2628	Oct. 21	3.51 p. m.	32 24 00	76 55 30	70	77	......	528	yl. M	SSW.	2	W.	.50	L. B. T.

* Lost trawl.

† Dredge-rope parted, losing large beam-trawl and 321 fathoms of wire rope.

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, during the year ending December 31, 1885.

Serial number.	Date.	Time.	Position.		Weight of sinker.	Reel.	Depth.	Character of bottom.	Temperature.		
			Lat. N.	Long. W.					Air.	Surface.	Bottom.
	1885.		° ′ ″	° ′ ″	*Lbs.*		*Fms.*		°	°	°
591	Mar. 4	8.50 a. m.	29 28 00	88 03 00	14	T.	25	gy. S	60	60	......
592	Mar. 4	12.12 p. m.	29 24 00	87 52 00	14	T.	36	fne. gy. S. bk. Sp	64	62	......
593	Mar. 4	3.22 p. m.	29 33 00	87 39 00	14	T.	25	crs. S. bk. Sp. brk. Sh	61	60	......
594	Mar. 4	4.18 p. m.	29 36 30	87 36 00	14	T.	22	fne. wh. S	60	61	......
595	Mar. 4	5.20 p. m.	29 40 30	87 32 30	14	T.	22	fne. wh. S	59	60	......
596	Mar. 7	5.48 a. m.	29 16 19	85 49 30	14	T.	30	gy. S. bk. Sp. brk. Sh.	58	61	......
597	Mar. 7	6.41 a. m.	29 16 00	85 47 30	14	T.	29	yl. S. bk. Sp. brk. Sh	58	64	......
598	Mar. 7	8.00 a. m.	29 17 20	85 45 30	14	T.	31	yl. S. bk. Sp. brk. Sh.	58	64	......
599	Mar. 7	9.10 a. m.	29 18 40	85 43 30	14	T.	30	yl. S. bk. Sh. brk. Sh	61	62	......
600	Mar. 7	9.38 a. m.	29 20 00	85 41 30	14	T.	27	yl. S. bk. Sp. brk. Sh	60	61	......
601	Mar. 7	10.02 a. m.	29 19 00	85 41 45	14	T.	29	yl. S. bk. Sp. brk. Sh.	60	61	......
602	Mar. 7	10.24 a. m	29 18 15	85 41 00	14	T.	28	yl. S. bk. Sp. brk. Sh.	60	61	......
603	Mar. 7	10.45 a. m.	29 17 30	85 40 15	14	T.	29	yl. S. bk. Sp. brk. Sh.	61	60	......
604	Mar. 7	11.03 a. m.	29 16 45	85 39 30	14	T.	28	yl. S. bk. Sp. brk. Sh.	61	60	......
605	Mar. 7	11.36 a. m.	29 16 00	85 38 45	14	T.	31	yl. S. bk. Sp. brk. Sh	61	60	......
606	Mar. 7	11.59 a. m.	29 15 11	85 38 00	14	T.	33	gy. S. bk. Sp	61	60	......
607	Mar. 7	12.16 p. m.	29 15 10	85 37 00	14	T.	32	fne. gy. S. bk. Sp	61	60	......
608	Mar. 7	12.33 p. m.	29 15 10	85 36 00	14	T.	31	fne. gy. S. bk. Sp	63	61	......
609	Mar. 7	12.56 p. m.	29 15 40	85 35 15	14	T.	29	fne. gy. S	65	62	......
610	Mar. 7	1.16 p. m.	29 16 15	85 34 30	14	T.	25	crs. R. bk. S. Sh.	65	62	......
611	Mar. 7	1.36 p. m.	29 15 00	85 34 30	14	T.	27	wh. S. bk. Sp. Sh	65	63	......
612	Mar. 7	1.55 p. m.	29 14 00	85 33 30	14	T.	27	fne. S. bk. Sp	65	63	......
613	Mar. 7	2.10 p. m.	29 13 00	85 32 30	14	T.	26	fne. wh. S. bk. Sp	65	63	......
614	Mar. 7	2.23 p. m.	29 12 30	85 32 00	14	T.	26	crs. S. bk. Sp. Sh	65	63	......
615	Mar. 7	2.57 p. m.	29 15 10	85 34 30	14	T.	29	fne. wh. S. bk. Sp	65	64	......
616	Mar. 7	3.16 p. m.	29 16 30	85 36 00	14	T.	29	fne. wh. S. bk. Sp	65	64	......
617	Mar. 7	3.32 p. m.	29 17 10	85 36 30	14	T.	27	fne. wh. S. bk. Sp	64	64	......
618	Mar. 7	3.48 p. m.	29 17 50	85 37 00	14	T.	27	fne. S. bk. Sp. brk. Sh.	63	64	......
619	Mar. 7	4.07 p. m.	29 18 30	85 37 30	14	T.	28	gy. bk. S. brk. Sh	63	64	......
620	Mar. 7	4.24 p. m.	29 19 15	85 38 00	14	T.	26	gy. bk. S. brk. Sh	63	64	......
621	Mar. 7	4.40 p. m.	29 19 40	85 39 20	14	T.	26	gy. bk. S. brk. Sh	63	63	......
622	Mar. 7	4.58 p. m.	29 20 05	85 40 40	14	T.	26	gy. bk. S. brk. Sh	63	63	......
623	Mar. 7	5.15 p. m.	29 20 30	85 42 00	14	T.	26	gy. bk. S. brk. Sh	63	63	......
624	Mar. 7	5.32 p. m.	29 19 45	85 42 50	14	T.	28	gy. bk. S. brk. Sh	62	63	......
625	Mar. 7	5.45 p. m.	29 19 20	85 43 15	14	T.	28	gy. bk. S. brk. Sh	62	63	......
626	Mar. 7	5.56 p. m.	29 19 00	85 43 15	14	T.	28	gy. bk. S. brk. Sh	62	63	......
627	Mar. 8	5.55 a. m.	29 16 15	85 42 30	14	T.	30	gy. bk. S. brk. Sh	58	60	......
628	Mar. 8	6.47 a. m.	29 16 45	85 41 00	14	T.	29	gy. bk. S. brk. Sh	56	59	......
629	Mar. 8	7.34 a. m.	29 15 30	85 40 15	14	T.	29	gy. bk. S. brk. Sh	57	60	......
630	Mar. 8	8.11 a. m.	29 17 45	85 42 00	14	T.	31	gy. bk. S. brk. Sh	57	60	......
631	Mar. 8	8.22 a. m.	29 20 30	85 44 00	14	T.	27	gy. bk. S. brk. Sh	57	60	......
632	Mar. 8	9.05 a. m.	29 19 30	85 45 00	14	T.	29	gy. bk. S. brk. Sh	57	60	......
633	Mar. 8	9.24 a. m.	29 20 15	85 45 40	14	T.	29	gy. bk. S brk. Sh	57	60	......
634	Mar. 8	9.58 a. m.	29 21 00	85 46 20	14	T.	28	G. brk. S. Sh	56	60	......
635	Mar. 8	2.56 p. m.	28 51 20	85 10 00	14	T.	31	gy. S. brk. Sh	64	65	......
636	Mar. 8	3.13 p. m.	28 52 10	85 09 20	14	T.	30	crs. gy. S. brk. Sh	64	65	......
637	Mar. 8	3.25 p. m.	28 53 00	85 08 40	14	T.	29	gy. S. brk. Sh	64	65	......
638	Mar. 8	3.37 p. m.	28 54 00	85 08 00	14	T.	28	gy. S. bk. Sp. brk. Sh	63	65	......
639	Mar. 15	1.53 p. m.	28 48 00	84 36 00	14	T.	24	S. Co. brk. Sh	61	63	......
640	Mar. 15	2.08 p. m.	28 47 00	84 35 50	14	T.	24	S. Co brk. Sh	63	62	......
641	Mar. 15	2.20 p. m.	28 46 00	84 35 40	14	T.	23	S. Co. brk. Sh	62	61	......
642	Mar. 15	2.44 p. m.	28 45 00	84 35 30	14	T.	24	S. Co. brk. Sh	61	60	......
643	Mar. 15	3.17 p. m.	28 44 00	84 35 20	14	T.	24	S. Co	60	59	......
644	Mar. 15	3.38 p. m.	28 43 00	84 35 30	14	T.	24	S. Co. brk. Sh.	60	62	62.4
645	Mar. 15	3.53 p. m.	28 42 00	84 35 40	14	T	26	S. bk. Sp. brk. Sh	60	61	
646	Mar. 15	4.02 p. m.	28 41 30	84 35 50	14	T.	26	crs. bk. gy. S. Co	60	61	......
647	Mar. 15	4.12 p. m.	28 41 00	84 36 00	14	T.	27	gy. S. bk. Sp Co	60	61	......
648	Mar. 15	4.24 p. m.	28 40 45	84 35 30	14	T.	26	wh. S. bk. Sp. brk. Sh	59	61	......
649	Mar. 15	4.50 p. m.	28 40 00	84 32 40	14	T.	26	wh. S. brk. Sh	58	62	......
650	Mar. 15	5.23 p. m.	28 42 00	84 29 50	14	T.	24	yl. S. bk. Sp. brk. Sh	58	62	......
651	Mar. 15	5.45 p. m.	28 43 20	84 28 00	14	T.	22	Co	58	62	......
652	Mar. 15	6.02 p. m.	28 44 00	84 27 00	14	T.	23	fne. wh. S. brk. Sh	58	62	......
653	Mar. 15	6.20 p. m.	28 44 40	84 26 00	14	T.	21	crs. gy. S	58	62	......
654	Mar. 16	5.30 a. m.	28 50 00	84 32 30	14	T.	21	brk. Sh	59	62	......
655	Mar. 16	6.22 a. m.	28 45 00	84 33 15	14	T.	24	fne. wh. S. bk. Sp. brk. Sh.	59	62	......
656	Mar. 16	7.05 a. m.	28 40 00	84 32 00	14	T.	27	fne. wh. S. bk. Sp	60	63	......
657	Mar. 16	7.51 a. m.	28 38 45	84 28 30	14	T.	24	fne. wh. S. brk. Sh	59	63	......
658	Mar. 16	8.42 a. m.	28 32 45	84 27 00	14	T.	24	crs. gy. S. brk. Sh	60	64	......
659	Mar. 16	10.50 a. m.	28 25 00	84 21 00	14	T.	24	crs. S. bk. Sp. Sh	62	63	......
660	Mar. 16	11.33 a. m.	28 21 00	84 18 00	14	T.	23	crs. S. bk. Sp. Sh	62	63	......
661	Mar. 16	12.18 p. m.	28 20 00	84 12 00	14	T.	22	gy. S	62	63	......
662	Mar. 16	1.02 p. m.	28 19 45	84 06 00	14	T.	21	wh. S. bk. Sp. brk. Sh.	59	63	......
663	Mar. 16	1.45 p. m.	28 15 45	84 02 35	14	T.	21	wh. S. bk. Sp. brk. Sh.	60	62	......

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, during the year ending December 31, 1885—Continued.

Serial number.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Weight of sinker.	Reel.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.
	1885.		° ′ ″	° ′ ″	Lbs.		Fms.		°	°	°
664	Mar. 16	2.46 p.m.	28 11 45	83 59 10	14	T.	22	wh. S. bk. Sp. brk. Sh.	61	63	......
665	Mar. 16	3.32 p.m.	28 07 45	83 55 40	14	T.	22	wh. S. bk. Sp	60	61	......
666	Mar. 16	4.15 p.m.	28 03 45	83 52 15	14	T.	22	fne. gy. S. bk. Sp	60	64	......
667	Mar. 16	5.00 p.m.	27 59 40	83 48 50	14	T.	22	crs. S. brk. Sh	60	63	......
668	Mar. 16	5.42 p.m.	27 55 30	83 45 25	14	T.	22	gy. bk. S	60	63	......
669	Mar. 16	6.23 p.m.	27 51 30	83 42 00	14	T.	21	fne. wh. S. bk. Sp	60	63	......
670	Mar. 16	7.05 p.m.	27 50 00	83 36 15	14	T.	20	wh. S. bk. Sp	60	62	......
671	Mar. 16	7.47 p.m.	27 49 00	83 30 30	14	T.	18	crs. S. bk. Sp. brk. Sh.	60	61	......
672	Mar. 16	8.26 p.m.	27 48 10	83 24 45	14	T.	16½	gy. S. brk. Sh	60	66	......
673	Mar. 16	9.08 p.m.	27 47 30	83 19 00	14	T.	15	gy. S. bk. Sp	60	62	......
674	Mar. 16	9.45 p.m.	27 46 45	83 13 15	14	T.	12	crs. gy. S. bk. Sp. brk. Sh.	60	62	......
675	Mar. 16	10.24 p.m.	27 46 10	83 07 30	14	T.	10	crs. gy. S. bk. Sp	60	62	......
676	Mar. 16	11.00 p.m.	27 46 00	83 02 00	14	T.	8	gy. S. bk. Sp. brk. Sh.	60	62	......
677	Mar. 18	11.06 a.m.	27 16 00	83 10 00	14	T.	18	gy. bk. S	65	64	......
678	Mar. 18	12.30 p.m.	27 08 30	83 19 30	14	T.	25	crs. gy. bk. S	67	66	......
679	Mar. 18	2.17 p.m.	26 58 00	83 22 30	14	T.	26	crs. gy. S. brk. Sh	68	66	......
680	Mar. 18	3.10 p.m.	26 53 00	83 24 00	14	T.	27	wh. S. bk. Sp. brk. Sh.	67	66	......
681	Mar. 18	5.06 p.m.	26 42 30	83 22 45	14	T.	29	crs. S. bk. Sp. brk. Sh.	80	67	......
682	Mar. 18	5.40 p.m.	26 38 00	83 20 00	14	T.	28	crs. S. bk. Sp	73	67	......
683	Mar. 19	5.22 a.m.	26 28 15	83 11 00	14	T.	26	fne. wh. S. bk. Sp	63	67	......
684	Mar. 19	6.10 a.m.	26 23 15	83 11 15	14	T.	28	crs. gy. S. bk. Sp. brk. Sh.	61	67	......
685	Mar. 19	7.53 a.m.	26 12 30	83 06 30	14	T.	27	crs. gy. S. bk. Sp. brk. Sh.	63	66	......
686	Mar. 19	8.37 a.m.	26 08 30	83 03 45	14	T.	25	fne. wh. S. bk. Sp. brk. Sh.	63	66	......
687	Mar. 19	9.23 a.m.	26 04 30	83 01 00	14	T.	24	fne. wh. S. bk. Sp. brk. Sh.	63	66	......
688	Mar. 19	10.20 a.m.	25 51 00	82 59 30	14	T.	24	fne. wh. S	67	66	......
689	Mar. 19	12.00 m.	25 49 00	83 01 00	14	T.	25	fne. wh. S	66	67	......
690	Mar. 19	12.39 p.m.	25 44 30	83 02 30	14	T.	27	S. Co	67	68	......
691	Mar. 19	1.26 p.m.	25 29 30	83 01 00	14	T.	27	gy. S. brk. Sh	68	69	......
692	Mar. 19	2.15 p.m.	25 34 30	83 01 00	14	T.	27	gy. S. bk. Sp	67	69	......
693	Mar. 19	2.59 p.m.	25 29 30	83 01 00	14	T.	28	crs. gy. S. brk. Sh	67	69	......
694	Mar. 19	3.38 p.m.	25 21 30	83 00 00	14	T.	27	gy. S. bk. Sp	67	69	......
695	Mar. 19	4.19 p.m.	25 19 30	82 59 30	14	T.	27	gy. M. brk. Sh	68	69	......
696	Mar. 19	4.56 p.m.	25 14 30	82 59 00	14	T.	27	gy. M. fne. S. brk. Sh.	68	69	......
697	Mar. 19	5.34 p.m.	25 09 30	82 59 00	14	T.	27	brk. Sh	67	69	......
698	Apr. 1	5.26 p.m.	31 55 00	79 20 00	35	S.	51	gy. bk. S. brk. Sh	66	69	60.8
699	Apr. 1	5.55 p.m.	31 54 45	79 17 00	14	T.	86	gy. M. brk. Sh	66	69	60.3
700	Apr. 2	11.33 a.m.	33 21 30	77 09 00	35	S.	71	gy. S	61	70	66.8
701	Apr. 2	5.03 p.m.	33 35 00	76 42 15	35	S.	91	fne. gy. S	65	72	65.2
702	Apr. 3	10.01 p.m.	36 30 00	73 14 00	60	S.	2,340	bu. Oz	59	72	36.8
703	Apr. 4	1.59 a.m.	36 45 00	73 28 00	60	S.	1,646	bu. Oz	68	66	37.2
704	Apr. 4	5.40 a.m.	36 57 30	73 47 00	60	S.	1,436	bu. Oz	61	55	37.5
705	Apr. 4	10.18 a.m.	37 01 08	71 10 00	35	S.	1,208	bu. Oz	50	52	38.7
706	Apr. 4	6.20 p.m.	37 09 23	74 30 30	35	S.	336	gn. M	45	46	......
707	Apr. 5	5.00 a.m.	37 03 00	71 39 00	14	T.	50	fne. yl. S. bk. Sp	42	46	......
708	Apr. 5	5.27 a.m.	37 03 45	74 37 10	14	T.	51	fne. yl. S. bk. Sp	42	46	46.8
709	Apr. 5	5.41 a.m.	37 03 40	71 35 00	14	T.	54	yl. S. bk. Sp. brk. Sh.	42	47	46.8
710	Apr. 5	6.05 a.m.	37 03 30	74 33 30	14	T.	59	G. crs. S. brk. Sh	42	47	47.7
711	Apr. 5	7.02 a.m.	37 03 00	74 33 00	14	T.	67	(Lost lead)	42	49	......
712	Apr. 5	8.09 a.m.	37 04 30	74 32 00	14	T.	98	bk. S	43	49	
713	Apr. 5	11.11 a.m.	37 05 00	74 57 30	14	T.	24	gy. S. brk. Sh	42	44	43
714	Apr. 5	1.36 p.m.	37 02 30	75 22 00	14	T.	17	fne. wh. S. bk. Sp	43	40	40.5
715	Apr. 5	4.10 p.m.	36 59 00	75 45 00	14	T.	9	fne. gy. S. bk. Sp	44	42	41.3
716	Apr. 5	5.32 p.m.	36 57 30	75 58 00	14	T.	6	gy. bk. S	46	43	42
717	Apr. 5	7.20 p.m.	37 07 30	76 08 30	14	T.	6½	M. brk. Sh	50	44	42.5
718	Apr. 5	10.12 p.m.	37 32 00	76 08 00	14	T.	7½	gn. M	48	44	40.5
719	Apr. 6	1.20 a.m.	37 51 00	76 09 00	14	T.	14	bu. M	50	42	37.7
720	Apr. 6	4.30 a.m.	38 07 30	76 32 00	14	T.	12	bu. M	52	43	38.7
721	June 3	4.39 a.m.	37 07 30	74 34 00	25	T.	75	fne. gy. S	61	60	......
722	June 3	6.37 a.m.	37 08 00	74 34 45	25	T.	61	crs. gy. S. P	61	61	54
723	June 3	9.40 a.m.	37 08 20	74 34 00	25	T.	68	crs. gy. bk. brk. Sh	66	67	52.5
724	June 3	10.45 a.m.	37 09 30	74 33 45	25	T.	75	crs. gy. S. bk. Sp. brk. Sh.	67	67	52.5
725	June 3	2.59 p.m.	37 10 15	74 31 00	25	T.	307	gn. M	65	67	......
726	June 3	3.52 p.m.	37 11 30	74 32 30	25	T.	103	gy. M. crs. S. bk. Sp	65	67	51.5
727	June 4	5.20 a.m.	36 40 30	74 42 00	25	T.	135	M. fne. bk. S	69	68	48.8
728	June 4	7.45 a.m.	36 43 00	74 41 00	25	T.	160	bk. M	71	69	48.5
729	June 4	8.35 a.m.	36 43 00	74 42 00	25	T.	98	brk. Sh. G	75	70	52
730	June 4	8.41 a.m.	36 43 00	74 46 30	25	T.	78	S G	75	70	......
731	June 5	4.47 a.m.	35 26 00	74 42 00	35	S.	87	gy. M	75	76	39.5

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, during the year ending December 31, 1885—Continued.

Serial number.	Date.	Time.	Position.		Weight of sinker.	Reel.	Depth.	Character of bottom.	Temperature.		
			Lat. N.	Long. W.					Air.	Surface.	Bottom.
	1885.		° ′ ″	° ′ ″	*Lbs.*		*Fms.*		°	°	°
732	June 5	5.38 a. m.	35 26 30	74 44 00	35	S.	388	bk. M	76	74	40.5
733	June 5	6.04 a. m.	35 27 00	74 46 00	20	T.	210	bk. M	76	74	44
734	June 5	6.22 a. m.	35 27 15	74 42 30	20	T.	69	bk. M	72	75	54
735	June 5	1.42 p. m.	35 12 00	75 09 30	35	S.	17	gy. S. brk. Sh	75	75	72.5
736	June 5	2.11 p. m.	35 12 15	75 05 00	20	T.	50½	fne. gy. S. bk. Sp. brk. Sh.	76	76	65
737	June 5	2.36 p. m.	35 12 30	75 03 30	20	T.	72	crs. gy. S. brk. Sh	76	76	60
738	June 5	2.46 p. m.	35 12 45	75 02 00	20	T.	68	R. Co	76	76	60
739	June 5	4.03 p. m.	35 13 00	75 01 00	20	T.	123	gy. S. bk.Sp. brk.Sh.	76	76	53
740	June 5	6.42 p. m.	35 11 00	75 07 00	20	T.	52	crs. gy. S. bk. Sp	78	75	65
741	June 6	5.38 a. m.	34 58 00	75 12 00	20	T.	66	fne. gy. S. bk. Sp	66	75	58
742	June 6	6.23 a. m.	34 59 00	75 13 00	20	T.	54	fne. gy. S. bk. Sp	66	75	61
743	June 19	5.45 a. m.	41 15 30	64 23 00	60	S.	1,915	yl. Oz	66	69	37.1
744	June 19	8.37 a. m.	41 18 15	63 55 00	35	S.	2,044	yl. Oz	68	66	......
745	June 19	11.45 a. m.	41 19 23	63 35 30	60	S.	2,071	gy. Oz	71	69	37
746	June 19	1.50 p. m.	41 23 20	63 23 15	60	S.	2,035	br. Oz	67	59	36.8
747	June 19	3.30 p. m.	41 26 15	63 15 00	60	S.	2,020	br. Oz	63	57	36.8
748	June 19	4.55 p. m.	41 22 00	63 10 00	60	S.	2,094	yl. Oz	61	60	36.7
749	June 19	6.45 p. m.	41 20 30	62 57 00	60	S.	2,178	gy. Oz	61	61	37
750	June 20	6.05 a. m.	40 40 30	60 33 00	60	S.	2,995	yl. Oz	63	75	36.5
751	June 21	4.15 a. m.	40 21 00	56 27 00	60	S.	3,103	gy. Oz	64	68	37.8
752	June 21	4.20 p. m.	40 24 30	54 24 00	60	S.	2,957	gy. Oz	78	74	36.8
753	June 21	9.50 p. m.	40 18 00	53 39 30	60	S.	2,863	gy. Oz	66	70	36.8
754	June 22	1.12 a. m.	40 16 00	53 16 30	60	S.	2,882	gy. Oz	66	69	37
755	June 22	3.45 a. m.	40 13 00	53 02 00	60	S.	2,897	gy. Oz	66	70	38.6
756	June 22	12.50 p. m.	40 55 30	52 02 30	60	S.	2,873	gy. Oz	71	67	36.8
757	June 22	8.20 p. m.	41 51 00	51 31 00	60	S.	2,118	gy. Oz	56	54	38.3
758	June 23	12.48 a. m.	42 18 30	51 16 00	60	S.	1,499	gy. Oz	51	52	37.2
759	June 23	3.42 a. m.	42 37 00	51 05 30	60	S.	1,070	gn. Oz	51	50	38
760	June 23	11.33 a. m.	42 51 30	50 55 00	35	S.	970	hrd	52	45	38.7
761	June 23	1.32 p. m.	42 56 00	50 50 00	35	S.	309	gn. M. S	51	45	38.7
762	June 24	8.55 a. m.	43 38 00	49 42 00	18	T.	30	S. brk. Sh	53	48	39.2
763	June 24	9.39 a. m.	43 38 00	49 34 30	18	T.	38	wh. S.bk.Sp. brk.Sh.	53	48	36
764	June 24	10.44 a. m.	43 38 00	49 27 00	18	T.	125	gn. M. crs. gy. S	53	49	......
765	June 24	6.28 p. m.	44 26 00	49 33 00	18	T.	34	wh. S. brk. Sh	51	45	35.1
766	June 24	11.00 p. m.	44 57 00	49 38 00	18	T.	36	wh. S. brk. Sh	46	44	32.7
767	June 25	4.59 p. m.	46 29 00	49 39 30	18	T.	39	gy. S	48	43	34.4
768	July 2	11.20 p. m.	46 02 30	53 26 00	18	T.	76½	crs. gy. bk. S	48	47	29.5
769	July 3	2.45 a. m.	45 51 00	53 53 00	35	S.	78	dk. gn. S.brk. Sh	49	47	29.5
770	July 3	3.32 a. m.	45 52 00	53 59 00	35	S.	75	fne. gy. S	49	47	29.5
771	July 3	5.04 a. m.	45 49 45	54 06 30	35	S.	67	bk. S	50	46	29.7
772	July 4	1.09 p. m.	44 21 30	56 52 15	35	S.	761	gy. Oz	56	52	38.7
773	July 4	1.53 p. m.	44 22 50	56 56 30	35	S.	795	gy. Oz	59	54	38.7
774	July 4	2.41 p. m.	44 24 10	57 00 40	35	S.	566	hrd	59	53	38.7
775	July 4	3.16 p. m.	44 25 30	57 04 45	35	S.	366	gy. Oz. P	59	53	39.7
776	July 4	3.37 p. m.	44 26 00	57 06 15	35	S.	454	gy. Oz	59	53	39.7
777	July 4	4.05 p. m.	44 27 00	57 09 15	35	S.	333	crs. S. G	59	53	40
778	July 4	8.33 p. m.	44 30 30	57 12 45	35	S.	99	crs. S. P	54	51	......
779	July 5	4.02 a. m.	44 05 15	57 14 15	35	S.	346	gy. C	54	54	......
780	July 5	4.26 a. m.	44 05 15	57 15 30	35	S.	375	S. brk. Co	54	54	......
781	July 5	6.27 a. m.	44 06 00	57 17 00	35	S.	90	wh. S. P	53	52	......
782	July 5	7.26 a. m.	44 06 30	57 17 00	35	S.	142	hrd. wh. S	54	52	......
783	July 5	9.20 a. m.	44 11 00	57 14 45	35	S.	183	P	55	53	......
784	July 5	9.50 a. m.	44 13 30	57 13 45	35	S.	155	lge. P	55	53	......
785	July 5	1.10 p. m.	44 24 45	57 10 15	35	S.	204	gy. S	59	54	......
786	July 5	2.03 p. m.	44 26 30	57 10 45	35	S.	175	crs. S	57	54	......
787	July 5	2.26 p. m.	44 28 30	57 10 45	35	S.	186	fne. S	57	54	......
788	July 5	2.50 p. m.	44 28 30	57 12 45	35	S.	145	fne. gy. S	57	54	39.7
789	July 5	3.43 p. m.	44 29 00	57 14 45	35	S.	40	hrd. crs. P	57	54	......
790	July 5	4.04 p. m.	44 31 00	57 14 45	35	S.	42	hrd. crs. P	57	54	......
791	July 5	4.23 p. m.	44 33 00	57 14 45	35	S.	48	fne. wh. S	57	54	......
792	July 5	4.43 p. m.	44 35 00	57 14 45	35	S.	90	yl. S	57	54	......
793	July 5	5.38 p. m.	44 35 00	57 12 15	35	S.	188	M. fne. S	56	53	......
794	July 5	6.28 p. m.	44 39 00	57 17 00	35	S.	124	wh. S	55	53	......
795	July 6	12.43 a. m.	45 03 00	57 56 00	18	T.	39	hrd	50	52	32
796	July 6	2.44 a. m.	45 16 00	58 11 45	18	T.	75	wh. S	50	52	33.5
797	July 6	3.35 a. m.	45 21 30	58 18 45	18	T.	54	rot. Co	50	52	32
798	July 6	5.12 a. m.	45 27 00	58 28 45	35	S.	45	fne. wh. S. bk. Sp	50	52	......
799	July 6	6.31 a. m.	45 24 00	58 36 45	35	S.	67	fne. M	51	53	......
800	July 6	7.56 a. m.	45 21 30	58 44 45	35	S.	42	wh. S. P	51	53	32
801	July 6	9.05 a. m.	45 18 30	58 52 45	18	T.	45	yl. S	52	53	......
802	July 6	10.52 a. m.	45 14 00	59 08 15	18	T.	48	S. G´	54	54	......
803	July 6	12.35 p. m.	45 09 30	59 25 15	18	T.	43	hrd.	51	54	......
804	July 6	1.48 p. m.	45 07 00	59 28 45	18	T.	46	yl. S	58	56	......

Record of hydrographic soundings of the U. S. Fish Commission steamer Albatross, during the year ending December 31, 1885—Continued.

Serial number.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Weight of sinker.	Reel.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.
			° ′ ″	° ′ ″	*Lbs.*		*Fms.*		°	°	°
805	July 6	2.30 p. m.	45 06 00	59 31 30	18	T.	48	yl. S	58	56	32.3
806	July 6	2.59 p. m.	45 05 00	59 34 00	18	T.	52	yl. S	58	55	......
807	July 6	3.47 p. m.	45 03 00	59 39 45	18	T.	58	yl. S	60	56	......
808	July 6	9.03 p. m.	44 36 00	59 51 45	18	T.	48	yl. S. G	59	58	35.8
809	July 6	9.43 p. m.	44 32 30	59 46 45	18	T.	70	fne. wh. S	59	58	35.3
810	July 7	4.12 a. m.	44 40 00	59 53 45	18	T.	48	S. G	58	58	34.8
811	July 7	4.39 a. m.	44 39 30	59 57 45	18	T.	54	S. brk. P	58	58	......
812	July 7	5.21 a. m.	44 38 00	60 03 45	18	T.	57	fne. gy. bk. S	58	58	......
813	July 7	6.24 a. m.	44 32 00	60 11 15	18	T.	74	S. G	57	58	......
814	July 7	7.34 a. m.	44 28 00	60 16 15	18	T.	33	S. G	59	58	......
815	July 7	8.15 a. m.	44 26 30	60 21 45	18	T.	26	S. G	59	58	......
816	July 7	11.37 a. m.	44 19 00	60 40 45	18	T.	63	yl. S. P	60	57	......
817	July 7	12.17 p. m.	44 22 00	60 44 15	18	T.	54	yl. S	65	57	34.1
818	July 8	10.46 a. m.	44 29 30	63 11 00	18	T.	51	hrd	64	61	34.6
819	July 8	12.17 p. m.	44 30 30	63 19 00	18	T.	40	R	65	61	......
820	July 11	10.23 p. m.	43 12 00	64 00 30	18	T.	54	hrd	60	58	37.8
821	July 12	12.08 p. m.	43 01 00	64 45 30	18	T.	47	hrd	60	60	38.7
822	July 12	10.00 p. m.	42 12 30	65 14 00	18	T.	100	G	61	62	......
823	July 12	11.59 p. m.	42 05 00	65 22 00	18	T.	74	crs. G	60	62	......
824	July 13	2.00 a. m.	41 58 00	65 30 00	18	T.	339	bu. M	60	62	......
825	July 13	6.42 a. m.	41 49 50	65 45 30	18	T.	85	S. G	62	60	42.6
826	July 13	6.51 a. m.	41 49 30	65 45 30	18	T.	82	S. G	63	60	......
827	July 13	7.04 a. m.	41 49 00	65 45 30	18	T.	81	S. G	63	60	42.3
828	July 13	7.23 a. m.	41 47 00	65 47 15	18	T.	75	S. G	63	60	42.6
829	July 13	7.44 a. m.	41 44 30	65 47 00	18	T.	79	stf. bu. C. G	63	60	45.2
830	July 13	7.59 a. m.	41 44 45	65 45 30	18	T.	84	S. G	63	60	45.2
831	July 13	8.20 a. m.	41 42 45	65 45 45	18	T.	83	S. G	63	60	......
832	July 13	9.24 a. m.	41 42 00	65 45 30	18	T.	84	crs. S. G	65	66	......
833	July 13	9.48 a. m.	41 40 30	65 45 00	18	T.	278	wh. S. bk. Sp	66	66	......
834	July 13	10.16 a. m.	41 42 30	65 44 15	18	T.	363	S. P	66	66	......
835	July 13	11.54 a. m.	41 55 10	65 44 00	18	T.	129	crs. S. G	64	60	41.6
836	July 13	12.19 p. m.	41 55 50	65 42 30	18	T.	136	hrd	64	60	......
837	July 13	12.37 p. m.	41 56 25	65 41 00	18	T.	175	brk. Sh	64	60	......
838	July 13	12.50 p. m.	41 57 00	65 39 40	18	T.	176	brk. Sh	66	61	......
839	July 13	1.09 p. m.	41 58 00	65 37 30	18	T.	128	P	66	61	......
840	Aug. 8	5.02 a. m.	39 57 45	70 23 30	18	T.	234	gn. S	71	75	41.6
841	Aug. 8	5.43 a. m.	40 00 45	70 24 00	18	T.	154	gn. S. bk. Sp	71	75	46.2
842	Aug. 8	10.50 a. m.	39 59 00	70 22 45	18	T.	167	gn. S. bk. Sp. brk. Sh.	71	74	45.7
843	Aug. 8	11.23 a. m.	39 56 15	70 21 30	18	T.	233	gn. M. S	71	72	41.9
844	Aug. 8	12.01 p. m.	39 53 28	70 20 30	35	S.	300	gn. M. S	73	72	40.6
845	Aug. 8	3.36 p. m.	39 56 00	70 20 45	35	S.	237	gn. M	70	76	41.6
846	Aug. 8	6.05 p. m.	39 51 30	70 15 30	35	S.	344	gn. M	76	76	43.9
847	Aug. 8	8.20 p. m.	39 52 30	70 21 00	35	S.	416	stf. gn. M	70	74	39.6
848	Aug. 9	3.08 a. m.	39 54 15	70 29 00	35	S.	315	hrd	71	76	41.6
849	Aug. 9	7.14 p. m.	39 49 00	70 42 00	35	S.	452	gy. M	71	77	39.6
850	Aug. 10	3.01 a. m.	39 44 30	71 20 30	35	S.	562	gn. M	71	76	39.3
851	Aug. 10	4.18 a. m.	39 47 15	71 24 30	35	S.	397	gy. Oz	71	76	39.6
852	Aug. 10	4.57 a. m.	39 49 40	71 27 30	35	S.	298	gn. Oz	69	74	40.6
853	Aug. 10	5.34 a. m.	39 52 00	71 30 30	35	S.	206	gn. M	72	75	43.6
854	Aug. 10	7.42 p. m.	39 41 00	71 42 00	35	S.	378	gn. S	76	77	39.6
855	Aug. 31	5.00 a. m.	38 45 00	68 04 00	60	S.	1,949	lt. bu. Glob. Oz	72	75	36.4
856	Sept. 1	4.09 a. m.	39 44 00	67 03 00	60	S.	2,009	gy. Oz	71	72	36.8
857	Sept. 3	4.15 a. m.	40 52 30	65 07 00	60	S.	2,009	yl. Glob. Oz	63	71	......
858	Sept. 18	1.25 p. m.	39 47 00	71 39 45	35	S.	291	gn. M	68	70	......
859	Sept. 19	8.52 a. m.	39 04 00	72 23 00	35	S.	659	gn. M	71	72	38.5
860	Sept. 19	9.41 a. m.	39 05 30	72 25 30	35	S.	519	gn. M	72	72	39
861	Sept. 20	4.10 a. m.	39 04 00	72 16 00	35	S.	877	......	70	72	(*)
862	Sept. 20	6.54 a. m.	39 05 30	72 20 00	35	S.	715	gy. M	70	62	38.7
863	Sept. 21	4.00 a. m.	39 04 30	73 02 00	35	S.	47	crs. gy. S. bk. Sp	67	70	48.8
864	Sept. 21	6.42 a. m.	39 02 00	72 59 30	35	S.	47	crs. gy. S. bk. Sp	66	70	48.8
865	Sept. 21	7.30 a. m.	38 58 30	72 55 00	35	S.	55	crs. dk. gy. S	66	70	50.9
866	Oct. 17	10.27 a. m.	35 02 00	75 09 30	35	S.	197	gy. M	70	79	......
867	Oct. 18	10.36 a. m.	34 38 00	75 32 00	18	T.	210	gn. M	75	78	46.7
868	Oct. 20	8.35 a. m.	33 40 30	77 37 00	18	T.	15	fne. gy. S. brk. Sh	76	77	......

* Wire parted, losing thermometer and 800 turns of wire.

Table of fishing stations of U. S. Fish Commission steamers Fish

Date.	Time.	Position. Lat. N.	Position. Long W.	Depth (fathoms).	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Object of search.	Implement used.
		° ′ ″	° ′ ″			°	°	°		
1880.										
Sept. 13	4.45 a. m.	39 57 00	70 56 00	126	S. M	68	70	53	Tile-fish	Trawl-line
13	3.12 p.m.	39 48 30	70 54 00	250	M	74	71.5	42	...do	...do
1881.										
Aug. 9	6.15 a. m.	40 01 00	71 12 30	138	S. M	72	69	50	...do	...do
23	4.20 a. m.	40 03 00	70 31 00	100	S. M	68	66	52	...do	...do
Sept. 21	6.00 a. m.	39 58 00	70 06 00	113	S. brk. Sh	67	67	47	...do	...do
1882.										
Aug. 22	5.58 a. m.	40 02 00	70 35 00	116	gy. M	69	71	48	...do	...do
Oct. 4	6.15 a. m.	40 00 00	70 37 00	99	S	65	62	47	...do	...do
1883.										
May 25	5.15 a. m.	40 05 25	70 28 00	91	gy. M. S	49	49	48	...do	...do
26	1.05 p.m.	39 29 00	72 19 55	74	gy. M. S	55	50	49.5	...do	...do
Sept. 20	6.56 a. m.	40 05 00	70 34 45	70	bn. M	67	68	50	...do	...do
20	2.45 p.m.	40 01 50	70 39 20	111	gy. S	70	68	47	...do	...do
21	5.30 a. m.	40 01 50	70 59 00	117	gn. M	68	69	49	...do	...do
Nov. 9	8.23 a. m.	35 19 30	75 15 20	16	S. Sh	71	76	66	General	Hand-line
9	11.00 a. m.	35 16 00	75 02 30	48	bn. M. S	76	78	66	Tile-fish	...do
12	7.59 a. m.	36 16 15	74 51 20	40	gy. S. G	....	68	56	...do	...do
1884.										
Aug. 1	.....	41 03 30	71 08 00	18	S. G	....	....	.	Codfish	...do
2	5.24 a. m.	40 03 00	70 38 00	101	gn. M. fne. S	65	63	51	Tile-fish	Trawl-line
2	1.08 p.m.	40 00 15	70 55 30	136	gn. M. S	71	70	49	...do	...do
3	5.13 a. m.	40 01 30	71 12 30	113	gn. M. S	67	66	48.6	...do	...do
3	1.51 p. m.	39 54 30	71 08 00	235	gn. M. S	73	70	43	...do	...do
6	11.24 a. m.	39 56 30	69 43 00	84	S. brk. Sh	77	75	52	...do	...do
Sept. 25	.....	41 03 30	71 08 00	18	S. G	....	....	...	Codfish	Hand-line
27	8.20 p. m.	40 46 30	69 50 15	18	S. bk. Sp	61	60	56	...do	...do
1885.										
Jan. 5	9.47 a. m.	32 55 00	77 54 00	79	S. bk. Sp	69	72	59	Tile-fish	Trawl-line
30	10.38 a. m.	22 07 30	87 06 00	21	wh. S. Co	78	77	....	General	Hand line
30	11.37 a. m.	22 08 40	87 06 00	22	S. Co	79	77	..	...do	...do
Feb. 7	8.11 a. m.	29 16 30	85 34 00	27	gy. and bk. S. and Sh	60	61	65	...do	...do
7	12.00 m	25 15 19	85 34 00	30	gy. and bk. S and Sh	...	...	...	...do	...do
Mar. 4	5.36 a. m.	29 15 00	88 06 00	60	bn. M	62	67	61.8	...do	...do
4	7.46 a. m.	29 24 00	88 04 00	32	S. G. brk. Sh	61	61	...	...do	...do
4	8.50 a. m.	29 28 00	88 03 09	25	gy. S	60	60	...	...do	...do
4	9.45 a. m.	29 24 30	88 01 00	35	yl. S. bk. Sp	61	61	....	...do	...do
4	10.56 a. m.	29 28 00	87 56 00	27	gy. S. brk. Sh	61	62	...	...do	...do
4	12.12 p.m.	29 24 00	87 52 00	36	fne. gy. S. bk. Sp	61	62	....	...do	...do
4	12.48 p.m.	29 27 30	87 48 30	30	crs. S. bk. Sp. brk. Sh	62	62	...	...do	...do
4	2.03 p.m.	29 32 00	87 45 00	25	gy. S. bk. Sp	61	59	...	...do	...do
4	3.22 p. m.	29 33 00	87 39 00	25	crs. S. bk. Sp. brk. Sh	61	66	...	...do	...do
4	4.18 p.m.	29 36 30	87 36 00	22	fne. wh. S	60	61	...	...do	...do
4	5.20 p.m.	29 40 30	87 32 30	22	fne. wh. S	59	60	..	...do	...do
7	5.48 a. m.	29 16 19	85 49 30	30	gy. S. bk. Sp. brk. Sh	58	64	..	...do	...do
7	6.44 a. m.	29 16 00	85 47 30	29	yl. S. bk. Sp. brk. Sh	58	64	....	...do	...do
7	8.00 a. m.	29 17 20	85 45 30	31	yl. S. bk. Sp. brk. Sh	58	64	....	...do	...do
7	9.10 a. m.	29 18 40	85 43 30	30	yl. S. bk. Sp. brk. Sh	61	62	....	...do	...do
7	9.38 a. m.	29 20 00	85 41 30	27	yl. S. bk. Sp. brk. Sh	60	61	....	...do	...do
7	10.02 a. m.	29 19 00	85 41 45	29	yl. S. bk. Sp. brk. Sh	60	61	....	...do	...do
7	10.24 a. m.	29 18 15	85 41 00	28	yl. S. bk. Sp. brk. Sh	60	61	....	...do	...do
7	10.45 a. m.	29 17 30	85 40 15	29	yl. S. bk. Sp. brk. Sh	61	60	....	...do	...do
7	11.03 a. m.	29 16 45	85 39 30	28	yl. S. bk. Sp. brk. Sh	61	60	....	...do	...do
7	11.36 a. m.	29 16 00	85 38 45	31	yl. S. bk. Sp. brk. Sh	61	60	....	...do	...do
7	11.59 a. m.	29 15 11	85 38 00	33	gy. S. bk. Sp	61	60	....	...do	...do
7	12.16 p.m.	29 15 10	85 37 00	32	fne. gy. S. bk. Sp	61	60	....	...do	...do
7	12.33 p.m.	29 15 10	85 36 00	31	fne. gy. S. bk. Sp	63	61	....	...do	...do
7	12.56 p.m.	29 15 40	85 35 15	29	fne. gy. S	65	62	....	...do	...do
7	1.16 p.m.	29 16 15	85 31 30	25	crs. R. bk. S. Sh	65	62	....	...do	...do
7	1.36 p.m.	29 15 00	85 34 30	27	wh. S. bk. Sp. Sh	65	63	....	...do	...do
7	1.55 p.m.	29 14 00	85 33 30	27	fne. S. bk. Sp	65	63	....	...do	...do
7	2.10 p.m.	29 13 00	85 32 30	26	fne. wh. S. bk. Sp	65	63	....	...do	...do
7	2.23 p.m.	29 12 30	85 32 00	26	crs. S. bk. Sp. Sh	65	63	....	...do	...do
7	2.57 p.m.	29 15 10	85 34 30	29	fne. wh. S. bk. Sh	65	61	....	...do	...do
7	3.16 p.m.	29 16 30	85 36 00	29	fne. wh. S. bk. Sp	65	65	....	...do	...do
7	3.32 p.m.	29 17 10	85 36 30	27	fne. wh. S. bk. Sp	64	64	....	...do	...do
7	3.48 p.m.	29 17 50	85 37 00	27	fne. S. bk. Sp. brk. Sh	63	64	...	...do	...do
7	4.07 p.m.	29 18 30	85 37 30	28	gy. bk. S. brk. Sh	63	64	....	...do	...do
7	4.24 p. m.	29 19 15	85 38 00	26	gy. bk. S. brk. Sh	63	61	....	...do	...do
7	4.40 p.m.	29 19 40	85 39 20	26	gy. bk. S. brk. Sh	63	63	....	...do	...do

Hawk and Albatross, September 13, 1880, to October 20, 1885.

Tile-fish (*Lopholatilus chamæleonticeps*).	Hake (*Phycis tenuis*).	Whiting (*Merlucius bilinearis*).	Skate (*Raia* sp.).	Dogfish (*Mustelus canis*).	Codfish (*Gadus morrhua*).	Red groupers (*Epinephelus morio*).	Black bass (*Serranus atrarius*).	Red snappers (*Lutjanus Blackfordii*).	Black groupers (*Epinephelus nigritus*).	Haddock (*Gadus æglefinus*).	Norway haddock (*Sebastes marinus*).	Miscellaneous.
6	Many.	......	Many.	......	......	......	......	......	......	......	......	......
......	Many.	......	Many.	......	......	......	......	......	......	......	......	......
19	Many.	Many.	Many.	......	......	......	......	......	......	......	......	......
67	Many.	Many.	Many.	......	......	......	......	......	......	......	......	......
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......	Many.	......	Many.	......	......	......	......	......	......	......	......	......
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......	Few ..	Few ..	Few ..	......	......	......	......	......	......	......	......	......
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Table of fishing stations of U. S. Fish Commission steamers Fish Hawk

Date.	Time.	Position. Lat. N.	Position. Long W.	Depth (fathoms).	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Object of search.	Implement used.
1885.		° ′ ″	° ′ ″			°	°	°		
Mar. 7	4.58 p.m.	29 20 05	85 40 40	26	gy. bk. S. brk. Sh	63	63	....	General	Hand-line
7	5.15 p.m.	29 20 30	85 42 00	26	gy. bk. S. brk. Sh	63	63	....	...do	...do
7	5.32 p.m.	29 19 45	85 42 50	28	gy. bk. S. brk. Sh	62	63	....	...do	...do
7	5.45 p.m.	29 19 20	85 43 15	28	gy. bk. S. brk. Sh	62	63	....	...do	...do
7	5.56 p.m.	29 19 00	85 43 15	28	gy bk. S. brk. Sh	62	63	....	...do	...do
8	5.55 a.m.	29 16 15	85 42 30	30	gy. bk. S. brk. Sh	58	60	....	...do	...do
8	6.47 a.m.	29 16 45	85 41 00	29	gy. bk. S. brk. Sh	56	59	....	...do	...do
8	7.34 a.m.	29 15 30	85 40 15	29	gy. bk. S. brk. Sh	57	60	....	...do	...do
8	8.11 a.m.	29 17 45	85 42 00	31	gy. bk. S. brk. Sh	57	60	....	...do	...do
8	8.22 a.m.	29 20 30	85 44 00	27	gy. bk. S. brk. Sh	57	60	....	...do	...do
8	9.05 a.m.	29 19 30	85 45 00	29	gy. bk. S. brk. Sh	57	60	....	...do	...do
8	9.24 a.m.	29 20 15	85 45 40	29	gy. bk. S. brk. Sh	57	60	....	...do	...do
8	9.58 a.m.	29 21 00	85 46 20	28	G. brk Sh	56	60	....	...do	...do
8	2.56 p.m.	28 51 20	85 10 00	31	gy. S. brk. Sh	64	65	....	...do	...do
8	3.13 p.m.	28 52 10	85 09 20	30	crs. gy. S. brk. Sh	64	65	....	...do	...do
8	3.25 p.m.	28 53 00	85 08 40	29	gy. S. brk. Sh	64	65	....	...do	...do
8	3.37 p.m.	28 54 00	85 08 00	28	gy. S. bk. Sp. brk. Sh	63	65	....	...do	...do
15	1.53 p.m.	28 48 00	84 36 00	24	S. Co. brk. Sh	64	63	....	...do	...do
15	2.08 p.m.	28 47 00	84 35 50	24	S. Co. brk. Sh	63	62	....	...do	...do
15	2.20 p.m.	28 46 00	84 35 40	23	S. Co. brk. Sh	62	61	....	...do	...do
15	2.44 p.m.	28 45 00	84 35 30	24	S. Co. brk. Sh	61	60	....	...do	...do
15	3.17 p.m.	28 44 00	84 35 20	24	S. Co	60	59	....	...do	...do
15	3.38 p.m.	28 43 00	84 35 30	24	S. Co. brk. Sh	60	62.1	62.1	...do	...do
15	3.53 p.m.	28 42 00	84 35 40	26	S. bk. Sp. brk. Sh	60	61	....	...do	...do
15	4.02 p.m.	28 41 30	84 35 50	26	crs. bk. gy. S. Co	60	61	....	...do	...do
15	4.12 p.m.	28 41 00	84 36 00	27	gy. S. bk. Sp. Co	60	61	....	...do	...do
15	4.24 p.m.	28 40 45	84 35 30	26	wh. S. bk. Sp. brk. Sh	59	61	....	...do	...do
15	4.50 p.m.	28 40 00	84 32 40	26	wh. S. brk. Sh	58	62	....	...do	...do
15	5.23 p.m.	28 42 00	84 29 50	24	yl. S. bk. Sp. brk. Sh	58	62	....	...do	...do
15	5.45 p.m.	28 43 20	84 28 00	22	Co	58	62	....	...do	...do
15	6.02 p.m.	28 44 00	84 27 00	23	fne. wh. S. brk. Sh	58	62	....	...do	...do
15	6.20 p.m.	28 44 40	84 26 00	21	crs. gy. S	58	62	....	...do	...do
16	5.30 a.m.	28 50 00	84 32 30	21	brk. Sh	59	62	....	...do	...do
16	6.22 a.m.	28 45 00	84 33 15	24	fne. wh. S. bk. Sp*	59	62	....	...do	...do
16	7.05 a.m.	28 40 00	84 34 00	27	fne. wh. S. bk. Sp	60	60	....	...do	...do
16	7.51 a.m.	28 38 45	84 28 30	24	fne. wh. S. brk. Sh	59	63	....	...do	...do
16	8.42 a.m.	28 32 45	84 27 00	24	crs. gy. S. brk. Sh	60	64	....	...do	...do
16	9.22 a.m.	28 28 00	84 25 00	21	Co	60	64	....	...do	...do
16	10.50 a.m.	28 25 00	84 21 00	24	crs. S. bk. Sp. Sh	62	63	....	...do	...do
16	11.33 a.m.	28 21 00	84 18 00	23	crs. S. bk Sp. Sh	62	63	....	...do	...do
16	12.18 p.m.	28 20 00	84 12 00	22	gy. S	62	63	....	...do	...do
16	1.02 p.m.	28 19 45	84 06 00	21	wh. S. bk. Sp. brk. Sh	59	63	....	...do	...do
16	1.15 p.m.	28 15 45	84 02 35	21	wh. S. bk. Sp. brk. Sh	60	62	....	...do	...do
16	2.46 p.m.	28 11 45	83 59 10	22	wh. S. bk. Sp. brk. Sh	61	63	....	...do	...do
16	3.32 p.m.	28 07 45	83 55 40	22	wh. S. bk. Sp.	60	64	....	...do	...do
16	4.15 p.m.	28 03 45	83 52 15	22	fne. gy. S. bk. Sp	60	64	....	...do	...do
16	5.00 p.m.	27 59 40	83 48 50	22	crs. S. brk. Sh	60	63	....	...do	...do
16	5.42 p.m.	27 55 30	83 45 25	22	gy. bk. S	60	63	....	...do	...do
16	6.23 p.m.	27 51 30	83 42 00	21	fne. wh. S. bk. Sp	60	63	....	...do	...do
16	7.05 p.m.	27 50 00	83 36 15	20	wh. S. bk. Sp	60	62	....	...do	...do
16	7.47 p.m.	27 49 00	83 30 30	18	crs. S. bk. Sp. brk. Sh	60	61	....	...do	...do
16	8.26 p.m.	27 48 10	83 24 45	16½	gy. S. brk. Sh	60	61	....	...do	...do
16	9.08 p.m.	27 47 30	83 19 00	15	gy. S. bk. Sp	60	62	....	...do	...do
16	9.45 p.m.	27 46 45	83 13 15	12	crs. gy. S. bk. Sp. brk. Sh	60	62	....	...do	...do
16	10.24 p.m.	27 46 10	83 07 30	10	crs. gy. S. bk. Sp	60	62	....	...do	...do
16	11.00 p.m.	27 46 00	83 02 00	8	gy. S. bk. Sp. brk. Sh	60	62	....	...do	...do
18	11.06 a.m.	27 16 00	83 10 00	18	gy. bk. S	65	64	....	...do	...do
18	12.30 p.m.	27 08 30	83 19 30	25	crs. gy. bk. S	67	66	....	...do	...do
18	1.12 p.m.	27 04 00	83 21 15	26	crs. gy. S. brk. Sh	67	66	....	...do	...do
18	2.17 p.m.	26 58 00	83 22 30	26	crs. gy. S. brk. Sh	68	66	....	...do	...do
18	3.10 p.m.	26 53 00	83 24 00	27	wh. S. bk. Sp. brk. Sh	67	66	....	...do	...do
18	5.06 p.m.	26 42 30	83 22 45	29	crs. S. bk. Sp. brk. Sh	80	67	....	...do	...do
18	5.40 p.m.	26 38 00	83 20 00	28	crs. S. bk. Sp	73	67	....	...do	...do
18	6.21 p.m.	26 33 30	83 15 30	27	fne. wh. S. bk. Sp	69	67	....	...do	...do
19	5.22 a.m.	26 28 15	83 11 00	26	fne. wh. S. bk. Sp	63	67	....	...do	...do
19	6.10 a.m.	26 23 15	83 11 15	28	crs. gy. S. bk. Sp. brk Sh	61	67	....	...do	...do
19	6.50 a.m.	26 18 30	83 08 45	27	fne. gy. S. bk Sp. brk. Sh	62	66	....	...do	...do
19	7.53 a.m.	26 12 30	83 06 30	27	crs. gy. S. bk Sp. brk. Sh	63	66	....	...do	...do
19	8.37 a.m.	26 08 30	83 03 45	25	fne. wh. S. bk. Sp*	63	66	....	...do	...do
19	9.23 a.m.	26 04 30	83 01 00	24	fne. wh. S. bk. Sp*	63	66	....	...do	...do

*Also brk. Sh.

and Albatross, September 13, 1880, *to October* 20, 1885—Continued.

Tile-fish (*Lopholatilus chamæleonticeps*).	Hake (*Phycis tenuis*).	Whiting (*Merlucius bilinearis*).	Skate (*Raia* sp.).	Dogfish (*Mustelus canis*).	Codfish (*Gadus morrhua*).	Red groupers (*Epinephelus morio*).	Black bass (*Serranus atrarius*).	Red snappers (*Lutjanus Blackfordii*).	Black groupers (*Epinephelus nigritus*).	Haddock (*Gadus æglefinus*).	Norway haddock (*Sebastes marinus*).	Miscellaneous.
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...	...	...	...	...	...	...	...	...	...	...	...	...

* 1 spotted hind.

† Also 1 scamp.

Table of fishing stations of U. S. Fish Commission steamers Fish Hawk

Date.	Time.	Position. Lat. N.	Position. Long W.	Depth (fathoms).	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Object of search.	Implement used.
1885.		° ′ ″	° ′ ″			°	°	°		
Mar. 19	10.04 a. m.	26 00 00	82 57 30	24	fne. S. bk. Sp. brk. Sh	68	66	....	General	Hand-line
19	10.20 a. m.	25 54 00	82 59 30	24	fne. wh. S	67	66	....	do	do
19	12.00 m.	25 49 00	83 01 00	25	fne. wh. S	66	67	....	do	do
19	12.39 p.m.	25 44 30	83 02 30	27	S. Co	67	68	....	do	do
19	1.26 p.m.	25 39 30	83 01 00	27	gy. S. brk. Sh	68	69	....	do	do
19	2.15 p.m.	25 34 30	83 01 00	27	gy. S. bk. Sp	67	69	....	do	do
19	2.59 p.m.	25 29 30	83 01 00	28	crs. gy. S. brk. Sh	67	69	....	do	do
19	3.38 p.m.	25 24 30	83 00 00	27	gy. S. bk. Sp	67	69	...	do	do
19	4.19 p.m.	25 19 30	82 59 30	27	gy. M. brk. Sh	68	69	...	do	do
19	4.56 p.m.	25 14 30	82 59 00	27	gy. M. fne. S. brk. Sh	68	69	....	do	do
19	5.34 p.m.	25 09 30	82 59 00	27	brk. Sh	67	69	..	do	do
19	6.11 p.m.	25 04 30	82 59 15	26	fne. wh. S. brk. Sh	67	69	..	do	do
Apr. 1	5.55 p.m.	31 54 45	79 17 00	86	gy. M. brk. Sh	66	69	60.3	Tile-fish	do
2	5.25 p.m.	33 34 00	76 40 30	107	fne. gy. S. bk. Sp	69	72	60.3	do	do
5	6.20 a. m.	37 03 20	74 31 40	104	S. M. G	42	47	48	do	do
5	7.02 a. m.	37 03 00	74 33 00	67	S. M. G	42	49	....	do	do
5	8.09 a. m.	37 04 30	74 32 00	98	brk. Sh	43	49	...	do	do
June 3	6.37 a. m.	37 08 00	74 34 45	61	crs. gy. S. P	62	60	54	do	Trawl-line
3	10.45 a. m.	37 09 30	74 33 45	75	crs. gy. S. brk. Sh	67	67	52.5	do	do
3	3.52 p.m.	37 11 30	74 32 30	103	S. gy. M. crs. bk. Sp	65	67	51.5	do	do
4	5.20 a. m.	36 40 30	74 42 00	135	S. gy. M. fne. bk. Sp	69	68	48.8	do	do
4	8.44 a. m.	36 43 00	74 46 30	78	S. G	75	70	....	do	Hand-line
4	11.30 a. m.	36 20 24	74 46 30	149	gy. M. fne. S	72	69	51.5	do	Trawl-line
4	4.49 p.m.	36 01 30	74 47 30	93	crs. gy. and bk. S*	77	71	52	do	do
5	6.22 a. m.	35 27 15	74 42 30	69	bk. M	72	75	54	do	do
5	2.11 p.m.	35 12 15	75 05 00	50½	fne. gy. and bk. S*	76	76	63	do	Hand-line
5	2.36 p.m.	35 12 30	75 03 30	72	crs. gy. S. brk. Sh	76	76	60	do	do
5	2.46 p.m.	35 12 45	75 02 00	68	R. Co	76	76	60	do	do
5	4.03 p.m.	35 13 00	75 01 00	123	gy. S. bk. Sp. brk. Sh	76	76	53	do	do
5	6.42 p.m.	35 11 00	75 07 00	52	crs. gy. S. bk. Sp	78	75	65	do	do
6	5.38 a. m.	34 58 20	75 12 00	66	fne. gy. S. bk. Sp	66	75	58	do	do
6	6.23 a. m.	34 59 00	75 13 00	54	fne. gy. S. bk. Sp	66	75	61	do	do
24	9.39 a. m.	43 38 00	49 34 30	38	wh. S. bk. Sp. brk. Sh	53	48	36.2	Codfish	do
25	4.59 p.m.	46 29 00	49 39 30	39	gy. S	48	43	34	do	do
July 3	6.03 a. m.	45 47 00	54 13 30	59	fne. S. bk. Sp	54	48	30	do	do
3	7.18 a. m.	45 45 30	54 20 30	41	wh. S. bk. Sp	52	48	30	do	do
3	8.30 a. m.	45 44 00	54 27 00	45	brk. Sh	51	50	30	do	do
3	10.14 a. m.	45 40 00	54 41 00	42	wh. and bk. S. brk. Sh.	52	47	32	do	do
3	5.31 p.m.	45 23 00	55 41 00	38	fne. wh. S. bk. Sp	58	52	36	do	do
5	7.17 p.m.	44 43 00	57 32 45	33	wh. S	55	53	....	do	do
6	6.31 a. m.	45 24 00	58 36 45	67	fne. M	51	53	....	do	do
6	7.56 a. m.	45 21 30	58 44 45	42	wh. S. P	51	53	32	do	do
6	9.05 a. m.	45 18 30	58 52 45	45	yl. S	52	53	....	do	do
6	10.52 a. m.	45 14 00	59 08 15	48	S. G	54	54	....	do	do
6	12.35 p.m.	45 09 30	59 25 15	43	hrd	54	54	....	do	do
6	1.48 p.m.	45 07 00	59 28 45	46	yl. S	58	56	....	do	do
7	8.02 a. m.	44 27 00	60 20 15	26	S. G	59	58	39	do	do
7	8.15 a. m.	44 26 30	60 21 45	26	S. G	59	58	....	do	do
7	1.43 p.m.	44 22 30	61 00 15	47	P	63	60	35.2	do	do
12	9.02 a. m.	43 10 00	64 18 00	55	yl. S. bk. Sp	60	60	38.5	do	do
12	12.08 p.m.	43 01 00	64 45 30	47	hrd	60	60	39	do	do
Aug. 7	8.57 a. m.	39 59 45	70 53 00	133	gn. S	71	74	47.7	Tile-fish	Trawl-line
7	3.00 p.m.	40 00 15	70 42 20	129	S. brk. Sh	73	76	47.2	do	do
8	6.19 a. m.	40 01 45	70 24 00	131	gn. S. bk. Sp	70	74	47.7	do	do
10	6.13 a. m.	39 53 00	71 32 00	136	gn. M. S	72	75	47.7	do	do
10	1.11 p.m.	39 48 00	71 48 30	120	br. M. S	78	76	..	do	do
Sept. 18	8.21 a. m.	39 43 00	71 34 00	394	gn. M	66	70	...	do	do
18	2.53 p.m.	39 50 00	71 43 00	137	gn. M	68	70	47.2	do	do
19	9.41 a. m.	39 05 30	72 25 30	519	gn. M	72	72	39	do	do
20	9.33 a. m.	39 02 40	72 40 00	328	dk. gy. M	69	71	40.2	do	do
21	8.37 a. m.	38 55 00	72 50 30	231	gn. M. S	66	70	44.2	do	do
Oct. 17	11.14 a. m.	35 02 20	75 12 00	120	fne. gy. S	70	79	....	do	do
18	12.03 p.m.	34 38 30	75 33 30	124	S. R	71	78	...	do	do
19	1.45 p.m.	34 09 00	76 02 00	168	gy. S. bk. Sp	77	78	....	do	do
20	7.20 a. m.	33 42 45	77 31 00	17	S. P	76	75	....	Sea-bass	Hand line
20	10.00 a. m.	33 37 30	77 36 30	11	crs. yl. S. brk. Sh	77	75	...	do	do
20	10.55 a. m.	33 37 15	77 35 30	17	crs. yl. S. brk. Sh	76	74	...	do	do
20	11.19 a. m.	33 38 00	77 36 00	15	crs. yl. S. rot. Co.	76	71	...	do	do
20	12.13 p.m.	33 37 45	77 36 30	15	gy. S. rot. Co	78	75	...	do	do
20	1.54 p.m.	33 31 00	77 42 00	9	gy. S. brk. Co	76	75	...	do	do
20	3.48 p.m.	33 38 00	77 36 00	15	gy. S. brk. Co	76	74	...	do	Trawl line
20	3.48 p.m.								do	Hand-line.

* Also brk. Sh.

and Albatross, September 13, 1880, *to October* 20, 1885—Continued.

Tile-fish (*Lopholatilus chamæleonticeps*).	Hake (*Phycis tenuis*).	Whiting (*Merlucius bilinearis*).	Skate (*Raia* sp.).	Dogfish (*Mustelus canis*).	Codfish (*Gadus morrhua*).	Red groupers (*Epinephelus morio*).	Black bass (*Serranus atrarius*).	Red snappers (*Lutjanus Blackfordii*).	Black groupers (*Epinephelus nigritus*).	Haddock (*Gadus æglefinus*).	Norway haddock (*Sebastes marinus*).	Miscellaneous.
								1				
								3	1			
				20								
				6								
	4											
	6											
	6	1										
							1					
							2		2			2
					13							
					33							4
					3							1
					10							
					2							
					5							
					1							1
					5							
					3							2
					3							3
					22							
					12							
					4					1		
	49	7	5									
	34	9									1	
	37	6	2								5	
	12		6									
	6	4	4									1
	1	1	1									4
	23		6									
	8	1	4									1
												2
							1					2
				1			14					3
							2					
							31					
												1
							12					3
							100					3

Record of serial temperatures taken by the U. S. Fish Commission steamer Albatross during the year 1885.

Date.	Serial number.	Position. Lat. N.	Position. Long. W.	Depth, (fathoms).	Character of bottom.	Temperature (degrees). Air.	Surface.	25 fathoms.	50 fathoms.	100 fathoms.	200 fathoms.	300 fathoms.	400 fathoms.	500 fathoms.	600 fathoms.	700 fathoms.	800 fathoms.	900 fathoms.	1,000 fathoms.	Bottom.
1885.		° ′ ″	° ′ ″																	
Mar. 13	2393	28 43 00	87 14 30	525	gy. M	70	64	65.2	64.0	57.9	......	45.7	43.0	......	......	......	......	......	......	41.0
Apr. 1	Hyd. 699	31 54 45	79 17 00	86	gy. M. brk. Sh	66	69	69.9*	68.4†	66.3‡	63.3§	60.8‖	......	......	......	......	......	......	......	60.3
3	Hyd. 702	36 30 00	73 14 00	2,340	bu. Oz	69	72	......	......	......	59.6¶	......	......	41.3	......	......	......	......	......	36.8
4	Hyd. 703	36 45 00	73 28 00	1,646	bu. Oz	68	66	......	......	......	43.0¶	......	......	39.6	......	......	......	......	......	37.2
4	Hyd. 704	36 57 30	73 47 00	1,456	bu. Oz	61	55	50.8	49.9	52.2	43.0	......	39.5	......	38.4	38.6	52.2	38.1	40.6	37.5
4	Hyd. 705	37 01 08	74 10 00	1,208	bu. Oz	50	52	50.1	44.0	51.3	44.0	......	39.7	39.3	40.8	......	......	......	......	38.7
5	Hyd. 712	37 04 30	74 32 00	98	bk. S	43	49	50.8	48.2	......	......	......	......	......	......	......	......	......	......	......
Aug. 7	2542	40 00 15	70 42 20	129	S. brk. Sh	73	76	59.8	56.3	49.8	......	......	......	......	......	......	......	......	......	47.2
9	Hyd. 849	39 49 00	70 42 00	452	gy. M	71	77	59.5	57.0	49.8	44.0	40.5	......	......	......	......	......	......	......	39.6
10	Hyd. 854	39 41 00	71 42 00	378	gn. S	76	77	62.5	45.8	49.0	42.1	40.1	......	......	......	......	......	......	......	39.6
11	2564	39 22 00	71 23 30	1,396	gy. Oz	79	78	61.6	58.1	51.3	48.8	40.3	40.0	39.4	39.0	39.2	38.8	38.5	41.3	37.3
28	2565	38 19 20	69 02 30	2,069	br. & gy. Oz	72	77	76.8	53.7	53.1	54.2	49.9	40.1	39.4	38.7	39.0	38.6	38.8	38.6	36.2
29	2566	37 23 00	68 08 00	2,620	gy. Oz	75	80	81.2	79.2	66.6	64.6	63.0	59.1	53.7	45.3	40.7	40.2	39.5	39.3	36.4
Sept. 1	2571	40 09 30	67 09 00	1,356	gy. Glob. Oz	75	72	65.7	60.2	54.8	45.7	41.8	40.0	39.7	38.8	39.8	......	......	......	37.8
2	2573	40 34 18	66 09 00	1,742	gy. M. S	71	71	68.3	61.0	52.8	49.4	42.0	40.2	39.7	39.1	39.4	38.6	38.8	38.1	37.3
3	2575	41 07 00	65 26 30	1,710	gy. Oz	64	71	71.2	59.1	52.8	47.0	41.3	40.2	39.8	39.3	38.7	38.8	38.4	38.0	37.1
Oct. 21	2628	32 24 00	76 55 30	528	yl. M	70	77	79.9	77.6	59.0	48.0	45.5	40.2	......	......	......	......	......	......	38.5

* 5 fathoms. † 10 fathoms. ‡ 15 fathoms. § 25 fathoms. ‖ 50 fathoms. ¶ 250 fathoms.

Record of temperatures and specific gravities taken by the U. S. Fish Commission steamer Albatross during the year 1885.

Date.	Time of day	Locality.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° Fahrenheit.
1885.			*Fathoms.*	°	°	°		
Jan. 22	9.40 a. m.	Sta. 2353, Lat. 20° 59′ N., Long. 86° 23′ W	Surface	79	80	83	1.0234	1.027126
Jan. 22	7.00 p. m.	Off island of Cozumel	...do	76	76	70	1.0265	1.027950
Feb. 7	1.00 p. m.	Sta. 2369, Lat. 29° 16′ 30″ N., Long. 85° 32′ W	...do	64	63	73	1.0238	1.025724
Feb. 11	11.45 a. m.	Hyd. 583, Lat. 28° 58′ 20″ N., Long. 88° 14′ W	...do	60	51	70	1.0264	1.027850
Mar. 1	5.00 p. m.	South Pass, Mississippi River	...do	41	58.5	58	1.0016	1.001360
Mar. 1	5.30 p. m.	Jetties, Mississippi River	...do	41	56	58	1.0016	1.001360
Mar. 1	6.00 p. m.	Off jetties, Mississippi River*	...do	54	55	67	1.0094	1.010387
Mar. 1	7.00 p. m.	...do	...do	58	61	61	1.0140	1.014130
Mar. 1	8.00 p. m.	...do	...do	58	61	64	1.0144	1.014948
Mar. 1	9.00 p. m.	...do	...do	62	60	68	1.0140	1.015136
Mar. 1	10.00 p. m.	...do	...do	57	60	60	1.0182	1.018200
Mar. 1	11.00 p. m.	...do	...do	58	58	69	1.0186	1.019887
Mar. 1	12.00 m.	...do	...do	64	59	68	1.0245	1.025636
Mar. 2	1.00 a. m.	...do	...do	65	60	68	1.0260	1.027136
Mar. 2	2.00 a. m.	...do	...do	66	60	68	1.0264	1.027536
Mar. 2	3.00 a. m.	...do	...do	61	67	69	1.0268	1.028087
Mar. 2	6.27 a. m.	Sta. 2379, Lat. 28° 00′ 15″ N., Long. 87° 42′ W	...do	66	61	76	1.0258	1.028232
Mar. 2	8.00 p. m.	Sta. 2381, Lat. 28° 05′ N., Long. 87° 56′ 15″ W	...do	66	60	79	1.0252	1.028183
Mar. 3	8.00 a. m.	Sta. 2382, Lat. 28° 19′ 45″ N., Long. 88° 01′ 30″ W	...do	68	61	81	1.0250	1.028339
Mar. 3	8.00 p. m.	Sta. 2385, Lat. 28° 51′ N., Long. 88° 18′ W	...do	69	60	79	1.0250	1.027983
Mar. 4	8.00 a. m.	Sta. 2387, Lat. 29° 24′ N., Long. 88° 04′ W	...do	61	61	77	1.0240	1.026618
Mar. 4	12.00 a. m.	Lat. 29° 25′ N., Long. 87° 52′ 30″ W	...do	62	64	79	1.0242	1.027183
Mar. 4	8.00 p. m.	Pensacola Bay, Florida	...do	61	56	76	1.0251	1.027532
Mar. 7	12.00 m.	Lat. 29° 15′ 11″ N., Long. 85° 38′ W	...do	60	61	76	1.0258	1.028232
Mar. 13	10.00 a. m.	Sta. 2393, Lat. 28° 43′ N., Long. 87° 14′ 30″ W	...do	65	70	79	1.0236	1.026583
Mar. 13	10.00 a. m.	...do	25	65.2	70	78	1.0248	1.027608
Mar. 13	10.00 a. m.	...do	50	64	70	77	1.0254	1.028018
Mar. 13	10.00 a. m.	...do	100	57.9	70	77	1.0250	1.027618
Mar. 13	10.00 a. m.	...do	200	.....	70	77	1.0248	1.027418
Mar. 13	10.00 a. m.	...do	300	45.7	70	77	1.0250	1.027618
Mar. 13	10.00 a. m.	...do	400	43	70	77	1.0248	1.027418
Mar. 13	10.00 a. m.	...do	500	41	70	77	1.0250	1.027618
Mar. 14	11.00 a. m.	Sta. 2399, Lat. 28° 44′ N., Long. 86° 18′ W.	Surface	68	70	81	1.0246	1.027939
Mar. 15	11.30 a. m.	Sta. 2406, Lat. 28° 46′ N., Long. 84° 49′ 30″ W	...do	64	66	82	1.0247	1.028220
Mar. 16	12.00 m.	Lat. 28° 20′ N., Long. 84° 15′ W	...do	63	62	83	1.0246	1.028326
Mar. 16	5.45 p. m.	Hyd. 668, Lat. 27° 55′ 30″ N., Long. 83° 45′ 25″ W	...do	63	60	82	1.0246	1.028120

*Course of ship SE. ¾ E., 8.2 knots per hour.

Record of temperatures and specific gravities taken by the U. S. Fish Commission steamer Albatross during the year 1885—Continued.

Date.	Time of day	Locality.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° Fahrenheit.
1885.			*Fathoms.*	°	°	°		
Mar. 17	12.00 m	Tampa Bay, Florida	Surface	63	63	78	1.0206	1.023408
Mar. 18	3 30 p.m.	Hyd. 678, Lat. 27° 08' 30" N., Long. 83° 19' 30" W	do	66	67	78	1.0248	1.027608
Mar. 19	8 30 a.m.	Hyd. 686, Lat. 26° 08' 30" N., Long. 83° 03' 45" W	do	66	65	82	1.0243	1.027820
Mar. 19	1.30 p.m.	Hyd. 691, Lat. 25° 39' 30" N., Long. 83° 01' W	do	69	67	81	1.0244	1.027739
Mar. 19	6.30 p.m.	Sta. 2414, Lat. 25° 04' 30" N., Long. 82° 59' 15" W	do	68	65	81	1.0244	1.027739
June 3	12.00 m	Lat. 37° 10' N., Long. 74° 34' W	do	67	65	81	1.0248	1.028139
June 4	12.00 m	Lat. 36° 20' 24" N., Long. 74° 46' 45" W	do	70	72.5	83	1.0242	1.027926
June 5	12.00 m	Lat. 35° 22' 57" N., Long. 75° W	do	72.5	75	78	1.0244	1.027208
June 19	9.00 a.m.	Hyd. 744, Lat. 41° 18' 15" N., Long. 63° 56' W	do	67.5	66	81	1.0248	1.028139
June 19	12.00 m	Hyd. 745, Lat. 41° 19' 23" N., Long. 63° 35' 30" W	do	69	71	79	1.0250	1.027983
June 19	7.00 p.m.	Hyd. 749, Lat. 41° 20' 30" N., Long. 62° 57' W	do	61.5	61	84	1.0232	1.027112
June 20	7.00 a.m.	Hyd. 750, Lat. 40° 40' 30" N., Long. 60° 33' W	do	77	62	82	1.0246	1.028120
June 21	12.00 m	Lat. 40° 22' 54" N., Long. 55° 21' W	do	71	68	80	1.0250	1.028160
June 21	4.30 p.m.	Hyd. 752, Lat. 40° 24' 30" N., Long. 54° 24' W	do	75	68	76	1.0257	1.028132
June 22	1.00 p.m.	Hyd. 756, Lat. 40° 55' 30" N., Long. 52° 02' 30" W	do	66	64	76	1.0250	1.027432
June 22	8.30 p.m.	Hyd. 757, Lat. 41° 51' N., Long. 51° 31' W	do	54	68	75	1.0230	1.025265
June 23	8.00 a.m.	Sta. 2427, Lat. 42° 46' N., Long. 51° W	do	48	50	78	1.0232	1.026008
June 23	7.00 p.m.	Sta. 2434, Lat. 43° 08' N., Long. 50° 40' W	do	48	52	77	1.0230	1.025618
June 24	9.00 a.m.	Hyd. 762, Lat. 43° 38' N., Long. 49° 42' W	do	48	53	76	1.0228	1.025232
June 24	6 30 p.m.	Hyd. 765, Lat. 44° 26' N., Long. 49° 33' W	do	45	50	75	1.0230	1.025265
June 25	8.45 a.m.	Sta. 2443, Lat. 45° 44' N., Long. 49° 45 W	do	46	50	74	1.0232	1.025286
June 25	12.50 p.m.	Sta. 2445, Lat. 46° 09' 30" N., Long. 49° 48' 30" W	do	44	47	74	1.0232	1.025286
June 25	7.00 p.m.	Sta. 2449, Lat. 46° 37' N., Long. 49° 50' 30" W	do	42	46	74	1.0234	1.025486
June 26	11.13 a.m.	Sta. 2454, Lat. 47° 16' N., Long. 51° 16' W	do	42	46	73	1.0236	1.025524
July 2	10.40 a.m.	Sta. 2457, Lat. 47° 13' N., Long. 52° 24' W	do	47	48	77	1.0226	1.025218
July 2	6.10 p.m.	Sta. 2459, Lat. 46° 23' N., Long. 52° 45' W	do	46	50	77	1.0224	1.025018
July 3	8.00 a.m.	Sta. 2463, Lat. 45° 44' N., Long. 54° 27' W	do	48	51	75	1.0230	1.025265
July 3	12.30 p.m.	Sta. 2465, Lat. 45° 35' N., Long. 55° 01' W	do	50	53	76	1.0228	1.025232
July 3	8.00 p.m.	Sta. 2468, Lat. 45° 11' 30" N., Long. 55° 51' 30" W	do	50	54	76	1.0228	1.025232
July 4	10.30 a.m.	Sta. 2471, Lat. 44° 34' N., Long. 56° 41' 45" W	do	54	56	76	1.0228	1.025232
July 4	5.10 p.m.	Sta. 2473, Lat. 44° 27' 15" N., Long. 57° 10' W	do	51	56	76	1.0220	1.024432
July 5	9.15 a.m.	Sta. 2483, Lat. 44° 16' N., Long. 57° 12' 45" W	do	53	56	78	1.0214	1.024208
July 5	7.12 p.m.	Sta. 2489, Lat. 44° 43' N., Long. 57° 22' 45" W	do	53	55	78	1.0214	1.024208
July 6	9.00 a.m.	Sta. 2493, Lat. 45° 19' N., Long. 58° 51' 15" W	do	54	54	78	1.0212	1.024008
July 6	7.00 p.m.	Sta. 2499, Lat. 44° 46' 30" N., Long. 59° 55' 45" W	do	56	62	77	1.0215	1.028118
July 7	8.00 a.m.	Sta. 2501, Lat. 44° 27' N., Long. 60° 20' 15" W	do	56	59	78	1.0213	1.024108

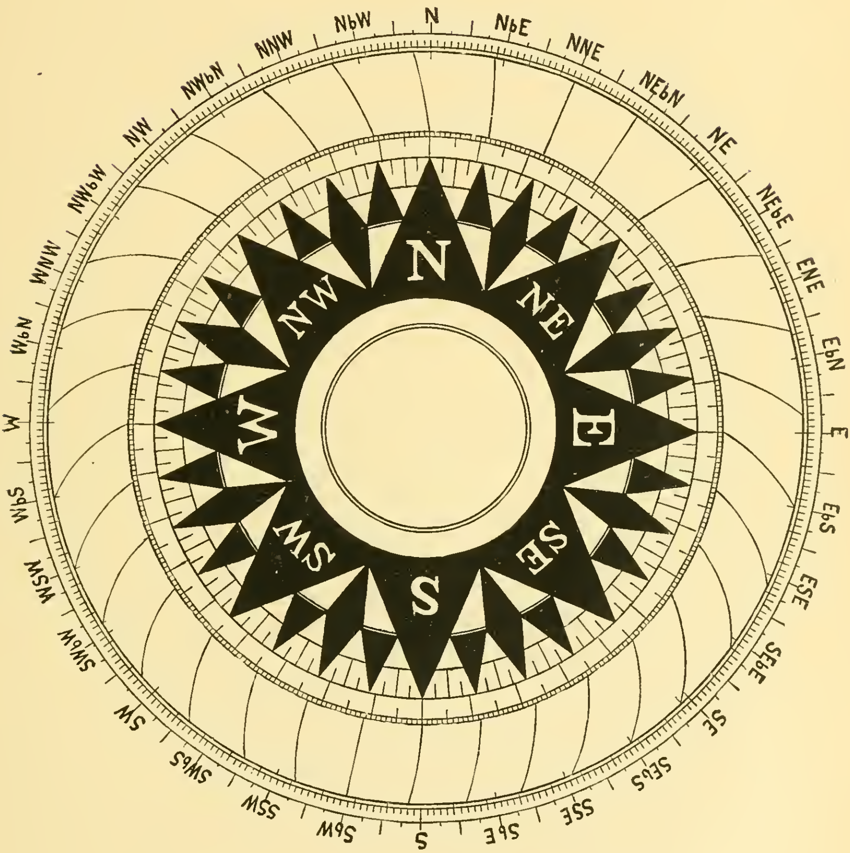
July 7	7.00 p. m.	Sta. 2505, Lat. 44° 23′ 30″ N., Lat. 61° 44′ 15″ W.	....do	63	63	80	1.0214	1.024560
July 8	9.00 a. m.	Sta. 2508, Lat. 44° 28′ 30″ N., Lat. 62° 56′ W.	....do	61	62	82	1.0210	1.024520
July 8	11.30 a. m.	Sta. 2509, Lat. 44° 30′ N., Long. 63° 18′ W.	....do	61	65	82	1.0208	1.024320
July 9	9.00 a. m.	Harbor of Halifax, Nova Scotia	....do	61	67	78	1.0206	1.023408
July 11	12.30 p. m.	Sta. 2511, Lat. 44° 05′ 30″ N., Long. 63° 31′ 30″ W.	....do	55	60	78	1.0216	1.024408
July 11	7.39 p. m.	Sta. 2514, Lat. 43° 28′ 30″ N., Long. 63° 57′ 30″ W.	....do	59	61	78	1.0216	1.024408
July 12	11.15 a. m.	Sta. 2518, Lat. 43° 05′ N., Long. 64° 40′ 30″ W.	....do	59	60	80	1.0216	1.024760
July 12	7.00 p. m.	Sta. 2522, Lat. 42° 20′ N., Long. 65° 07′ 30″ W.	....do	62	62	80	1.0216	1.024760
July 13	8.40 a. m.	Sta. 2526, Lat. 41° 40′ 45″ N., Long. 65′ 46″ W.	....do	66	65	82	1.0230	1.026520
July 13	7.00 p. m.	Sta. 2528, Lat. 41° 47′ N., Long. 65° 37′ 30″ W.	....do	60	65	82	1.0230	1.026520
July 14	8.30 a. m.	Sta. 2530, Lat. 40° 53′ 30″ N., Long. 66° 24′ W.	....do	67	70	85	1.0224	1.026500
July 14	6.00 p. m.	Sta. 2532, Lat. 40° 34′ 30″ N., Long. 66° 48′ W.	....do	66	72	85	1.0224	1.026500
July 15	8.30 a. m.	Sta. 2534, Lat. 40° 01′ N., Long. 67° 29′ 15″ W.	....do	70	66	85	1.0234	1.027500

NOTE.—Specimens retained in lower laboratory until they had acquired about the temperature of the room; thermometer corrections applied; Tagliabue thermometer used; makers No. 344, F. C. No. 5300; F. C. No. of float 5165.

In the preceding tables the abbreviations for the characters of the bottom and the instrument used are from the following code:

Abbreviation.	Meaning.	Abbreviation.	Meaning.	Abbreviation.	Meaning.	Abbreviation.	Meaning.	Abbreviation.	Meaning.	Abbreviation.	Meaning.
C	Clay.	P	Pebbles.	lge	large.	br	brown.	dk	dark.	L. B. T.	Large beam-trawl.
Co	Coral.	Oz	Ooze.	rky	rocky.	choc	chocolate color.	gy	gray.	S. B. T.	Small beam-trawl.
St	Stones.	R	Rock.	rot	rotten.	gn	green.	rd	red.	Bl. Dr	Blake dredge (deep-sea dredge).
G	Gravel.	Sh	Shells.	stk	sticky.	lt	light.	wh	white.	Sh. Dr	Ship's dredge (mud-bag).
S	Sand.	Glob	Globigerina.	crs	coarse.	slat	slate color.	stf	stiff.	Tgls	Tangles.
For	Foraminifera.	Sp	Specks.	hrd	hard.	yl	yellow.				
Pter	Pteropods.	brk	broken.	sml	small.	bk	black.				
M	Mud.	fne	fine.	sft	soft.	bu	blue.				

Key West, Fla. January 1885.

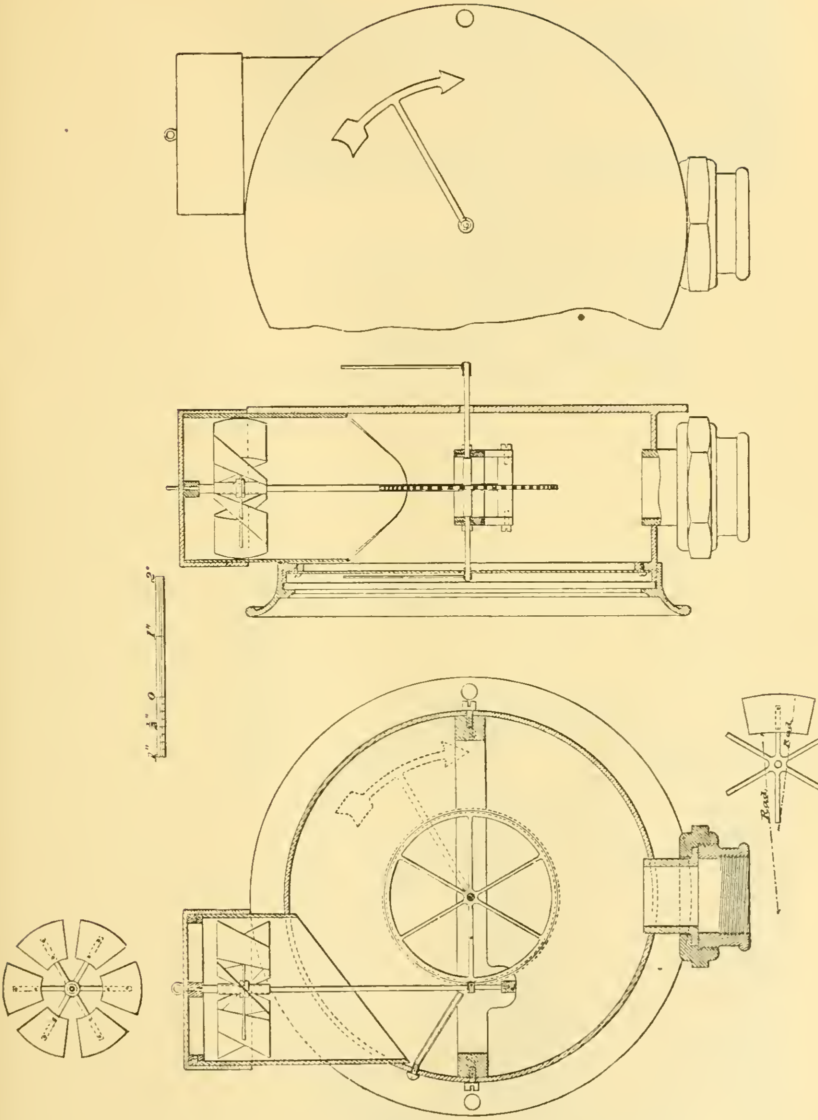


Steering-card. Key West, Florida, January, 1885.

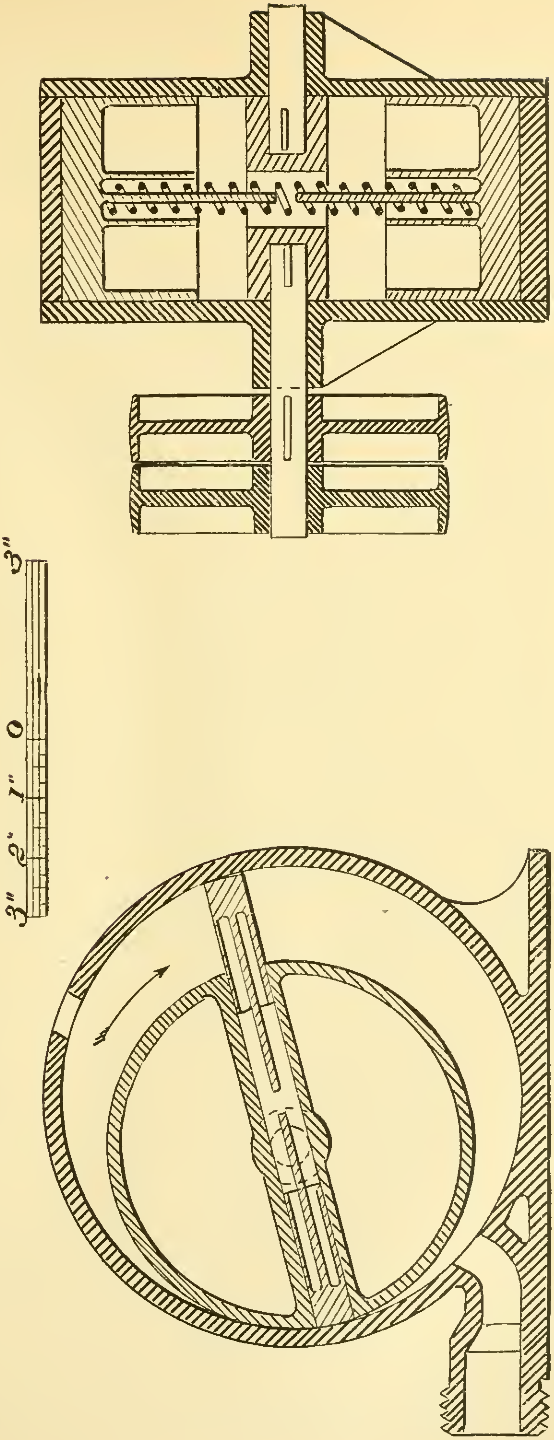
Steering-card. Narragansett Bay, June, 1885.

ChesapeakeBay, October 1885.

Steering-card. Chesapeake Bay, October, 1885.



Baird's annunciator, showing index and method of its working.



Baird's annunciator, showing rotary blower near engine.

INDEX.

[NOTE.—The references are to page-figures in brackets.]

II.—REPORT ON THE WORK OF THE UNITED STATES FISH COMMISSION STEAMER FISH HAWK FOR THE YEAR ENDING DECEMBER 31, 1885.

By Lieut. L. W. Piepmeyer, U. S. N., Commanding.

[Abstract.]

On January 1, 1885, Lieut. W. M. Wood, U. S. N., having been detached from the command of this vessel, I assumed command, being the next in rank in the naval branch of the service. From that time until the 7th of that month I caused to be made such repairs as the weather would permit, and made preparations for shad-hatching work in Florida.

On the morning of the 7th, at 7.40 o'clock, the river being comparatively free of ice and the weather clear, I proceeded down the Potomac River and Chesapeake Bay to Norfolk, Va., arriving at Norfolk at 9.20 a. m. on the 8th, having anchored off Fort Monroe during part of the night. On February 1st I received orders to coal at the Norfolk navy-yard, and on the 2d steamed to the navy-yard and filled up with coal.

On March 15 received orders from Professor Baird to proceed to Havre de Grace, calling at Saint Jerome Station for a scow to be towed up. In obedience to these orders I got under way on the morning of the 16th and proceeded up the bay. At 6.20 p. m. came into Potomac River. At 12.05 p. m. secured scow astern of ship, hoisted boats, and steamed up the bay. In the morning of the next day, when within 3 miles of Battery Station, found the ice too heavy to proceed, and anchored, but, finding that the ice was drifting the vessel ashore, got under way and steamed toward Baltimore. Arrived at Baltimore and secured to Hooper's wharf, where I repaired damage caused by the ice, and awaited the disappearance of ice from about the mouth of the Susquehanna River.

On the morning of the 2d of April cast off from the wharf, steamed up the river, took in tow a coal schooner with 40 tons of coal for the station, and steamed towards Battery Station. Arrived off the Battery at 5.25 p. m., and at 11.30 a. m. next day secured to wharf. During the passage up, found most of the buoys displaced by the ice. Remained at this station until April 8. During this time the crew were employed in dragging the seine-haul and clearing it of obstructions.

On the morning of April 8, at 7 a. m., in obedience to orders of Professor Baird, got under way with Generals Heth and Smith, United States Army, of the Engineer Corps, on board, and steamed towards the Sassafras River to search for the wreck of two coal barges which had sunk in the track of vessels bound up the bay. After cruising about for some time in the supposed vicinity of the wrecks, getting what information I could from fishermen, I was unable to find the wrecks. I headed for Betterton and sent the launch ashore to bring off some persons who knew the location of the wrecks. The launch brought off Mr. Turner, who had reported the obstructions, and a fisherman whose nets had fouled them. They piloted the vessel to the wreck buoys, which we had seen, but which did not correspond with the description of them given in the reports. They explained that the buoys had been changed. After sounding with boats for a long time, it was found that one buoy was entirely wrong; the other buoy was on the wreck of one of the barges with 13 feet of water over it. We took up the first buoy with our dredging-boom. General Heth went out with the two boats, with a long line weighted with lead, and swept for the other barge, which he finally found with 12 feet of water over it. I steamed up and anchored the buoy, which we had taken up on the wreck. The buoys are 400 feet apart. I then steamed back to Betterton, landed Mr. Turner and the fisherman, then returned to Battery Station, and secured to wharf at 3 p. m.

The bearings (magnetic) of the wrecks are as follows: Grove Point, SE. by E. $\frac{1}{2}$ E.; Turkey Point, NE. $\frac{3}{4}$ N.; Sandy Point, N. $\frac{3}{4}$ E.; latitude N. 39° 23′ 30″; longitude W. 76° 03′ 30″. On April 9 Generals Heth and Smith left the vessel.

April 24, at 3.45, started fires under main boiler. At 5.30 unmoored ship and steamed up the Susquehanna, in obedience to orders from Professor Baird. At 6.20 moored at coal wharf at Havre de Grace. Took in 65 tons anthracite coal. Draught before coaling: Forward, 7 feet 4 inches; aft, 7 feet 6 inches. After coaling: Forward, 7 feet 10 inches; aft, 8 feet 2 inches. Received $2\frac{388}{2240}$ tons of coal for steam launch. Hoisted in steam launch.

April 25, at 5, unmoored ship and steamed down river and bay. At 10.20 passed the U. S. S. Wyoming, cruising in the bay with the naval cadets for practice. At 12.30 p. m. passed Point Lookout and proceeded up the Potomac River, and on April 26, at 12.30, arrived at the Washington navy-yard.

April 29, George F. Nelson was appointed apothecary for duty on board this vessel; and on April 30, J. A. Kite, M. D., left the ship, having resigned his position as assistant in the Fish Commission.

May 7, at 10.40, in obedience to orders of the Fish Commissioner, unmoored and steamed around to the Sixth street wharf, Washington. At 12.20 cast off and steamed down the river with party of fish-culturists on board. At 2 p. m. turned off White House fishery and proceeded up the river. At 2.45 arrived at Fort Washington and secured to wharf. The party left the ship to inspect the hatching station. At 5.25 the party returned on board, unmoored ship, and steamed up the river. At 6.50 arrived at the Sixth street wharf.

May 16, at 8.30 a. m., cast off from wharf and steamed down Potomac River. At 10 a. m. arrived at Fort Washington. At 11.30 a fire broke out in the fort; landed crew with fire-buckets, and went to assist in putting out the fire. The following named men were detailed to take spawn under instructions: Jacob Svedlin, quartermaster; R. W. Owens, coxswain; John Baker, quartermaster; Andrew Solvin, seaman; Charles Stiffinson, seaman. On May 17, the spawn-takers visited the fisheries, and returned with 90,000 shad eggs, which were delivered to the station.

May 20, at 11.55, in obedience to orders from Professor Baird, got under way and steamed down the river, bound for the Delaware; and at 9.25 on the 26th arrived off Gloucester Point, New Jersey. On May 28, the spawn-takers reported Bakeoven's fishery as having ceased fishing for the season. At 7.55 p. m. the steamer Lookout arrived with steam launch Cygnet in tow, and anchored near this vessel. Obtained 677,000 shad eggs to-day.

June 1, at 10.35, got under way and steamed down the river. At 11 stopped off Bennett's fishery, and I took some young shad ashore to show the fishermen. At 11.55 steamed up the river. Deposited 330,000 young shad. On June 3, Faunce's fishery stopped work for the season, and Frank N. Clark left the ship, having been connected with the shad work since May 23. On the 13th, at 8 a. m., got under way and steamed down the Delaware River.* At 12 arrived at Port Richmond, Philadelphia, and moored ship to coal wharf.

June 14, at 9.20, got under way and steamed down Delaware River; and on the next day at 7.50, passed Cape Charles and steamed up Chesapeake Bay.

June 19, at 11.10, got under way and steamed out of Hampton Roads. At 1.40 anchored off Butler's Bluff in 5 fathoms of water, veered to 10 fathoms of chains. Took two spawn-takers in flat-boat and went to inspect trap-nets. At 3.30 returned to ship with 200,000 mackerel eggs. On the next day these 200,000 Spanish mackerel eggs were dark colored and did not seem to be thriving, owing to rust in the tank. At 9.20 of this day arrived off Butler's Bluff with schooner Oriole in tow. Sent four boats with spawn-takers to attend pound-nets. About 150 Spanish mackerel were caught in four pound-nets, but few found ripe. On the 21st, of the 200,000 Spanish mackerel eggs obtained on the 19th, a few had hatched, but all died, caused probably by rust in the water. On June 23, W. P. Sauerhoff reported on board for duty in connection with Spanish mackerel hatching.

* For a fuller account of the shad work of this season, see Bulletin U. S. F. C., 1885, pp. 395-399.

June 29, at 2.40 p. m., while unmooring ship from navy-yard at Norfolk the after mooring line parted, and the port propeller took against a large spar fender across the slip, carrying away two blades of propeller.

On July 6, the spawn-takers reported considerable numbers of Spanish mackerel taken, as many as 800 in a single pound-net; they also reported that the fish were either spent, or in various degrees of immaturity. On the 8th the spawn-takers visited the several pound-nets during the day and night but obtained no spawn. Fishermen report a large decrease in the catch of Spanish mackerel. At 2, the steamer Lookout arrived and anchored near this vessel. At 3.15, the Lookout got under way and proceeded to Hampton Roads.

July 13, at 9.20 a. m., the steamer Lookout, with Assistant Commissioner T. B. Ferguson, arrived and anchored near this vessel. Received from the Lookout six small hatching cylinders in bad order. I visited the Lookout, and the assistant commissioner visited this vessel and inspected the hatching apparatus. At 11.20 the Lookout proceeded down the bay.

July 15, at 4.30, the spawn-takers returned, having obtained from gillers 500,000 good Spanish mackerel eggs. At 12.20 I went in steam launch to inspect hatching operations at Cape Charles City and to make arrangements for quartering spawn-takers. Returned with steam launch at 2. Sent Mr. Cleaveland ashore at Cape Charles City to establish a sub-station for the purpose of hatching Spanish mackerel. F. J. Barry, machinist, and Charles Winters, boatswain's mate, were sent with steam launch. The 500,000 Spanish mackerel eggs obtained last night all died while under process of hatching.

On July 18, W. P. Sauerhoff and C. Stiffinson, spawn-takers, with one flat-boat, were stationed on Tangier Island to attend pound-nets. On the 20th, received 125,000 Spanish mackerel eggs; of this number, 30,000 good fish were hatched out on the 22d, and were inspected and deposited in Tangier Sound at 6 p. m. of the same day.

August 6, sent to Battery Station the hatching cones, frames, pipes, cylinders, spawning buckets, and pans; and on the 9th, took a party of men with me in the steam launch and second cutter; got pile-driver under way and towed it into Fish Commission station at Saint Jerome, Md., and returned to ship. On August 15, Assistant Engineer S. H. Leonard, jr., reported for duty, relieving Passed Assistant Engineer I. S. K. Reeves, detached from this date.

August 29, at 6, got under way and steamed up the Chesapeake. On September 1, hoisted in the steam launch, and at 8.15 got under way and steamed down the bay. At 2 p. m. arrived at foot of Skinner & Son's marine railway and moored ship alongside of steamer Mary Washington. On the 6th, the ship was hauled out on the railway to clean bottom and put on new propellers. On the 11th, Messrs. Clark & Co., machinists, took old propellers off and commenced fitting new ones in place, with the assistance of the ship's crew. On September

12, engineer's force and machinists from the shop were employed fitting new propellers. At 4 the ship was launched from the railway and moored to the wharf.

September 18, Passed Assistant Engineer I. S. K. Reeves left the ship to report to Professor Baird for special duty, having been relieved by Assistant Engineer S. H. Leonard, jr. At 12 got under way and steamed out of Baltimore harbor. At 4.30 arrived at Battery Station and moored ship to wharf.

September 19, at 7.30, unmoored ship and steamed up Susquehanna River. At 8.05 arrived at Havre de Grace, Md., and moored ship to Furnace coal wharf. At 4.50 unmoored ship and proceeded down the Susquehanna River. On the next day, at 5.30, arrived off Saint Jerome Creek, Maryland; and at 11.30 got under way and steamed down Chesapeake Bay.

September 24, at 12.45 a. m. got under way. At 2.10 Cape Henry was abeam, and about 4 passed out of Chesapeake Bay, bound to Wood's Holl, Mass. On the 25th, at 5.55 a. m., passed Sandy Hook and steamed up New York Bay. At 8 arrived at the Brooklyn navy-yard, and moored ship to wharf. The next day, at 10.45 a. m., left the navy-yard and proceeded up the East River. On the 27th, at 5.30, arrived at Wood's Holl, Mass., and moored to Fish Commission wharf; and on the 28th, sent all articles of hatching apparatus ashore and stored them in Fish Commission storehouse. Sent fyke-net to storehouse. On November 18, hauled ship to coal wharf and moored. Stored three flat-boats and the black gig in Fish Commission storehouse. On December 3, Ensign W. J. Maxwell reported on board this vessel for duty.

December 5, by order of Professor Baird, Isaac Scott, machinist, reported on board this vessel for duty from steam launch No. 68, and F. J. Barry, machinist, of this vessel, was ordered to report to Passed Assistant Engineer I. S. K. Reeves, consulting engineer of the United States Fish Commission, for duty on steam launch No. 68. The vessel was at Wood's Holl at the end of the year.

GLOUCESTER CITY, N. J., *May* 28, 1886.

Record of Spanish mackerel hatching by the Fish Hawk during the season of 1885.

Date.	Station.	Fishery whence obtained.	Number taken.			Time put in cones.	Time of hatching.	Number hatched.
			Males.	Females.	Eggs.			
1885.								
June 19	Fish Hawk	Howard	1	1	*300, 000	3 p. m	June 22	*25, 000
20	Tangier Island..	....	3	3	*75, 000	1 p. m	....	....
July 10	....do.	Cooper & Parks..	3	3	*200, 000	12.30 p. m.	....	....
10	.. do.	Spence	1	1	†50, 000	1 p. m	....	....
13	Hunger's Creek.	Raynor	1	1	100, 000	....	July 14	‡75, 000
13	Back River.....	Hamilton........	3	3	600, 000	....	July 14	§600, 000
14	....do..........	... do	3	3	‖450, 000	....	....	....
15	Tangier Island..	Gillers: Lorson.	2	2	*250, 000	1 p. m	....	....
15	....do..........	Gillers: Cooper & Parks.	3	3	*250, 000	1 p. m	....	....
17	Hunger's Creek.	Raynor..........	1	1	100, 000	....	July 18	‡75, 000
18	Tangier Island..	Gillers: Cooper & Parks.	1	1	*100, 000	2 p. m	....	....
20	....do.	....do	1	1	125, 000	3 p. m	July 24	¶30, 000
21	Cape Charles City.	Raley............	3	3	**1, 000, 000	7 a. m	....	....
22	....do	J. S. Warren.....	1	1	*75, 000	9 a. m	....	....
22	Hunger's Creek.	Raynor	3	3	600, 000	....	July 25	‡500, 000
23	....do.	....do	1	1	75, 000	....	July 24	‡60, 000
27	Cape Charles City.	Warren	1	1	*150, 000	8 a. m	....	....
			32	32	4, 500, 000			1, 365, 000

Record of temperatures on the Fish Hawk during the Spanish mackerel season of 1885.

Date.	Station.	Air.		Cones.		Surface.		Barometer.	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1885.		°	°	°	°	°	°	°	°
June 19	Fish Hawk	80	65	72	72	77	75	30. 92	30. 83
20	Tangier Island.	86	70	75	73	75	73	30. 87	30. 80
July 10	....do	95	73	80	79	80	79	30. 58	30. 45
10	....do	95	73	80	79	80	79	30. 58	30. 45
13	Hunger's Creek.	81	71	78	78	79	77	30. 70	30. 49
13	Back River.....	81	71	88	78	79	77	30. 70	30. 49
14	....do	89	71	79	79	77	77	30. 52	30. 37
15	Tangier Island.	88	75	79	78	79	78	30. 72	30. 50
15	....do	88	75	79	78	79	78	30. 72	30. 50
17	Hunger's Creek.	95	79	79	79	80	78	30. 90	30. 76
18	Tangier Island.	92	79	79	77	79	77	30. 80	30. 70
20	....do	94	74	80	79	84	83	30. 79	30. 65
21	Cape Charles City.	94	74	79	79	82	82	30. 76	30. 60
22	... do	90	81	79	79	82	81	30. 78	30. 62
22	Hunger's Creek.	90	81	79	79	82	81	30. 78	30. 62
23	....do	86	78	79	79	82	81	30. 86	30. 73
27	Cape Charles City.	86	76	....	....	83	78	30. 74	30. 62

*Died. † Unimpregnated. ‡ Deposited in Hunger's Creek. § Deposited in Back River.
‖ Put on board Lookout. ¶ Deposited in Tangier Sound. ** Escaped.

III.—REPORT ON THE WORK OF THE UNITED STATES FISH COMMISSION STEAMER LOOKOUT FOR THE YEAR ENDING DECEMBER 31, 1885.

By Mate James A. Smith, U. S. N., Commanding.

[Abstract.]

At the beginning of the year the Lookout was at Waters's wharf, Baltimore, Md., as stated at the close of my last report.

On January 22 instructions were received to prepare for a cruise to the Gulf of Mexico for the purpose of making an investigation into the fish resources of the Gulf coast of Florida. On the completion of the equipment, February 4, sailed from Baltimore, touched at Norfolk for coal, proceeded by way of Chesapeake and Albemarle Canal and through Pamlico and Core Sounds to Beaufort, N. C., arriving there on February 12, where we were detained by bad weather till the 21st. Arrived at Charleston, S. C., on the 22d, and, continuing, touched at Tybee Roads and Fernandina, coaled ship at Key West, and arrived at Cedar Keys, Fla., on March 12, where we awaited the arrival of Assistant Commissioner T. B. Ferguson, who joined the vessel on March 14.

On March 17 sailed from Cedar Keys for Pensacola, stopped on the way at Saint Joseph's and Saint Andrew's Bays, and on March 24 arrived at Pensacola at 5 p. m. The next day sailed for Mobile, Ala., reaching there on the 26th, during the afternoon of which day hauled the vessel out on the floating dock to make some repairs, a slight leak in the stern having been discovered during the passage. On March 30, repairs being finished, the vessel was launched, and sailed for Pensacola, arriving on the 31st. Coaled ship, and sailed for Cedar Keys on April 1, touched at Saint Joseph's Bay and Appalachicola Bay, and arrived at Cedar Keys on the 4th. Was at Anclote Keys on the 5th and at Clear Water Harbor on the 6th. On April 7 was at Tampa, coaled ship, and proceeded to Punta Rassa, which was reached on the 9th, and remained in that vicinity till the 13th, when we sailed for Key West, arriving there at 2 p. m. Coaled ship, and sailed for Havana, Cuba, at 4 a. m. on April 17, and reached there at 5.45 p. m.; and on the 22d Assistant Commissioner T. B. Ferguson left the vessel.

Received instructions from the assistant commissioner to proceed to Washington, D. C., but was detained until April 25, on which day sailed for Key West, reaching there at noon. Coaled ship, and sailed on the 26th for Charleston, touched at Fernandina and Port Royal, and arrived on the 30th. Coaled and proceeded on May 3. Passed in Hatteras Inlet on the 5th, steamed up Pamlico Sound and through the Chesapeake and Albemarle Canal, touching at Norfolk, and arrived at the Washington navy-yard on May 7.

On May 8 the hatching equipment was taken on board, and on May 13 shad operations were begun in the Chesapeake Bay, near Battery Station and in Elk River, and continued till the 17th, taking 1,406,000 eggs. From May 17 to June 5 the Lookout was engaged in two trips to the Delaware River and one in the upper part of Chesapeake Bay, procuring shad eggs and investigating the shad fisheries, especially those in the Delaware above Philadelphia. Many fishermen were interviewed as to the condition of the fishery, and the spawn-takers were kept busy in visiting the fishing-shores and gill-boats to obtain eggs. During these three trips 3,003,000 eggs were collected, making a total of 4,409,000 shad eggs taken during the season. Of this number 2,115,000 eggs and 454,000 fry were transferred to Battery Station, and 340,000 fry were successfully planted, 190,000 being put into the Delaware River and 150,000 into the Chesapeake Bay and its tributaries.*

On June 6 proceeded to Baltimore, and on the 8th hauled the vessel out on Skinner's marine railway and had top, sides, and deck calked, and also some repairs made on boiler, which work lasted until the 19th.

On June 20 Assistant Commissioner Ferguson joined the vessel, and we proceeded to Saint Jerome Station, which Mr. Ferguson inspected. At 1 p. m., on the 21st, got under way and proceeded up the Potomac River, arriving at the Washington navy-yard on the next day. On June 23 left the navy-yard with launch No. 68 in tow, and proceeded to Battery Station, where we awaited orders until July 3, when Assistant Commissioner Ferguson came on board, and we proceeded to Baltimore. On July 6, with Mr. Ferguson on board, went down the bay to Saint Jerome Station, arriving there at 9 a. m. on the 7th. At 3 p. m. got under way and steamed down to Tangier Island and anchored in Cod Harbor over night. On July 8 started for Old Point, Va., touched at Hunger's Creek, and anchored near Fortress Monroe at 4 p. m.

From July 9 to the 15th were engaged in the lower part of the bay, communicating with fishermen, carrying lumber to the Fish Hawk, taking on coal, &c., stopping at Saint Jerome Station, and reaching Battery Station at 7.15 a. m. on the 16th. On July 14 and 15, with hy-

* For a detailed account of these shad operations, see the report on this work in the F. C. Bulletin for 1885, p. 386.

drometer No. 5247, took the density and temperature of the water at the following places:

Date.	Locality.	Density.	Temperature.
1885.			°
July 14	Off Tangier Island	1.0122	77
July 14	At pound-nets near Fortress Monroe	1.0140	78
July 14	At mouth of Cherrystone Creek	1.0184	78
July 15	At Poole Island	1.0034	78

On July 16 left Battery Station, stopped at Havre de Grace, coaled ship, and started for New York, going by way of the Chesapeake and Delaware Canal to the Delaware River, then down Delaware Bay and along the coast of New Jersey, reaching New York on the 18th. At 1 p. m. of this day Assistant Commissioner Ferguson came on board, and we proceeded up East River and Long Island Sound to Wood's Holl, Mass., touching at New London, Bristol, and Newport, taking in coal at the latter place, and arriving at Wood's Holl on the 20th, where we awaited orders until the 28th.

On July 28 went to Clark's Cove, near New Bedford, took scow in tow, and returned to Wood's Holl. The scow was towed back on August 5.

On July 29 took out a party of four scientists of the Fish Commission to No Man's Land for the purpose of catching swordfish, and returned to Wood's Holl at 5.30 p. m.

On July 31 left for New Haven, where we took on board 20 bushels of oysters to be used at Wood's Holl for spawning purposes, and returned to Wood's Holl on August 2, stopping at New London on the way. The density of the water off Southwest Ledge, New Haven harbor, was found to be 1.0204.

On August 7 left Wood's Holl with Assistant Commissioner T. B. Ferguson and Prof. G. Brown Goode on board, and steamed out to No Man's Land looking for swordfish, but found none. On the 8th went off towards Southwest Ledge hunting unsuccessfully for swordfish, and at night returned to Wood's Holl, where we awaited orders till the 12th.

On August 12 left Wood's Holl for New York, arrived there on the 14th, and reported for duty to E. G. Blackford, a fish commissioner of the State of New York, to assist him in making an investigation of the oyster-beds in different parts of Long Island Sound, Prince's Bay, Kill von Kull, and Hudson River. Several trips were made to these points, and the vessel was engaged in this duty till August 27.*

On August 28 left New York for Wood's Holl, stopping at Newport to get a refrigerator, which was delivered at the Wood's Holl Station on the 29th. From this time to September 5 were making arrangements

* For report on this subject, see article of Mr. Blackford in this volume.

to transport some live sole and turbot, which were expected from England, from New York to Wood's Holl. On September 5 went to the assistance of steamer Monohanset, which was aground, took off about two hundred passengers, and landed them at the Old Colony Railroad wharf.

On September 6, with Assistant Commissioner Ferguson on board, left Wood's Holl, stopped at New London over night, and reached New York on the 7th. On the 11th went alongside the steamer Republic at Jersey City to get the expected fish, but none having arrived, the transporting equipment was removed and shipped to Washington, and on the 13th we returned to Wood's Holl.

On September 21 left Wood's Holl, with Secretary of State Thomas F. Bayard on board, and proceeded to Newport, where Secretary Bayard left the vessel. On the 22d took on board a beam-trawl and carried it to Wood's Holl, where we awaited orders.

On October 2 carried several boxes of specimens to New Haven for the Peabody Museum, and then took on board 50 bushels of oysters, with which returned to Wood's Holl on the 5th. From October 6 to 17 were engaged in cleaning and painting the vessel.

On October 17 Assistant Commissioner Ferguson came on board, and we proceeded to New York, touching at Newport (where launch Cygnet and a cat-boat were taken in tow) and New Haven on the way, and arriving at New York on the 20th, when Mr. Ferguson left the vessel. With the launch and cat-boat in tow, we passed through the Delaware and Raritan Canal and down the Delaware River, coaled ship at Philadelphia, and reached Wilmington on the 22d. From the 22d to the 28th were loading barge with old piles at the mouth of Christiana Creek, with which arrived at Battery Station on the 29th. On the 31st towed the barge through the Chesapeake and Delaware Canal, and delivered it in Wilmington, after which returned to Battery Station, arriving on November 1.

On November 2 towed a lighter of coal from Havre de Grace to Battery Station, and on the 3d left the station with Assistant Commissioner Ferguson on board, and went to Baltimore, where Mr. Ferguson left the vessel. On the 5th took some freight back to the superintendent of Battery Station. On the 9th brought a lot of lumber from Havre de Grace to the station for use there.

On November 12 left Battery Station and proceeded by way of the canal to the League Island navy-yard, below Philadelphia, where we took on several pieces of heavy machinery and transferred them to Battery Station, reaching there on the 14th, from which date to the 30th we awaited orders, the crew being employed at the station in building a wharf, &c. On the 30th two trips were made to Havre de Grace and back.

On December 1 left Battery Station, having on board Messrs. Sauerhoff, Tolbert, and Kenly, and proceeded to Saint Jerome Station, there to erect a wharf and clear the channel of sea-weed, in which work the vessel and crew were engaged till the 10th, when it was finished, and on the 11th left Saint Jerome Station and went to Baltimore, where we took in coal on the 12th.

On December 14 left Baltimore bound to Battery Station, with Assistant Commissioner Ferguson on board, but on reaching Sassafras River we were compelled to turn back on account of the great quantity of ice in the bay, and so we returned to Baltimore, and Mr. Ferguson left the vessel. On the 15th made a second attempt to reach the station, but after getting within half a mile of it were obliged to return to Baltimore. On the 18th made another trial, and anchored for the night near the station, the channel being still full of ice; but on the 19th reached the station without difficulty, the tide having taken out the ice during the night.

We hauled the vessel into the basin, moored her with chains 15 feet from the west side of the basin, secured the boats on shore, unrove running gear, and otherwise prepared the vessel for winter-quarters. On December 24 hauled fires on main boiler, blew it down, disconnected all pipes in danger of freezing, and moved crew from vessel to quarters on shore which had been provided for them by instructions of Assistant Commissioner Ferguson. Such was the condition of things at the end of the year.

The number of geographical miles made during the year was 9,887, and the number of revolutions of the engine was 8,524,234.

U. S. Fish Commission Steamer Lookout,

Havre de Grace, Md., June 26, 1886.

IV.—REPORT OF OPERATIONS AT THE TROUT-BREEDING STATION AT WYTHEVILLE, VA., FROM ITS OCCUPATION IN JANUARY, 1882, TO THE CLOSE OF 1884.

By M. McDonald.

The grounds, ponds, buildings, and other permanent improvements at this station are the property of the State of Virginia. Its occupation by the United States Fish Commission is under an agreement or contract which provides that the United States Commission shall have full use, occupation, and control of the station for fish-cultural purposes, conditioned upon the payment of an annual rental of $500. The cost of the maintenance and conduct of the station is, of course, defrayed by the United States Commission. Such permanent improvements or alterations as may from time to time be required in the development of the work of the station or to increase the convenience and facilities for such work, are to be provided by the commissioner of fisheries of Virginia, and at the cost of the State.

The station was first occupied conditionally in January, 1882, with the view of determining experimentally its adaptations as a breeding and rearing station for the *Salmonidæ*, and the results of the season's work were so satisfactory that its permanent occupation was determined upon and definite articles of agreement entered into in July, 1882.

OBJECT OF THE STATION.

The Wytheville station is centrally situated in the Appalachians, an extensive tract of mountains stretching northeast and southwest from New York to Georgia, and having an average breadth of more than 100 miles. The thousands of streams which drain this area are well adapted to the trout. To most of them the red-speckled or brook trout is indigenous, and in many which have been protected from excessive or unlawful fishing this favorite of the angler still abounds.

It is believed that, with proper protective laws, enacted by the legislatures of the several States, and upheld and enforced by public opinion, it is practicable to make both the brook trout (*Salvelinus fontinalis*) and the rainbow or California trout (*Salmo irideus*) abundant in all the streams of the Appalachian region. The Wytheville station occupies the geographical center of the region to be stocked, and is in easy communication by rail with all parts of it.

The supply of water for the hatchery and ponds is practically unlimited, and the facilities for the breeding, rearing, and distribution of the *Salmonidæ* so exceptional that this station has been selected for the prolonged, extensive, and systematic work necessary to re-establish the trout fishing in the Piedmont and mountain regions of Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Tennessee, and the northern portions of Alabama and Georgia.

Experience has shown that it is not well, in general, to attempt the stocking of streams with fish less than one year old. To hold and feed the fish will require an extensive system of rearing-ponds, and entail considerable cost in feeding, and greater expense in distribution. But the assurance of success in stocking afforded by planting fish of such size and vigor of movement as will give immunity from capture by the small native predaceous fish of the waters will more than counterbalance the increased cost of the work.

DEVELOPMENT OF THE STATION.

Prior to the occupation of the Wytheville hatchery by the United States Commission the superintendent's house, hatchery, and other buildings were upon grounds not the property of the State, but occupied under a conditional grant from S. P. Browning, the owner. When it was definitely determined that the United States Commission would occupy and operate the station, the commissioner of fisheries of Virginia, to avoid the possibility of any embarrassment or complications arising from a presumed uncertainty of tenure, acquired by purchase from Mr. Browning the title in fee simple to 12 acres of land lying on both sides of Tate's Run, and extending to the line of the Atlantic, Mississippi and Ohio Railroad. Within the limits of this tract are all the buildings and other improvements belonging to the State.

At the time the station was occupied the improvements consisted of a rough hatchery, its dimensions being 25 feet by 50 feet, equipped to carry at one time 500,000 eggs of trout or other *Salmonidæ;* a comfortable and convenient superintendent's house, and all necessary outbuildings, &c. There were no ponds for brood fish and none for the fry, so that the California trout hatched out during the season of 1881–'82 and intended to be reared for breeders were retained in the hatching-troughs until the fall of 1883.

IMPROVEMENTS IN 1883 AND 1884.

During the summer and fall of 1883 the State commissioner constructed three ponds for the reception of the brood fish. These were 15 feet wide, 50 feet long, and 3 feet deep, and connected with each other and the head of the spring by races for spawning. The ponds and races were constructed entirely of oak plank, supported and held together by trussed frames. The interior surface of both ponds and raceways was painted with coal-tar. Immediately after the completion of the ponds the California trout, then eighteen months old, were transferred to them. The paint was not thoroughly dry, and the coal-tar diffused in the water exerted a distinctly deleterious influence, and occasioned the loss of twelve or fifteen hundred fine fish. A number of those which survived this calamity became subsequently blind, doubtless from the same cause.

The springs which furnish the water-supply to the hatchery break out in an oval depression in the hillside, and after flowing a short distance, the waters enter a subterranean channel, which they follow for a distance of 200 yards, and finally reappear in the bed of Tate's Run, at too low a level to be used for the supply of the breeding-ponds to be located on the sloping hillside south of the hatchery. To obtain the necessary control of water-supply, the State commission caused to be excavated through solid rock a channel leading from the basin in which are the springs to the site of the proposed ponds, and, by intercepting the flow through the underground channel, diverted the whole volume of water (1,100 gallons per minute) so as to make it available for the supply of breeding-ponds.

In the latter part of 1884 four additional ponds, 12 feet by 50 feet, were constructed on the hillside sloping south from the hatchery. The lower sides and ends of these are formed of sheet-piling supported by triangular trusses and stringers. The bottom and upper side of each are of earth or rock. This modification in construction was adopted because experience had shown that trout in ponds with earth or rock bottoms thrive much better than where the sides and bottom are formed of plank. Various minor improvements, adding to the appearance of the station and the comfort and convenience of the work, were also made by the State commission.

The improvements contemplated are as follows:

(1) The construction of a railroad siding on the hatchery grounds for the greater convenience and economy of distribution.

(2) The erection of a new hatchery, 30 feet by 50 feet in plan, two stories high, and thoroughly equipped for the most extensive work of propagation.

(3) The construction of eight additional ponds for rearing the *Salmonidæ*.

(4) The construction of a complete series of ponds for breeding carp and other warm-water species.

The estimated cost of these and a number of minor improvements is $3,200, the entire expense of which, under our agreement with the State commissioner, is to be borne by the State of Virginia.

PROPAGATION AND DISTRIBUTION.

No fish or eggs were distributed from this station in 1882. Twenty-five thousand eggs of the California trout, forwarded from the collecting station at Baird, Cal., were hatched out at the station and yielded 12,000 fry, which were retained at the station to be reared for breeders. Twenty-five thousand eggs of the Penobscot salmon were hatched, yielding 22,000 fry, which were retained in the hatching-troughs and fed until they were fifteen months old, and then turned out in the tributaries of New River, with the view of making a conclusive test of the adaptation of this species of migratory fish to the rivers of the Mississippi Basin. It is not expected that they will ever reappear in the waters in which they were planted, since the falls of the Great Kanawha River present an insuperable barrier to their return; but should they live to mature, we would expect them to be found in some of the tributaries of the Ohio which are unobstructed by falls or dams.

The only eggs hatched at the station in 1883 were those of the California trout. Eighty-two thousand ova, forwarded from the McCloud River station, were hatched out, yielding 44,000 fry, of which number 6,000 were retained to rear for breeders, and the remainder distributed as follows:

To streams in South Carolina, under the direction of the State commissioner	8,000
To the Roanoke and its tributaries, in Virginia	4,000
To tributaries of the Holston, in Smyth County, Virginia	5,000
To headwaters of James River, in Virginia	2,000
To tributaries of the Shenandoah, in the Valley of Virginia	6,000
To tributaries of the Potomac, in Maryland and West Virginia	13,000

Of the yearlings 500 were furnished to stock the ponds of the South Side Sportmen's Club, on Long Island, and 50 were placed in the Roanoke River, in the vicinity of Big Spring, Va. Those furnished the South Side Club are now breeding, and the great financial success that has attended the fish-cultural enterprise of this club is a conspicuous example of what may be accomplished in this direction by individual or associated effort when intelligently directed.

The eggs hatched in 1884 were as follows:

From the Bucksport station, Maine, 100,000 salmon ova.

From the Northville station, Michigan, 75,000 brook trout ova.

In both cases the mortality after hatching was, for some unexplained reason, very large.

Full details of the distribution of fish from this station during the season will be found in the following table:

Distribution of Salmonidæ from Wytheville Station during 1884.

Date.	Water in which placed and locality.	California trout.			Brook trout.		Rangeley trout, one year.	Penobscot salmon fry.
		One year.	Two years.	Three years.	Fry.	One year.		
1884.								
Feb. 25	Spring Creek, near Warm Springs, N. C.	....	....	....	4,500	....	....	....
25	Laurel River, near Warm Springs, N. C.	....	....	....	5,500	....	....	....
Mar. 5	Mill Creek, near Round Knob, N. C.	....	150	....	5,000	....	....	....
19	Watauga River, near Carter's Depot, Tenn.	....	350	....	....	....	....	....
19	Hiawassee River, Calhoun, Tenn.	....	324	....	....	....	....	....
19	In pond of Tipton Jobe, Johnson City, Tenn.	....	100	....	....	....	....	....
19	Wills Creek, De Kalb County, railroad crossing, Ala.	....	368	....	....	....	....	....
19	Warrior River, Warrior Station, Ala.	....	387	....	....	....	....	....
19	Cahawba River, Shelby County, railroad crossing, Ala.	....	396	....	....	....	....	....
19	Choccolocco Cr., Oxford, Ala.	....	400	....	....	....	....	....
19	Tallapoosa River, at railroad crossing, Ala.	....	370	....	....	....	....	....
19	Etowah River, Cartersville, Ga.	....	400	....	....	....	....	....
19	Coosawattee River, E. Tenn., Va. & Ga. R. R. crossing.	....	398	....	....	....	....	....
Apr. 10	Morgan's Run, near Berryville, Clarke County, Va.	100	100	....	....	50	50	....
10	Harris Run, 3½ miles from Oswego, N. Y.	350	100	....	....	....	....	....
10	E. G. Blackford, New York F. C., for exhibition.	30	6	6	....	....	6	....
10	Oswego River, near Fulton, N. Y.	....	....	....	....	....	....	50,000
16	Ponds of Hon. C. Delano, Mount Vernon, Ohio.	....	50	....	....	....	....	....
		480	3,899	6	15,000	50	56	50,000

Distribution made by car No. 1, Messenger George H. H. Moore being in charge.

A notable feature of the work was the stocking of a number of streams in Georgia, Tennessee, and Northern Alabama with two-year-old California trout. The rivers thus stocked were:

Mill Creek, near Round Knob, N. C.
Watauga River, near Carter's Depot, Tenn.
Hiawassee River, near Calhoun, Tenn.
Wills Creek, De Kalb County, Ala.
Warrior River, Warrior Station, Ala.
Cahawba River, Shelby County, Ala.
Choccolocco Creek, Oxford, Ala.
Tallapoosa River, Ala.
Etowah River, Cartersville, Ga.
Coosawattee River, near Rome, Ga.

From 300 to 500 nearly adult fish were planted at each locality, and, if the waters prove suitable and reasonable protection is afforded, we may in a few years expect to find the California trout common in the streams above referred to.

In the fall and early winter of 1884–'85 some of the rainbow trout bred at the station spawned. The spawning began in December and continued up to the first of March, yielding 49,000 eggs of fair quality.

WASHINGTON, D. C., *April* 14, 1886.

V.—REPORT OF OPERATIONS AT COLD SPRING HARBOR, NEW YORK, DURING THE SEASON OF 1885.

By Fred Mather.

On the work in hatching and distributing different species of Salmonidæ and other fishes at this station (owned by the New York fish commission), done wholly or in part by the U. S. Fish Commission, I have the honor to report as follows:

WHITEFISH (COREGONUS CLUPEIFORMIS).

On January 1, 1885, there was received from Mr. Frank N. Clark, of the Northville, Mich., station, one case containing 1,000,000 whitefish eggs in excellent condition. These eggs were placed in the McDonald jars, and hatched well. They were distributed in the deep lakes of Long Island, where it is possible that they will live. Letters from J. H. Perkins, esq., of Riverhead, Suffolk County, New York, the county treasurer, say that it is rumored that specimens of whitefish of a quarter of a pound had been taken from Great Pond, near that place, of the previous year's planting, but we have been unable to get specimens, and the rumors cannot be traced to any reliable source, although Mr. Perkins has tried to do so.

BROOK TROUT (SALVELINUS FONTINALIS).

On January 31, 1885, we received from Mr. Clark one case containing 7,000 eggs. They came during very cold weather, and much of the moss packing was frozen, and some ice was among the eggs, which were quite dry and considerably indented. We sprinkled them with spring water, at 38° Fahr., until we brought them up to that temperature, when they were placed in the troughs. The loss of eggs during hatching was 687, and of fry 536, or about 1,200 in all. The fish were placed in streams at Islip and Bellport, on Long Island. Also there were planted 10,500 fry, hatched from eggs taken at the hatchery.

RAINBOW TROUT (SALMO IRIDEUS).

February 25, 1885, we received from the station at Northville, Mich., 10,000 eggs of the rainbow trout in good condition, and on March 9 another case containing an equal number, which were also in good order. These eggs hatched very well, and 14,500 fry were placed in streams within the State of New York.

The details will be found in Table III.

PENOBSCOT SALMON (SALMO SALAR).

This was the second year of our operations at this station, and the apparatus was in better working order, as is usually the case with older troughs, and we had a very successful hatching season. Encouraging accounts of the plantings in Clendon Brook, one of the tributaries of the Hudson, have been received from Mr. A. N. Cheney, of Glens Falls, N. Y., who writes that this brook is swarming with them, and who, by request, in October, 1885, went there and with a fly captured several specimens, which he sent to Mr. E. G. Blackford, of the New York commission, who forwarded them to Professor Baird at Washington. These fish were from 6 to 7 inches long, and were probably of the plant made in April, when the fry were from 1 inch to 1½ inches long.*

In 1885, we received 500,000 eggs of the *Salmo salar* from the station

*Since the above was written authentic accounts have been received of the capture of four adult salmon in the Hudson. One of these was taken about the middle of May, 1886, in Gravesend Bay, at the mouth of the Hudson, and weighed about 10 pounds. It was captured by Mr. John Denyse, of Gravesend, and sent to Fulton Market. Between June 1 and 4, 1886, three salmon were captured at the dam at Troy in the shad nets. These fish weighed respectively 10, 10½, and 14½ pounds.

The following notes from Forest and Stream of June 10, 1886, refer to these fish:

Salmon in the Hudson.—Another triumph has been scored for fish-culture. Salmon have been taken in the Hudson this season to the number of perhaps half a dozen at present writing. They are all recorded from Troy, below the State dam, with the exception of one taken in Gravesend Bay, which we noticed a few weeks ago. In former years an occasional stray salmon has been captured in the river at rare intervals, but these fish, coming just four years after the first stocking of the river, point to the planting of 1882 as the source of their origin. In that year a small plant was made for the U. S. Fish Commission from the hatchery of Mr. Thomas Clapham, at Roslyn, Long Island, by Mr. Fred Mather, who has since continued the work on a larger scale from the station of the New York Fish Commission at Cold Spring Harbor, under orders of Professor Baird, of the U. S. Fish Commission. State Commissioner Blackford is making efforts to get all the information possible concerning the capture of salmon in the river, and we shall, no doubt, hear of others being taken. The eggs from which these fish were hatched came from the United States station at Orland, Me., in charge of Mr. C. G. Atkins. The Hudson may yet become a salmon stream. Put up the fishways now, and protect the fish which have escaped the meshes of the innumerable shad-nets of the lower river, and give them a fair chance.

Several salmon have been taken below the dam at this city within the past week. There are known to be four, and there are rumors of others. The largest one which we have any positive record of weighed 14½ pounds, and it was a fine plump fish. The salmon are now stopped at the dam here, and are being taken in nets. This should be stopped at once, and fishways should be built to allow them to reach the upper river, where they can spawn. The fact that there are salmon in the Hudson at Orland, Me., in charge of Mr. C. G. Atkins. Four cases, containing 250,000 in all, arrived on January 15, 1885, at 7 p. m., in good condition, and were unpacked the next day at 10 a. m. The temperature of the water was 44 degrees and that of the eggs the same. Three hundred and eighty eggs were found dead on unpacking. On January 22 we received from the same source four additional cases, containing the remainder of the eggs, which were in equally good condition. They were unpacked the next morning at 8 o'clock, the temperature of the packing being 34 degrees, while the water in our troughs was 36 degrees. The number of dead eggs in this last lot was 1,930. In none of these cases were there any indented eggs, which is always a sign of lack of moisture in the package, and I cannot too highly commend the excellent manner in which they were packed for domestic shipment. Of these 500,000 eggs, which will be accounted for in exact figures in the tables at the close of this report, our loss was 75,000 in eggs or fry and by reason of those different deformities which are familiar to fish-culturists. Of the 425,000 remaining, 270,000 were planted in the tributaries of the Hudson in Warren County, N. Y.; 100,000 were sent to the tributaries of the Delaware River in Sussex County, N. J.; 50,000 were placed in the Oswego River; and 5,000 were distributed privately.

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should arouse anglers and game protectors to see that the first crop is not destroyed. [J. H. R., TROY, N. Y., *June* 7, 1886.]

Mr. H. P. Schuyler, of Troy, has written to Mr. M. M. Backus, of New York, that on Monday last a 14½-pound salmon was caught at the State dam, making the third within a week, whose aggregate weight was 35 pounds. Mr. Backus writes to Mr. Blackford that there is an impression at Troy that a few years ago the State legislature made an appropriation for a fishway at Troy, but it has never been built. Mr. Schuyler says that the fish referred to will be the last one killed, as "a few knights of the angle intend to take matters in hand," and that his brother has notified the fishermen that all fish taken in future must be returned to the water, and adds: "I believe the waters in the vicinity of the dam are swarming with salmon that are unable to get above the dam."

Two salmon have been taken here. These must be fish that were planted three or four years ago by the U. S. Fish Commission from the Long Island hatchery. I saw the first shipment taken to North Creek by Mr. Mather in 1882, while they were on the platform at Saratoga, and expressed my opinion to him that it was doubtful if they would ever return, because they were so small. I am prepared to believe that more will come. [D. Y. SMITH, TROY, N. Y., *June* 7, 1886.]

On the 2d day of June some fishermen took from the waters of the Hudson, just below the State dam at this city, a strange fish, some 10 pounds in weight. They presented the fish to their employer, who was also ignorant of its proper name and species, but found it very good eating. Yesterday another of the same fish was taken at the same place. It was brought to the city, and in the evening I had the pleasure of inspecting a fine male salmon, which measured 28 inches in length, 16 in girth, and weighed 10 pounds 8 ounces. Did not the legislature provide for the construction of a fishway in the above-mentioned dam? If so, let us have it at once. [SEYMOUR VAN SANTVOORD, TROY, N. Y., *June* 4, 1886.]

These adult salmon, I have no doubt, are of the planting in 1882, which was made from the hatchery of Mr. Clapham, at Roslyn, N. Y.

In the distribution to the waters of the Hudson I relied upon my own knowledge of the character of those Adirondack streams, and of the reports of the residents there concerning the logging operations, and all streams on which there were dams and logging was going on were avoided. It often happens that a stream is used for logging one season and is not so used the next. The logs are hauled to the bank of a stream in winter when the snow will permit sleds to be used in the woods. A dam is built which floods the water back as far as possible and makes a large lake. The logs are all brought in at this point or below and thrown into the water; those above are held by a boom. When all is ready in the spring, and the snows are melting, and the streams are consequently filled, this dam is cut away and the logs are swept down into the river below, while all those which were thrown into the river below the dam are picked up and carried down with the flood. They are caught miles below with a boom, and each owner recognizes his logs by the marks upon them. This work causes a plowing up of the gravel-beds by the logs, which are tumbled over each other, and the sweeping out of the bed of the stream; and the young fish seek safety on the banks, where they are often left in pools to perish. We have in every case avoided streams which were being used for this purpose, and have planted only streams which were left in a natural condition, and which were at the time, or had been, trout-streams, where we felt sure that the young would find sufficient food at the time of planting.

LANDLOCKED SALMON (SALMO SALAR *var.* SEBAGO).

On March 19, 1885, we received 60,000 eggs of the landlocked salmon from Mr. Charles G. Atkins, Grand Lake Stream, Maine. They were unpacked the next day and found to be in excellent condition. These eggs were presented by the Commissioner to the New York State fish commission, and were by them assigned to some of the Adirondack lakes, but, through some misunderstanding, I did not get specific orders in time to plant them there, and the fish were kept so long in the troughs that there was danger of losing them, and they were finally planted, from the middle to the end of May, in lakes on Long Island.

BROWN TROUT (SALMO FARIO).

On February 24, 1885, we received from the Deutsche Fischerei-Verein, through its president, Herr von Behr, a box containing 40,000 eggs of the *Salmo fario*, popularly called in England "brown trout." The eggs were forwarded by Mr. F. Busse, of Geestemünde, and half of them were billed to Mr. E. G. Blackford, and the remainder to myself. These eggs, which came from the ponds of Mr. Carl Schuster, near Freiburg, in Baden, arrived in very good order. The fry from these eggs were planted in Queens, Suffolk, Westchester, and Rockland Counties, N. Y.

The few which we have kept have grown wonderfully, are handsome and gamy trout, and are said to bear some what warmer water than our Eastern brook trout, the *Salvelinus fontinalis*. We have one of these fish now in our ponds, a male, which at two years old weighed over a pound. I think them the strongest and gamiest trout I have ever handled.

SMELTS (OSMERUS MORDAX).

We have been fairly successful in hatching these very refractory eggs, which, on account of their glutinous character, give us a great deal of trouble. We obtained the parent fish from the streams about Brookhaven, Long Island, which empty into the Great South Bay, and brought them here about the spawning time, in the first week in March. The fish are not very common on Long Island, but still inhabit a few streams. It seems to be their habit to run up at night and spawn, and the fishing for them is done mainly at this time. The fishermen all report that the catch has been decreasing for the past eight or ten years, as there is no protection by law for the fish. We had very little to guide us in our experiments, as but little had been attempted with these fish, and that in a small way, and not much has been published on the subject. The fish begin to run up the streams of Long Island from the middle to the last of February, and the run lasts about a month. Our fish were brought up on the 4th of March by the foreman, Mr. Walters, and numbered 120, some of which were nearly ripe. We experimented with the eggs on bunches of meadow-grass, on stones, and in jars of the McDonald pattern, and found that when they adhered in bunches we were more or less successful, and although all the eggs on the outside of the bunches died, the eggs inside were bright and good. A detailed report of this work was made to the American Fisheries Society at its fourteenth annual meeting, May 5 and 6, at Washington, D. C., and can be found in the published report of that society. We succeeded in hatching about 50 per cent of the eggs taken, which is, at this state of our knowledge of handling adhesive eggs, considered to be a fair working average; but it is possible that we may be able to increase this percentage. We took this year some 200,000 eggs, and turned out about 100,000 fry in different streams about the head of Cold Spring Harbor.

THE SALT-WATER DEPARTMENT.

Situated as we are at the head of an inlet where the fresh-water springs from the hillside flow into the harbor, we can obtain salt water of a density of 1.019 to 1.022 at high tide. The State commission has built a pond with a flood-gate which holds the water at low tide, and from which we pump it into a reservoir on the hill. The work this year was confined to hatching the little tomcod (*Microgadus tomcodus*), known in many parts of the island as "frost-fish," and which is much esteemed here as food. These fish come close to the shores and along the docks to spawn in November and December. The eggs are not adhesive, nor are they as buoyant as the egg of the codfish, although structurally the cod and the tomcod are closely related. We took the eggs in milk-pans, after the manner of handling trout and similar fishes. The eggs were placed in the McDonald jars, where they hatched in about twenty-five days, at a temperature which ranged during the period between December 15 and January 8 from 36 to 46 degrees Fahrenheit The fry were planted in the harbor.

The following tables show the distribution of the various kinds of fish handled at this station during the season:

TABLE I.—*Distribution of whitefish from Cold Spring Harbor in March and April*, 1885.

Date.	By whose order.	Messenger.	Where planted.	Number of fish.
Mar. 4	E. G. Blackford	F. A. Walters	Great Pond, near Riverhead, N. Y	600,000
11	Fred Mather	F. A. Walters	Mill-pond, near Cold Spring Harbor, N. Y.	50,000
Apr. 8	E. G. Blackford	F. A. Walters	Lake Ronkonkoma, on Long Island	340,000
	Total			990,000

TABLE II.—*Distribution of brook trout from Cold Spring Harbor in April and May*, 1885.

Date.	Delivered to—	Post-office address.	Number of fish.
Apr. 19	Geo. Snyder	Manhasset, N. Y	5,500
20	H. Scudder	Northport, N. Y	1,300
30	H. S. Jennings	Islip, N. Y	3,000
30	W. T. Hawkins	Bellport, N. Y	3,000
30	Wood Fosdick	Bellport, N. Y	2,000
May 18	Townsend Jones	Cold Spring Harbor, N. Y	1,500
	Total		16,300

TABLE III.—*Distribution of rainbow trout from Cold Spring Harbor in May*, 1885.

Date.	Delivered to—	Post-office address.	Number of fish.
May 3	George Snyder	Manhasset, N. Y	1,000
4	J. R. Wood	Cold Spring Harbor, N. Y	1,000
12	F. H. Weeks	do	1,000
13	A. W. Benson	Montauk Point, N. Y	4,000
14	Patrick McGovern	Brooklyn, N. Y	500
15	Dr. A. K. Fisher	Sing Sing, N. Y	2,500
21	A. W. Humphreys	Sterlington, N. Y	3,000
22	James Ramsbottom	Baldwin, N. Y	500
30	Weeks & De Forest	Cold Spring Harbor, N. Y	1,000
	Total		14,500

TABLE IV.—*Distribution of Penobscot salmon from Cold Spring Harbor in April and May, 1885.*

Date.		Place of deposit.	Messenger.	Fish supplied.	Loss in transportation.	Fish planted.
Apr.	27	Clendon Brook, Hudson River	F. A. Walters	*60,000	300	59,700
May	5	North River, Hudson River	....do	80,000	100	79,900
	8	Carr's Brook, Hudson River	....do	70,000	200	69,800
	13	Cedar River, Hudson River	....do	60,000	100	59,900
	14	Brooklyn, N. Y	By express to Patrick McGovern.	1,000	....	1,000
	20	Paulin's Kill, N. J., Delaware River	F. A. Walters	50,000	250	49,750
	22	Pequest River, N. J., Delaware River	....do	50,000	400	49,600
	27	Oswego River, Lake Ontario	....do	50,000	†4,000	46,000
	30	Pond of J. D. Jones, Great South Bay	W. S. Stoots	4,000	100	3,900
		Total		425,000	5,450	419,550

* 150 yearlings placed in Clendon Brook at the same time.
† Loss owing to weakness of fish.

TABLE V.—*Distribution of landlocked salmon from Cold Spring Harbor in May, 1885.*

Date.		By whose order.	Messenger.	Where planted.	Number of fish.
May	13	E. G. Blackford	Long Island Railroad Express Company.	Pond at Montauk, L. I	4,000
	22	.. do	James Ramsbottom	Pond of J. Ramsbottom	1,500
	30	....do	W. S. Stoots	Pond of John D. Jones	6,000
	30	Fred Mather	F. A. Walters	Lake Ronkonkoma, Long Island.	8,000
		Total			19,500

TABLE VI.—*Distribution of brown or European trout from Cold Spring Harbor in April and May, 1885.*

Date.		Delivered to—	Post-office address.	Number of fish.
April	30	H. S. Jennings	Islip, N. Y	3,000
May	3	George Snyder	Manhasset, N. Y	6,000
	4	J. R. Wood	Cold Spring Harbor, N. Y	3,000
	12	F. H. Weeks	......do	2,000
	13	H. Scudder	Northport, N. Y	1,700
	15	Dr. A. K. Fisher	Sing Sing, N. Y	3,500
	21	A. W. Humphreys	Sterlington, N. Y	2,000
	30	Weeks & De Forest	Cold Spring Harbor, N. Y	2,200
	30	Townsend Jones	......do	5,500
		Total		28,900

TABLE VII.—*Planting of smelts and tomcod from Cold Spring Harbor hatchery in January and April, 1885, by F. A. Walters, under the direction of Fred Mather.*

Date.		Kind.	Where planted.	Number of fish.
1885.				
Jan.	8	Tomcod	Cold Spring Harbor, N. Y	150,000
	15	....do	......do	60,000
April	17	Smelts	In brook west side of meadow	20,000
	20	....do	In brook leading from mill-pond	15,000
	22	....do	In brook east side of meadow	30,000
	22	....do	Kept in the hatchery, and subsequently escaped	35,000

VI.—REPORT OF EGGS SHIPPED TO AND RECEIVED FROM FOREIGN COUNTRIES AT THE COLD SPRING HARBOR, NEW YORK, STATION DURING THE SEASON OF 1885-'86, AND THE DISTRIBUTION IN THE SPRING OF 1886.

By Fred Mather.

SHIPPED TO FOREIGN COUNTRIES.

GERMANY.

A. Lake trout (*Salvelinus namaycush*).—On January 7 received from Mr. Frank N. Clark, superintendent of the station at Northville, Mich., one case containing 50,000 lake-trout eggs, which were in good order. We repacked them in our refrigerating boxes and shipped them on January 18, by the North German Lloyd steamer Fulda, to the Deutsche Fischerei-Verein, in care of F. Busse, Geestemünde. Concerning this shipment Herr von Behr, president of the Fischerei-Verein, writes, under date of February 13, that the eggs arrived in good order.

B. Brook trout (*Salvelinus fontinalis*).—On January 29 we received 25,000 brook trout from Mr. Clark, and repacked and shipped them by steamer Eider on February 22, to the address given above. I have no report concerning the receipt of these eggs.

C. Rainbow trout (*Salmo gairdneri*, var. *irideus*).—On February 18th 25,000 of these eggs were received from the Wytheville, Va., Station, in charge of Col. M. McDonald. They were repacked and shipped by the steamer Hermann to the Fischerei-Verein on the next day. No returns have been received from this lot.

D. Landlocked salmon (*Salmo salar*, var. *sebago*).—From Mr. Henry H. Buck, in charge of the station at Grand Lake Stream, Me., there were received 20,000 eggs of the landlocked salmon in excellent condition on March 12. These were repacked and shipped by steamer Fulda to the Fischerei-Verein on March 20. Have received no account of their arrival.

E. Whitefish (*Coregonus clupeiformis*).—On January 23d 1,000,000 whitefish eggs were received from Mr. Clark, of the Northville Station. On January 25 they were repacked and shipped by the steamer Ems to the Fischerei-Verein. Concerning this shipment Herr von Behr, under date of February 13, writes substantially as follows:

I am happy to state that the lake trout, as well as the whitefish, arrived in good condition. Bavaria was to have nearly half the eggs, and Mr. Carl Schuster the other half. Now, by a mistake of the railroad, nearly all the eggs went to Mr. Schuster. This upset our calculations of sending one-half of them to Bavaria, for the eggs were very near hatching, and it was too late to reship them. If there are still more eggs at the disposition of Professor Baird, please ask him to send me some whitefish eggs for Bavaria; as the most distinguished and influential persons in that country take great interest in fish-culture.

ENGLAND.

All shipments to England were made to the National Fish Culture Association, in care of W. Oldham Chambers, esq., secretary, South Kensington, London.

A. LAKE TROUT (*Salvelinus namaycush*).—On January 7th 50,000 eggs of this fish were received from Mr. Clark, of the Northville Station, repacked in refrigerating boxes, and sent by the steamer Aurania, of the Cunard line, on January 15. A statement of their arrival is found under the heading of whitefish.

B. BROOK TROUT (*Salvelinus fontinalis*).—On January 25 received 10,000 eggs from Mr. Clark, and repacked and shipped them on the 29th by the steamer Servia, of the Cunard line.

C. LANDLOCKED SALMON (*Salmo salar*, var. *sebago*).—Ten thousand eggs of this fish were received from Mr. Buck, of the Grand Lake Stream Station, on March 12. They were repacked in refrigerating boxes and shipped on March 16 by the steamer Germanic, of the White Star Line. I have no advices of their condition on arriving in England.

D. WHITEFISH (*Coregonus clupeiformis*).—On January 7th 1,000,000 eggs were received from Mr. Clark, and repacked and shipped by the Cunard steamer Aurania on January 15. The following letter refers to this shipment and also to that of the lake trout mentioned above:

LONDON, *January* 28, 1886.

DEAR SIR: I am desired by the council of the National Fish Culture Association to tender their best thanks for the kindness you have displayed in forwarding 1,000,000 ova of the whitefish (*Coregonus albus*) and 50,000 ova of the lake trout, which duly arrived on Tuesday last. I am pleased to inform you that they arrived in perfect condition and commenced to hatch out as soon as they were placed in the hatchery. I cannot speak too highly of the method and care with which they were packed.

Yours faithfully,

W. OLDHAM CHAMBERS.

Prof. S. F. BAIRD,
Washington, D. C.

Another lot of 1,000,000 whitefish eggs was received from Mr. Clark on January 25, and the eggs were repacked and shipped by the Cunard steamer Servia on the 29th. No account of their arrival has been received.

SWITZERLAND.

All eggs shipped to this country were sent to New York, in care of the Swiss consul, J. Bertsmann, esq.

A. LAKE TROUT (*Salvelinus namaycush*).—On January 7th 50,000 eggs of this fish were received from Mr. Clark, and were repacked and shipped to New York on January 11, in time for the steamer Amérique, of the General Transatlantic Company. I have no account of their arrival.

B. BROOK TROUT (*Salvelinus fontinalis*).—On January 29 there were received from Mr. Clark 10,000 brook-trout eggs, which were repacked and forwarded to New York on February 2, in time for the steamer St. Simon.

C. WHITEFISH (*Coregonus clupeiformis*).—On January 7th 1,000,000 eggs were received from Mr. Clark in good order, and were forwarded four days later by steamer Amérique. I have no advices concerning the arrival of any of these eggs at their destination.

FRANCE.

On March 1 I received through Mr. E. G. Blackford, commissioner of fisheries of New York, a package of 10,000 rainbow-trout eggs from the Wytheville Station, and returned them to Mr. Blackford the next day, as I understood these were for foreign shipment.*

RECEIVED FROM FOREIGN COUNTRIES.

GERMANY.

A. COREGONUS.—On January 28 a case containing 100,000 eggs of some small species of whitefish, perhaps *Coregonus albula* or *C. maræna*, was received from the Deutsche Fischerei-Verein, in very fair order. There were 5,000 of the eggs dead, and some fungus had grown. These were re-iced and shipped as per orders, on the same day, to Mr. Charles G. Atkins, Bucksport, Me. On February 4 another case, containing 50,000 eggs, apparently the same kind, was received, in which 22,000 were dead. The good ones were placed in a hatching-jar to await orders, where they were kept until February 14, when they were repacked and shipped to Mr. Frank N. Clark, Northville, Mich.

B. BROWN TROUT (*Salmo fario*).—Notice had been received from Herr von Behr that a shipment of 64,000 eggs of this fish would be sent to Professor Baird, and that a second package would be forwarded to Mr.

*These were sent by Mr. Blackford as a present to the Société d'Acclimatation, Paris.—EDITOR.

E. G. Blackford and myself. It was agreed that both packages should be equally divided between the three, so that in case of failure in either lot we would all receive a share of such eggs as were good. On March 1 the case for Professor Baird, containing 64,000, came to hand in a very bad condition. There were about 10,000 eggs which had not turned white, and hopes were entertained that some fish might come from them. These were placed upon the hatching trays, but within a week all had turned white or burst, showing that the embryos were dead in the egg when received, although they had not become opaque. This fact was suspected at the time, because no movement could be seen in the eggs which were very far advanced.

On March 20 we received another package from Herr von Behr, containing 40,000 eggs of brown trout packed by Mr. Schuster, of Freiburg, Baden, in good order. Some of these eggs were exceedingly light colored, and I wrote to Mr. Schuster, asking if they were a different fish. He answered me, "the light colored eggs came from tributaries of the Danube, while the higher colored ones are from the Neckar." We removed 4,134 dead ones, and shipped 10,000 to Mr. Clark, Northville, Mich., and 3,000 to the station at Wytheville, Va. Those retained at Cold Spring Harbor hatched exceedingly well, and some of them were planted in Clendon Brook, Warren County, New York, and the others were kept at the hatchery. From this stock some 7,000 fry were sent to Lake Brandon, Essex County, the Adirondack Station of the New York fish commission.

On April 16 we received from Max von dem Borne, the celebrated fish-culturist of Berneuchen, Germany, two cases, each containing 25,000 eggs of the brown trout, in excellent condition; only 480 dead eggs were removed. Thirteen thousand were shipped to Mr. Clark, Northville, Mich., and 1,000 to James Nevin, superintendent of the Wisconsin fishery commission, at Madison. At present writing the fry are strong and healthy, but have not begun to take food. Concerning these last two lots of fish, Mr. Clark writes me under date of May 10, as follows:

"The first lot of brown trout came in excellent condition; and the fry are doing well. The last—the von dem Borne lot—came in poor condition, about one-half being hatched on arrival; but we shall save four or five thousand nice fry from the last lot."

This fish is strong, quick-growing, and gamy, and I have on several occasions declared it to be the finest trout that I have ever seen. In Europe they endure waters considerably warmer than our Atlantic brook trout (*S. fontinalis*) can stand. I have one specimen in the ponds, a fine male trout, which at two years old would weigh nearly 2 pounds.

COLD SPRING HARBOR, N. Y., *May* 15, 1886.

VII.—REPORT OF OPERATIONS AT THE NORTHVILLE AND ALPENA (MICH.) STATIONS FOR THE SEASON OF 1885-'86.

By Frank N. Clark.

The work, on the whole, shows a satisfactory increase in results over the preceding year, though there is a slight falling off in the brook-trout and rainbow-trout branches of the service.

The receipts of whitefish eggs at both stations amounted to 168,000,000, an increase of 13,000,000 over last year. Most of this supply was drawn from the usual sources, namely, the island region of Lake Erie, the penning station at Monroe, and the west shore of Lake Huron. About 20,000,000 were secured from new territory along the north shore of Lake Michigan, from the spawning runs to the reefs fished from Thompson, Mich. These runs occur in November and December, the late runs to the gill-net grounds beginning as a rule several days after the collection of spawn has been discontinued at other points. Eggs were taken here as late as December 16, and even then the fish were spawning freely; but fishing was discontinued on that date.

The shipments of whitefish eggs foot up 42,800,000, an increase of 11,800,000. The extent to which the shipping of eggs is now carried adds not a little to the winter work. In every instance the eggs were carefully hand-picked, and the strictest attention was given to all the numerous details involved in preparing, packing, and forwarding.

The number of whitefish eggs hatched at both stations, for distribution to the waters of the Great Lakes, was 92,000,000, an increase of 4,000,000. The increase in the number actually planted was, however, much greater than is shown by the latter figures, owing to the slight losses in transit, as compared with last year. The car work was highly successful, due chiefly to the employment of two cars, instead of one, as heretofore; by which additional service the accumulation and exhaustion of young fish in the tanks was prevented, the fry being disposed of while in a vigorous condition.

The whitefish eggs were carried forward in creek water, which is several degrees colder than spring water, until about six weeks prior to the hatching period. From that time forward nearly one-half the eggs were transferred at intervals to spring water, thus preventing, to a certain extent, a precipitation of the entire hatch, which would overtax the storage and shipping facilities.

The lake-trout work was more than three times that of any preceding year. The number of eggs received was 1,475,000; from which number, 1,031,000 were shipped and 115,500 fish hatched; of the latter, 75,500 were distributed and 40,000 retained at the station.

Heretofore the supply of lake-trout eggs was drawn from the big reef of central Lake Huron, but as the fishing was very light on these grounds the past season, new territory was worked with much better success than formerly. Most of the supply was obtained from the fisheries operated from Thompson, Mich., on the north shore of Lake Michigan. This is one of the best points on the lakes for securing the spawn of this species. The spawning season begins in the last week of October and continues nearly a month. The other source of supply was the island shoals of Thunder Bay and vicinity. The runs occur very early here, beginning about September 25 and ending about October 10. The Thompson eggs were received at Northville in good condition, being forwarded in cool weather by regular line of steamers to Saint Ignace, thence transferred to regular lines for Detroit, where they were met by messenger. The Thunder Bay eggs arrived at Northville in fair condition, though not so good as those from Lake Michigan, the weather at this time being some warmer. The water was also warm and the eggs advanced rapidly, those retained at the Northville Station hatching in December.

The number of brook-trout eggs taken at Northville was 225,000, but these were not of the best quality, and a considerable percentage died soon after being placed in the hatching boxes. One hundred and seventy thousand eggs were shipped, of which 25,000 were exchanged for an equal number from the Paris Station of the Michigan commission. The latter were hatched and most of them retained at Northville for the purpose of introducing new stock and crossing with the old, the vigor and vitality of which have become impaired through a long term of interbreeding.

Additional new stock, in the form of wild trout, was placed in the Northville ponds in the month of June. These fish, 305 in number, chiefly yearlings and two-year-olds, were taken from Deer Creek and Boyne River, Charlevoix County, Michigan.

The rainbow-trout work was much less satisfactory than that with the brook trout; 167,000 eggs were taken, from which number, 5,000 were shipped and 30,000 fry hatched, while the remainder of the eggs died in the hatching boxes.

On account of the continued partial failure in the returns from this species, I would recommend that the stock on hand be distributed, and their propagation at the Northville Station be discontinued. At present about one-half of the water supply and pond facilities is devoted to rainbow trout, the returns from which are meager and unsatisfactory.

By supplanting them with brook trout and German trout, or by concentrating the divided forces on one line, the aggregate results would be greatly increased.

A few of the German trout, from stock raised from eggs received at Northville in the spring of 1883, spawned last December. In all, 8,000 eggs of prime quality were taken. In addition, two consignments of these eggs were received from Fred Mather. The first lot, 10,000 in number, arrived on March 25, in good condition; the second lot, 13,000 in number, on April 23, in very poor condition, about one-half having hatched *en route*. The stock fish of this species in the Northville ponds show a better and more uniform growth than our brook trout, and promise exceedingly well.

A case of 29,000 eggs of landlocked salmon was transferred from Grand Lake Stream, Maine, arriving on March 19 in fine condition. The hatching percentage was very good, but there was considerable loss on fry. Total number of fry distributed, 22,000.

The distribution of stock fish from the ponds of the Northville Station was successfully carried on during the past spring, chiefly by car No. 2, the remainder by special messengers. The fish thus disposed of were yearling and two-year-old brook and rainbow trout. The number disbursed to each applicant or locality was small as compared with the usual assignments of fry, but the relative importance of the distribution should not on this account be underestimated. The measure of results, I am thoroughly satisfied, will be a hundred-fold greater. Time will prove—if, indeed, it has not already done so—the wisdom of the plan of using fish not less than a year old for stocking new waters.

During the fall and winter 4,000 carp from the national ponds at Washington were forwarded, on orders, to applicants; also 85 goldfish.

A few thousand eggs of German whitefish, and about the same number of smelt, were forwarded to Northville by Fred Mather last spring, but they were in very poor condition and few hatched. The final results were purely negative, as the young fish soon died.

Two new ponds, each 10 by 40 feet, were added to the plant of the Northville Station during the first two months of the fiscal year, and two others were subdivided into sections, thus affording more perfect isolation of the various sizes and varieties in stock.

WHITEFISH.

In submitting this report of the operations in the whitefish department I am gratified to announce that the past season has been abundantly fruitful of good results in the three important divisions into which successful propagation naturally divides itself, namely, first, collection of spawn; second, hatching of same; third, distribution of fry.

During the months of November and December upwards of 100,000,000 whitefish eggs were received at Northville Hatchery and 68,000,000 at Alpena Hatchery, a satisfactory increase over the work of last season. The eggs shipped to Northville were taken principally from the island region of western Lake Erie, and at Monroe, Mich., from penned fish. Later in the season, however, 16,000,000 of the eggs taken in at Alpena were repacked and shipped to Northville, as better facilities for shipping are obtainable at the latter place. The first eggs were received from the spawning beds of Lake Erie on November 11, and the last on December 7. The general plan of operations in the manipulation of spawn and the treatment of fry varies so little from preceding years that it is unnecessary to dwell at length upon this department of the industry. Eggs commenced hatching at Northville on March 7 and ended on April 20, thus showing an average period of incubation of one hundred and twenty-five days. The temperature of water varied from 32° to 43° Fahr., averaging 34¼°. The water used for whitefish eggs at Northville was pumped from a small river near the hatchery; that used at Alpena was drawn from Thunder Bay. The hatching season at Alpena was about a month later than at Northville. The period of spawning in the waters of Lakes Huron and Michigan varies considerably from that of Erie, but the great bulk of eggs are taken at the same time, consequently the busy season at Alpena commences about the same time as at Northville. There are several localities in the waters of Lakes Huron and Michigan where eggs are taken for Alpena Station, but at least 75 per cent are and obtained at Miller's Point and Alcona, in Lake Huron, and Epoufette and Thompson, in Lake Michigan.

The season's shipments of eggs were made principally during the months of December and January, as shown in the following tables, to several States and Territories, the District of Columbia, England, Germany, Switzerland, and New Zealand by way of California, this last covering a distance of nearly half around the globe.

BROOK TROUT.

The brook-trout work this season may be considered fairly successful, although it would scarcely be a favorable comparison with that of the past few seasons. In all, 225,000 eggs were obtained; from which number, 145,000 eggs were shipped, and 25,000 fry hatched, 4,000 of which were shipped during April and May, as follows:

W. S. Woodward, Plymouth, Ind	1,000
J. S. Little, Niles, Mich	1,000
Rev. Father Maher, Notre Dame, Ind	1,000
C. H. Bates, Lake Station, Mich., for F. and P. M. R. R	1,000

The remaining fry have been kept to replenish ponds from which yearlings and two-year-olds have been distributed. The first eggs were taken from a two-year-old on October 16. The fish continued to spawn till December 31, on which date 400 eggs were taken from a two-year-old, which closed the spawning season.

Fifty-five thousand five hundred eggs were taken from 272 spawners one year old, an average of 204 from each; 79,400 eggs from 269 spawners two years old, an average of 295; 90,100 from 137 spawners three years old, an average of 657. On December 31, 25,000 eggs were shipped to W. D. Marks, superintendent Michigan commission, Paris, Mich., in exchange for an equal number of same species which were hatched at Northville Station and mostly retained for breeding purposes. In connection with this may be mentioned the taking of 305 yearling and two-year-old wild trout in the month of June from the streams of Northern Michigan and successful shipment of same to the Northville Station.

The following table shows the date, number of eggs taken from females of different ages, and number of males used:

ONE YEAR OLD.

Date.	Male.	Female.	No. of eggs.	Date.	Male.	Female.	No. of eggs.	Date.	Male.	Female.	No. of eggs.
1885.				1885.				1885.			
Oct. 22	4	1	200	Nov. 4	12	12	2,200	Nov. 15	9	9	1,700
27	12	8	2,000	5	21	21	4,000	20	13	13	2,000
28	13	9	2,000	6	20	18	3,600	25	7	6	1,200
29	13	14	2,400	7	6	6	1,400	30	4	4	1,000
30	20	20	3,800	9	13	13	2,500	Dec. 10	3	3	800
31	18	18	3,700	10	18	18	4,400				
Nov. 1	8	5	1,900	11	10	11	2,300			272	55,500
2	11	11	2,800	12	2	2	600				
3	24	24	4,200	13	26	26	4,800				

TWO YEARS OLD.

Date.	Male.	Female.	No. of eggs.	Date.	Male.	Female.	No. of eggs.	Date.	Male.	Female.	No. of eggs.
1885.				1885.				1885.			
Oct. 16	1	1	800	Nov. 4	4	4	900	Nov. 19	16	18	5,400
20	1	1	600	5	7	6	1,500	20	18	18	4,800
21	2	1	400	6	4	4	1,400	21	19	19	5,000
24	2	1	200	7	10	9	3,200	22	1	1	400
25	5	4	800	8	3	2	700	23	1	1	200
26	1	1	200	9	19	17	5,600	24	19	19	7,200
27	6	4	500	10	12	11	3,000	25	5	5	1,400
28	3	2	600	11	15	15	4,600	26	6	6	1,600
29	3	3	800	12	14	14	3,500	27	1	1	400
30	2	1	400	13	13	13	3,200	Dec. 18	9	9	3,500
31	1	1	300	15	5	5	1,400	31	1	1	400
Nov. 1	2	2	800	16	15	15	4,600				
2	5	5	1,200	17	13	13	3,200			269	79,400
3	4	4	1,600	18	12	12	3,100				

THREE YEARS OLD.

Date.	Male.	Female.	No. of eggs.	Date.	Male.	Female.	No. of eggs.	Date.	Male.	Female.	No. of eggs.
1885.				1885.				1885.			
Oct. 17	1	1	1,500	Nov. 1	6	6	5,000	Nov. 16	1	1	300
18	1	1	1,500	2	4	4	3,400	18	4	4	1,600
19	2	1	1,400	3	5	3	2,600	20	14	14	6,400
20	2	2	2,000	4	5	4	4,300	21	6	6	3,800
21	3	2	1,700	5	4	4	2,400	23	1	1	600
22	4	1	800	6	7	7	4,000	24	1	1	800
24	2	1	1,600	7	9	9	5,800	26	2	2	1,600
25	2	1	600	8	5	4	3,400	28	1	1	400
26	5	3	2,200	9	7	6	2,800	Dec. 4	2	2	1,200
27	8	7	2,800	10	4	4	2,200	7	1	1	800
28	5	4	3,200	11	7	7	4,200	11	1	1	1,600
29	3	2	1,200	12	7	7	3,200				
30	3	3	2,000	13	4	4	2,000			137	90,100
31	2	3	2,200	15	2	2	1,000				

Total, 225,000.

RAINBOW TROUT.

The following table shows the dates of spawning, and number of fish spawned and eggs taken:

Date.	Male.	Female.	No. of eggs.	Date.	Male.	Female.	No. of eggs.	Date.	Male.	Female.	No. of eggs.
1885.				1886.				1886.			
Dec. 29	1	1	900	Feb. 17	2	2	1,600	Mar. 22	4	4	1,500
1886.				18	2	3	3,000	23	7	7	3,000
Jan. 1	1	1	900	20	1	1	400	24	4	4	1,200
3	3	2	2,000	21	2	2	1,200	25	3	3	1,200
5	1	1	600	22	6	6	3,400	26	9	9	4,000
6	1	1	700	23	8	8	3,300	27	6	6	2,000
8	1	1	300	24	10	10	5,400	28	2	2	300
11	1	1	200	25	3	3	400	29	5	5	2,100
12	3	3	1,600	26	2	2	700	30	6	6	2,300
13	3	2	800	27	3	3	1,800	31	7	7	3,000
14	2	1	600	Mar. 28	2	2	700	Apr. 1	3	3	1,200
15	1	2	1,200	1	2	2	1,200	2	5	5	2,100
16	2	2	1,800	2	3	3	1,300	3	3	3	1,000
17	1	1	800	3	5	5	2,200	5	2	2	700
20	4	4	3,000	4	5	5	2,800	8	2	2	600
27	6	5	3,400	5	11	11	3,900	9	9	10	3,300
28	2	2	1,000	6	14	14	5,600	10	5	5	1,600
30	1	2	1,800	7	3	3	1,200	11	2	2	700
31	1	2	800	8	11	11	5,300	13	3	3	900
Feb. 1	1	1	600	9	8	8	3,200	14	6	6	2,700
4	1	1	400	10	16	16	6,700	15	3	3	1,100
5	2	2	1,000	11	8	8	2,800	16	4	4	1,800
7	1	1	300	12	17	17	5,400	17	6	6	1,700
8	3	4	3,200	13	5	5	2,200	18	2	2	600
9	2	2	1,100	14	5	5	1,900	20	2	2	600
10	3	3	1,400	15	6	6	2,500	21	2	2	600
11	7	9	5,300	16	3	3	900	22	2	2	400
12	2	1	800	17	12	12	5,200	23	3	3	800
13	2	1	800	18	5	5	1,800	24	1	1	200
14	3	3	1,800	19	3	3	1,500	25	1	1	200
15	2	2	1,200	20	2	2	1,000				
16	1	1	300	21	6	6	2,500	Total	375	377	167,000

The eggs turned out very poorly, only 35,000 being saved, of which 3,000 were shipped to B. F. Ferris, Castalia, Ohio, and 2,000 to S. B. Smith, Zanesville, Ohio. The remaining 30,000 hatched; but a large percentage of the young fish died within six weeks, despite the greatest care and attention. Not more than 5,000 survived the critical period of trout raising, namely, the first three weeks after the absorption of the food-sac. The continued meager returns from this variety of trout scarcely justifies a continuance of this branch of the service at the Northville Station. It would seem that the species will not acclimatize to the waters of this station, notwithstanding the special effort that has been made for a number of years to bring about this result. The waters are well adapted to brook trout, and it would seem to be a wise policy to displace the rainbow trout by the brook trout as soon as possible.

LAKE TROUT.

The season's work in this species has been unprecedented in the history of the hatchery, having received nearly one and one-half million of eggs from the spawning grounds of Lake Huron, in the vicinity of Alpena on Thunder Bay, and Epoufette and Thompson on Lake Michigan. The eggs were taken by Superintendent S. P. Wires and assistants, of the Alpena Hatchery, all of whom have had several seasons' experience in spawn gathering, thus insuring care in the collection and forwarding.

The first eggs were taken about the first of October, the fish continuing to spawn into November. During the latter part of October and the first part of November the eggs were shipped by boat to Detroit, thence by rail to Northville, with scarcely any loss in transit of the many shipments, showing good work on the part of packers and dispatch by carriers. The season was not marked by any noteworthy changes in the methods of hatching, having failed by various experiments in finding one more satisfactory or successful than that used in preceding years. During the winter and spring 1,031,000 eggs and 75,500 fry were shipped to various points in this and foreign countries, and 40,000 fry were retained at the hatchery, making a total of 1,146,500 eggs and fry successfully handled.

More eggs were taken at Thompson, Mich., on the north shore of Lake Michigan, than at any other point, although this was the first attempt in that region. E. A. Tulian, who had charge of the collection in that section, writes as follows: "The first trout eggs were taken at Thompson on October 31. The fish had then just commenced to spawn. At this time only the small trout on the inside grounds were spawning. The large trout on the outside grounds commenced spawning November 10, and were still spawning freely when the work closed on November 21. We collected during this time nine cases of eggs, all taken from fish caught by two tugs."

LANDLOCKED SALMON.

On March 19 a case containing 29,000 eggs of this species was received at this station from Charles G. Atkins, of Grand Lake Stream, Maine. Only 100 dead eggs were picked out when unpacked, having come this long distance in exceptionally fine condition. They were immediately transferred to the hatching boxes, in which they remained till after hatching. April 8 they commenced to hatch, and were all through by the 14th. From the time of transfer to hatching boxes till all were hatched only 475 dead eggs were taken out. The fry were transferred from boxes to nursery tanks into water varying in temperature from 38° to 50°. On April 27th 10,000 fry were shipped in U. S. Fish Commission car No. 2, to the township of Hayes, Clare County, Mich., and planted in a small lake, the headwaters of Cedar River, with only a nominal loss in shipment. The 12,000 fry delivered to Mr. Eli Tinlin, agent of the Michigan Fish Commission, on May 15, were planted the day following in Rapid River, tributary to Torch Lake, Kalkaska and Antrim Counties, Michigan.

THE BROWN, EUROPEAN, OR GERMAN TROUT.

A few of the German trout reared at the Northville Station spawned in December, and about 8,000 eggs of very good quality were obtained. Two cases of eggs of the same species were forwarded to Northville by Fred Mather. The first lot, consisting of 10,000, came in good condition; the second lot, 13,000 in number, arrived in very poor condition, being too far advanced when shipped. The total results from the above amounted to 20,000 fry, which were retained at the station.

Temperature of river water used at Northville Station for incubating whitefish eggs, from November 25, 1885, *to April* 15, 1886.

Date.	8 a. m.	12 m.	5 p. m.	Date.	8 a. m.	12 m.	5 p. m.	Date.	8 a. m.	12 m.	5 p. m.
	°	°	°		°	°	°		°	°	°
Nov. 25..	36	36	36	Jan. 12..	32	32	32	Mar. 1..	32	32	32
26..	36	36	36	13..	32	32	32	2..	32	32	32
27..	36	36	36	14..	32	32	32	3..	32	32	33
28..	36	36	36	15..	32	32	32	4..	32	34	38
29..	35	35	35	16..	33	33	33	5..	32	35	39
30..	35	35	35	17..	32	32	32	6..	32	34	41
Dec. 1..	35	35	34	18..	32	32	32	7..	32	38	38
2..	34	34	34	19..	32	33	32	8..	33	37	38
3..	34	34	33	20..	32	32	32	9..	33	34	35
4..	33	33	33	21..	32	32	32	10..	32	38	40
5..	33	33	33	22..	32	32	32	11..	32	39	40
6..	32	32	32	23..	32	32	32	12..	34	35	40
7..	32	32	32	24..	32	32	32	13..	34	36	40
8.	32	32	32	25..	32	32	32	14..	33	36	39
9..	32	32	32	26..	32	33	32	15..	33	36	39
10..	32	32	32	27..	33	33	34	16..	33	35	37
11..	32	32	32	28..	33	34	34	17..	33	34	38
12..	32	32	32	29..	33	33	34	18..	34	35	38
13..	32	32	32	30..	32	33	33	19..	34	38	41
14..	32	32	32	31..	32	32	32	20..	36	39	40
15..	32	32	32	Feb. 1..	32	32	32	21..	34	35	35
16..	32	32	32	2..	32	32	32	22..	32	33	33
17..	32	32	33	3..	32	32	32	23..	32	34	38
18..	33	35	33	4..	32	32	32	24..	33	36	41
19..	32	34	33	5..	32	32	32	25..	37	38	43
20..	32	32	32	6..	32	32	32	26..	42	43	43
21..	32	36	35	7..	32	32	32	27..	37	37	41
22..	32	34	34	8..	32	33	33	28..	32	34	43
23..	34	34	34	9..	32	34	36	29..	34	39	43
24..	32	32	33	10..	33	35	36	30..	39	40	42
25..	32	32	32	11..	34	36	36	31..	38	38	41
26..	32	32	32	12..	32	33	32	Apr. 1..	36	36	35
27.	32	32	33	13..	32	32	32	2..	33	36	38
28..	33	35	34	14..	32	32	32	3..	32	35	42
29..	34	35	35	15..	32	32	32	4..	34	38	41
30..	36	37	37	16..	32	32	32	5..	34	39	40
31..	37	37	36	17..	32	32	32	6..	35	33	32
Jan. 1..	35	36	38	18..	32	32	34	7..	33	33	33
2..	34	35	37	19..	32	33	32	8..	32	34	36
3..	38	38	40	20.	32	32	32	9..	32	35	37
4..	42	42	42	21..	32	32	32	10..	34	36	38
5..	34	34	34	22..	32	32	32	11..	37	40	44
6..	32	32	32	23..	32	33	33	12..	44	45	47
7..	32	32	32	24..	32	34	38	13..	49	48	48
8..	32	32	32	25..	35	33	32	14..	51	49	52
9..	32	32	32	26..	32	32	32	15..	55	52	52
10..	32	32	32	27..	32	32	32				
11..	32	32	32	28..	32	32	32				

Temperature of spring water used at Northville Station for incubating trout eggs, from November 25, 1885, to April 15, 1886.

Date.	8 a. m.	12 m.	5 p. m.	Date.	8 a. m.	12 m.	5 p. m.	Date.	8 a. m.	12 m.	5 p. m.
	°	°	°		°	°	°		°	°	°
Nov. 25....	40	40	40	Jan. 12...	39	39	40	Mar. 1...	39	42	42
26....	40	40	40	13...	39	40	40	2...	39	41	42
27....	41	41	41	14...	39	41	40	3...	39	43	44
28....	39	40	40	15...	40	41	41	4...	42	45	47
29....	39	39	40	16...	42	42	41	5...	44	47	49
30....	38	39	39	17...	38	39	39	6...	44	47	50
Dec. 1....	38	39	39	18...	40	41	41	7...	46	50	50
2....	38	38	38	19...	41	40	40	8...	46	48	49
3....	37	38	38	20...	39	40	40	9...	44	45	45
4....	37	37	37	21...	39	39	42	10...	42	47	47
5....	36	37	36	22...	39	40	40	11...	43	46	47
6....	36	36	36	23...	37	39	40	12...	44	47	48
7....	36	37	38	24...	39	40	42	13...	45	46	48
8....	38	38	40	25...	40	41	42	14...	44	48	49
9....	39	41	40	26...	42	43	43	15...	43	46	49
10....	39	40	39	27...	42	44	43	16...	45	48	48
11....	38	39	39	28...	42	42	43	17...	46	46	48
12....	39	40	38	29...	42	42	43	18...	46	47	48
13....	40	40	40	30...	40	41	42	19...	46	48	51
14....	39	39	39	31...	38	39	39	20...	48	51	51
15....	38	39	39	Feb. 1...	39	40	40	21...	46	47	46
16....	40	41	42	2...	38	36	36	22...	43	45	44
17....	42	43	43	3...	38	38	38	23...	41	46	46
18....	44	45	43	4...	38	40	40	24...	44	49	50
19....	41	42	43	5...	39	39	39	25...	40	48	49
20....	39	41	40	6...	39	40	41	26...	45	51	51
21....	41	44	41	7...	41	43	44	27...	46	47	48
22....	47	47	44	8...	42	45	45	28...	43	44	48
23 ...	47	48	47	9...	42	46	47	29...	44	48	49
24....	44	44	47	10...	45	46	48	30...	46	49	49
25....	42	42	42	11...	46	49	49	31...	46	47	48
26 ...	40	41	40	12...	47	47	47	Apr. 1...	46	46	47
27....	40	41	41	13...	47	47	46	2...	42	46	44
28....	42	45	41	14...	45	45	44	3...	41	47	48
29....	44	45	45	15...	43	44	43	4...	43	48	48
30....	46	46	46	16...	36	37	38	5...	43	48	48
31....	46	46	46	17...	39	43	42	6...	40	36	36
Jan. 1....	45	45	45	18...	40	44	46	7...	37	40	44
2....	44	44	45	19...	45	45	44	8...	42	46	50
3....	46	47	48	20...	34	36	38	9...	46	49	51
4....	49	50	49	21...	36	37	37	10...	49	51	51
5....	44	44	44	22...	38	40	40	11...	49	50	51
6....	36	37	38	23...	42	44	45	12...	49	51	53
7....	39	40	40	24...	41	45	48	13...	50	52	53
8....	39	39	39	25...	46	45	42	14...	49	55	58
9....	38	38	38	26...	36	38	39	15...	52	55	56
10....	38	38	38	27...	39	42	43				
11....	38	38	38	28...	39	42	42				

NORTHVILLE, MICH., *August* 14, 1886.

VIII.—REPORT OF OPERATIONS AT THE U. S. SALMON AND TROUT STATIONS ON THE McCLOUD RIVER, CALIFORNIA, FOR THE YEAR 1885.

By Livingston Stone.

SALMON.

Everything at this station remains in very much the same condition as at the close of my last report, active operations not having been carried on here during this year.

All parties agree in reporting a very small run of salmon in the river this year. Indeed, salmon appear to have been scarcer than ever before in the McCloud River. This scarcity was probably caused partly by the illegal small-mesh fishing of the Chinese and Portuguese in the Sacramento, partly by the great number of sea-lions at the mouth of the Sacramento River, and partly by the great draft upon the salmon supply which is made by the numerous canneries on the river.

The effect of these destructive agencies upon the supply of salmon in the river was not felt so long as it was being offset by artificial propagation; but now that this has been suspended or nearly suspended for two or three years, the diminution of salmon in the Sacramento is becoming alarmingly apparent, and unless something is speedily done on a large scale, in the way of hatching salmon and placing them in the Sacramento or its tributaries, the river will soon be depleted of its most valuable fish.

TROUT.

After the date of my last report (October 1, 1884) nothing of special interest occurred at the United States trout-breeding station on the McCloud River until about Christmas time, when one of those terrific rain-storms peculiar to the west slope of the Sierra Nevada range visited the McCloud River. It rained in such torrents and the river and trout-pond creek rose so rapidly as to cause considerable alarm for the safety of the trout and the station. Mr. Green, the superintendent of the station, in a letter written on the spot, speaks of the storm as follows:

"*December* 25, 1884.—It has rained all the time since I wrote you before, and indications are of another flood. The water in the river is getting up near the house, the large rocks in front are all covered, and great trees, root and branch, are passing every minute. The creek runs through one corner of the hatching-house. We have not shut our eyes for two days and nights, and to-night will be much the worst of any yet. We—my brother, myself, and two men—have been out in the pouring rain all day, and this afternoon, as I write, at 3 o'clock, have managed to save everything, with the exception of one trap and perhaps one boat. The traps are all some ten feet under water, but, as far as I can see, are still there. There is also one boat—one of the small ones—that we cannot get to. I do not know whether it is gone or not. It is very dangerous crossing the creeks, especially after dark. The water comes into the pond thick with mud; the fish all seem very uneasy, and are jumping continually, but I think they are all right as yet. One of our best dogs attempted to cross the creek this afternoon on a log, but for some reason slipped off and fell into the water, when he was immediately taken under and carried to the river. He kept his head up for about a mile. We started down the bank as fast as we could run, but could not keep in sight of him, and the last we saw he was sinking. Should the rain continue hard until to-morrow morning, it will reach the high mark made in 1881. Since commencing this letter the river has risen a foot. I will write more in the morning. Expect a very severe night, as the ponds require our constant attention.

"*Later* (*midnight*).—It is still raining, but not so hard. The water has been at a standstill since 10 p. m. The water in the ponds is thick with mud, and the fish are all gathered under the fall where it pours in. I am running as little water through the ponds as possible to-night, so as to keep out all the mud I can. The creek is fearfully high, but as yet I think the trap is safe, although it is impossible to be sure. I have never seen the McCloud so high except once before, and that was in the flood of 1881.

"*Later* (*December* 26, 9 a. m.).—It began raining harder about 2 a. m., and continued until nearly daylight; but since light, although it has been very dark and cloudy, it has not rained. The creek keeps about the same, but the water in the river has fallen two feet or more, so I think the danger of a flood is passed. The ponds are about six inches deep with mud, and we are now busy getting it out. Some eight or ten trout have died, but the rest look well, and just as soon as the water gets clear I shall take some eggs. Should have overhauled the fish before this had the weather been good; but being as it was, I dared not take eggs, for they would all have died at once when the mud struck them. We shall get no mail now for several days, as no boats can cross the river."

The worst of the storm was over by the next day, and on the day following (December 27) the spawning season began with the taking of 15,000 eggs. This storm was succeeded by one of the driest winters ever known in Northern California. This was unfavorable to the taking of eggs, because it kept the river trout from running up the creeks to spawn, so that very few spawning trout were caught in the traps, of which Mr. Green had several in the creeks; and, besides this, it brought the spawning season to a sudden and very unexpected close in March, only 12,300 eggs being taken after the 1st day of April. A total, however, of 313,600 eggs was secured during the season, which appears to be very creditable, considering the circumstances.

One lot shipped to Washington was frozen in transit, but the temperature that week at various places on the overland route was 27° below zero, which, with some possible lack of attention on the part of the agents of the express company, readily accounts for the disaster.

In speaking of this shipment, Mr. Green says: "They were the best eggs ever taken here, and I got splendid moss and packed them with great care myself. I then made nice crates, exactly as always before, and had ice put on them in Redding; sent them from here to Redding on a spring wagon. The first lot was shipped in two crates. The box the eggs were in was 15 inches square and 7 inches high, and I made the crates 22 inches square and 2 feet high. The second box was 14 inches square and 7 inches wide, and crate 21 inches square and 2 feet high. They were one inch larger than I generally make them."

It accordingly appears that Mr. Green took sufficient care to get this lot of eggs through safely in ordinary weather, but the extreme cold on the way would freeze eggs in any kind of packing, if exposed to it, which was probably the case with this lot. The eggs generally, which were sent East, arrived, with the above-mentioned exception, in good order, as the following letters to Mr. Loren W. Green indicate:

"I am in receipt of your letter of the 9th announcing the transmission of an additional supply of trout eggs. It gives me pleasure to find the station so productive this year and to receive the eggs in such good condition. With the exception of the first lot, which was comparatively worthless, nearly everything has come to hand in an entirely satisfactory condition." [SPENCER F. BAIRD.]

"The trout eggs came safely to hand here on the 31st of March, and were immediately shipped to the hatchery at Allentown. The superintendent reports them in good order. Only 224 out of the 10,000 were dead, which, considering the circumstances, we think very good." [A. M. SPANGLER, Philadelphia, Pa., April 3, 1885.]

"I am very sorry you could not send us the full complement of eggs. They came through very nicely, and were in excellent condition, and I do not think there were twenty dead ones in the lot. Your mode of packing cannot be excelled." [OTTO GRAMM, Laramie City, Wyo., April 7, 1885.]

A circumstance occurred during the spawning season sufficiently extraordinary, I think, to entitle it to a brief notice here. It is a singular fact that the central line of the total solar eclipse of March 16, 1885, passed within six miles of the trout-breeding station. Mr. Green wrote to me of it, and of the singular manner in which the Indians took it, as follows:

"*March* 17, 1885.—Our weather is still hot and very dry. Not a cloud has been seen the past two weeks, and there are no signs of rain. Yesterday was the day of the great eclipse of the sun, and it was the grandest sight I ever saw. The moon crossed the sun between 8 and 9 a. m., and it was dark as evening. I stood on the bank of the McCloud, just as near the line as possible. The water in the river showed the colors of the rainbow, and trees that stood near the water, their shadows reflecting back in the water, looked as though their limbs were edged with all the different colors. I never expect to see anything half so beautiful again. Just before the eclipse I happened to go over the river, and there were six of the old Indians gathered together, Old Kloochy among them. I told them it was going to be dark pretty soon, and they all laughed and said, "Chipealla" (bad), but I persuaded them to come up on the flat near the river and wait a little while. Then I told them to watch the sun and it would soon grow dark. I had some smoked glass, and could already see the black moon very plainly. They were all jabbering away, laughing and having a great time, but very soon it commenced growing visibly dark, and they noticed it. Then their fun was over. They were all very quiet for awhile and watched the sun closely. It grew dark very rapidly, and the first thing I knew they were all on their feet, and had begun to dance and scream, and of all the noises I ever heard they made the worst. They said they were all going to die. Very soon I noticed a change in them. They all stopped and talked very fast for a moment. Then two of them started for the house. It was dark as evening. Pretty soon they returned, bringing all their bows and arrows, flints, beads, and almost everything they had. Then they took the oldest squaw and laid her out as though she was dead; placed the trinkets all around her, and then began that awful cry and wail again. By this time the eclipse was passing away, and I told them it would soon be light again. It kept growing lighter and lighter. Soon the sun was clear again, and although they let the old woman up, it was some time before they would believe they were going to live."

The weather continued warm and very dry till the last eggs were taken, which was on the 29th of April.

During the summer several improvements were made about the station, the principal of which was an addition to the dwelling-house, which was very much needed, the original house being small, unfinished, and made chiefly of shakes.

Towards the latter part of the summer the trout were observed to be dying, both in the pond and in the McCloud River. There was no apparent cause for it, and it was hoped at first that it was only a temporary trouble,* caused by something unwholesome in the water, the

*See F. C. Bulletin, 1885, p. 472.

streams being very low; but it did not pass away, and on October 5 Mr. Green wrote me that the trout were continuing to die and that the disease was as destructive in the river as in the ponds. Some of the features of this singular mortality among the fish are presented in the following letters from Mr. Green:

"I have some five or six large trout now in a pond by themselves, which have showed no signs of life, save their breathing, for the past five days. They lie perfectly still on their sides, and when disturbed or taken from the water they seem to shake or quiver, and will splash around quite lively for a moment, then lie back on the bottom and remain perfectly still for days; and while keeping so quiet, sediment from the water gathers in their gills. They sometimes linger for six or eight days, just in this way. It is my opinion that the disease was brought to our ponds by the fish caught in the river. Our fish were all perfectly healthy until we commenced fishing this fall; we lost but very few fish during the summer, and they were all fat and nice. The first I noticed were those dying in the river, and I also noticed that some of the fish that died first in our ponds were those lately put in. I have examined a number of those dying in the river, as well as those from the ponds, and all that I can find is that the stomachs seem hard and drawn up, and that in some of them there is a yellowish fluid around the heart. The first symptom of the fish, before taken, is that it turns a very dark color. I can now tell some three or four days in advance those that are going to be taken with it, for they turn so dark. The fish seem in no pain; only seem stupid. I have seen hundreds of trout die from old age or from fungus, bruises, or something of that kind, but I never saw a trout sick before that would lie on the bottom. They almost invariably keep near the top and keep falling back against the back screen; but not so with these; they are strong until they die. I wish I could send you one for examination. I think hereafter I shall never mix again the trout caught in the river with those wintered in our ponds, for it is almost certain to me that the disease is one that is catching, and was brought from the river. What seems more sure than anything else is that I have one pond containing nothing but large females. It is the new pond, or last one made. Water runs in it directly from the flume before running over any other fish. I wished to keep the females separate, and for this reason have put no other fish in this pond at all, and strange to say, the fish in this pond have not been troubled.

"Our small fish have also suffered but little. However, the loss has been very heavy, and unless we have unusually good luck with our traps I am afraid we must fall short somewhat of our usual amount of eggs.

"We are fishing now every day and having fair luck, and, had we not had this loss, would have taken a splendid lot of eggs. The water in the river is much lower than I have ever known before, and the snow on Mount Shasta seems greatly reduced. The river has been of a milky, muddy color all summer long, until about a week ago the weather got cool, and it is now clear. The temperature of the water while the trout have been dying has been 58 or 60 degrees Fahr.

"There is not a salmon to be seen in the river, and there have been but very few fish up here at all. I have kept a very close watch on them, and have tried in all ways to get eggs to fish with for bait, but have succeeded during the whole season in getting the eggs from only five salmon. The last reports from Hat Creek were that there were no salmon there yet."

"*September* 15, 1885.—Our weather is still hot and very dry, and our water supply is very low. Our fish have been dying considerably lately, from what cause I cannot tell. I have taken great pains with them, and they look splendidly. They are all fat. The first we notice of their being sick we find them lying in the ponds on their sides, with not a mark of any kind; great, large, bright fish, and they are fat as can be. They refuse to eat perhaps a day before they are taken; up to that time they eat heartily. Some of them seem to cramp and their bodies will be crooked, and it is almost impossible to straighten them. They lie in the ponds in this way, breathing faintly for three or four days, and then die. It is something never known here before. I have given them quantities of earth, salt, and everything I could think of, but to no account. It attacks only the large fish. I have one pond of two-year-old trout, that has five hundred or so in it, which has not been troubled at all. Fish in the river are just the same. I found three large trout this morning lying in the bottom of the river, not any of them dead. I went up and caught them, and after rousing them they would swim off a short distance and then turn on their sides. The water has never been so low by half since we were here. I thought once I should be obliged to build ponds in the river, but that would have caused a great loss of fish, as it is almost impossible to build a wall along the river secure from minks and otters, and they are very plentiful here. I am afraid our egg supply will be rather short next winter. Fish in the river are very scarce. I have been fishing the past four or five days and have caught only two large trout. Can catch plenty of small ones, but they will not spawn this season."

"*September* 18, 1885.—The trout still continue to die, and from what cause I cannot tell. I have just taken out eight very large, fat trout, with not a single spot on any of them. Their eyes and gills are perfectly healthy and the females are full of eggs. It is something never known before here, and it has caused a great loss of fish. For two or three days after they are taken they lie on their sides and do not move unless touched. If taken from the water they tremble and quiver. I am doing the best I can to save those not yet sick. Strange to say, none but the very large fish are troubled. The yearlings and two-year-olds are perfectly healthy. I sometimes think they were poisoned by some one, yet I have no idea who could have done such a thing."

"*September* 23, 1885.—Since I last wrote, there has been no great loss of life. I got up very early one morning, I think the next after I wrote you, and went to the ponds, and there were several in each pond lying on their sides, but they were not dead. I got them all up, and then cut some fresh venison up fine and soaked it in lard and fed it to the fish that would eat, and since that they seem to have brightened up wonderfully, and I think now the danger is mostly passed. The only cause that I could find for their dying was in their stomach. There was not a single spot on any of them; eyes were bright and gills perfectly natural, and they were all fat fish, but their stomachs seemed hard and drawn up. The fish that died I think suffered but little. They would be taken suddenly, and perhaps for one day would lie on the bottom very still, but right side up, then the next day they would lie on their sides, but breathe rather more quickly than was natural. If disturbed, they would swim a short distance as though all right, only some of them seemed cramped, and their heads were crooked to one side. They would remain in this state sometimes three or four days, and then die. Our water supply seems a little on the rise now, and the remaining fish look splendidly, and I think now with good care we shall bring the rest through. Our young fish are in good condition and we have just added a nice lot—75 yearlings and two-year-olds—to our ponds. Fish in the river are very scarce; we have been fishing now some time, but have only succeeded in capturing small fish. The water in the river has been very muddy all summer and is still so. We have had a loss of large fish this time that it will take some time to replace, yet, if no more die now, we can get along."

"*November* 14, 1885.—I have thought all along that as soon as the rains began there would be a change in the mortality of the trout; but it seems not. There are six in one pond this morning that refuse food and have turned the dark color, and are resting on the ground. We have been at work very hard, catching trout, and adding to our ponds from the river; but it seems of little use, as the ones caught from the river die very fast. Some of the smaller fish have died lately. Professor Baird has written that he has asked Prof. S. A. Forbes, of Champaign, Ill., to forward me a preserving fluid, and wished me to send some of the diseased specimens direct to him. Professor Baird says that Professor Forbes is preparing a general report for the Commission upon the subject of the diseases of fish. He also says that the fish of Wisconsin have died in great numbers, and that Professor Forbes had traced the disease to the immense development of bacteria, called micrococci, congesting the liver and spleen of the fish."

At present the prospect is rather discouraging for a good yield of trout eggs during the season of 1885–'86; but a considerable number of young fish are coming on, and perhaps next year's harvest may make up for the deficiencies of this season.

Appended to this report will be found memoranda from Mr. Green's diary, relating to the weather, &c., from September 24, 1884, to April 20, 1885, and tables of statistics as follows:

1. Record of trout caught.
2. Record of trout eggs taken.
3. Distribution of trout eggs.
4. Temperatures of air and water.

CHARLESTOWN, N. H., *December* 31, 1885.

Memoranda relating to the weather, &c., at McCloud River Station from September 24, 1884, *to April* 20, 1885.

Date.	Condition of weather.	Date.	Condition of weather.
1884.		1884.	
Sept. 24	Weather warm and clear.	Dec. 21	Raining very hard, with heavy wind and thunder; trees breaking down; river very high and rising fast.
26	Strong north wind and cool.	22	Raining hard; heavy wind; river 8 feet above usual summer level. In evening 10 feet above, and rising.
27	Warmer.	23	Still raining hard; water very high and muddy.
28	Quite warm.	24	Raining slowly all day; water at a standstill; very high and river full of logs; water in the ponds clearing, and fish looking and feeding well.
29	Do.	25	Raining very hard; water rising fast; very muddy; traps are covered and under water, and trout running over top; one trap gone out; wind blowing; trees falling on all sides; heavy tree fell across one of the ponds; no damage.
30	Raining all the afternoon.	26	Still raining; water 18 feet above low-water mark; fish running over traps.
Oct. 1	Heavy hail-storm.	27	Clear, and heavy frost; water falling fast.
2	Very cool, but clear.	28	Raining slowly, and very dark; water falling.
4	Very cool.	29	Clear, and ground frozen.
5	Do.	30	Clear and warmer.
6	Raining all day.	31	Cloudy and quite warm.
7	Do.	1885.	
8	Warmer and clear.	Jan. 1	Raining hard all day.
9	Warm and clear.	2	Clear and warm.
10	Do.	3	Warm and cloudy; no fish.
11	Do.	4	Raining hard all day; very warm; no wind.
12	Raining hard all day and cool.	5	Very cloudy; no rain; warm.
13	Raining hard; water rising rapidly.	6	Clear and warm; water falling.
14	Very dark and cloudy; no rain; water 3 feet above low-water mark.	8	Cloudy and misty; very dark; no trout running.
15	Morning clear and frosty.	9	Cloudy and warm; snow melting fast on mountains; water rising fast.
16	Clear and warmer.	10	Raining all day; creeks and river rising fast.
17	Morning clear and cool; evening cloudy and showery.	11	Clear and warm.
18	Cloudy and showery.	12	Clear and cool in morning; trout eggs taken advancing slowly, but doing splendidly; no dead ones.
19	Clear and warm.	13	Clear and cool.
20	Do.	15	Clear and warmer.
21	Lost 26 trout by Indians.	16	Cloudy; raining hard in afternoon; warm.
22	Had Indians arrested; weather clear and warm.	17	Clear and warm; eggs doing splendidly; no dead ones yet.
23	Weather warm.	18	Clear and warm.
24	Clear and warm.	21	No trout running; very warm, and water getting very low.
25	Do.	22	Clear and warm; trout and eggs doing splendidly.
26	Clear, warm, and very dry.	23	Heavy frost this morning; day clear and warm.
27	Do.	24	Clear, and getting dry.
28	Do.	25	Very warm; eggs doing splendidly; very few dead ones.
30	Very cloudy; south wind.		
31	Raining slowly.		
Nov. 1	Clear and warm; north wind.		
5	Cloudy and warm.		
9	Clear and hot.		
14	Clear and warm; very still.		
16	Trout biting very poorly.		
17	Clear and warm.		
26	Very warm.		
27	Beautiful day.		
28	Clear and warm; very still.		
29	Clear and warm.		
30	Cloudy and cool.		
Dec. 1	Clear and warm.		
2	Cool wind.		
6	Frost last night.		
7	Cold and clear; north wind.		
13	Very cool and windy.		
14	Very cloudy.		
15	Showery and cold.		
16	Hard snow and rain all day.		
17	Four inches of snow, and cold.		
18	Snow and rain; warmer.		
19	Trees heavily loaded with snow.		
20	Raining very hard; water rising and muddy.		

Memoranda relating to the weather, &c., at McCloud River Station, &c.—Continued.

Date.	Condition of weather.	Date.	Condition of weather.
1885.		1885.	
Jan. 26	Warm and dry; trout in ponds spawning well.	Feb. 27	Warm and dry; water very low.
27	Cloudy and warm.	28	Clear and warm.
29	Raining hard all day.	Mar. 1	Water low, and trout spawning freely in the river.
30	Cloudy; no rain.	2	Warm and clear.
31	Clear and warm.	3	Strong north wind.
Feb. 2	Raining hard; water 1 foot high; some of the trout caught had already spawned.	5	Strong north wind, and very dry.
		6	Clear and warm.
		7	Fish nearly done spawning.
3	Raining hard all day.	8	Warm and clear.
4	Forenoon cloudy and misty; afternoon clear and warm.	9	Warm, cloudy, and a little rain.
		11	Clear and warm.
5	Water falling, and quite warm.	13	Very dry.
6	Clear and very warm.	17	Very clear and hot; ground dry.
7	Clear and warm.	25	Clear, warm, and very dry.
8	Warmer, and water low.	26	Strong north wind; fish about done spawning.
9	Clear and warm.		
12	Eggs doing nicely, and fish feeling well.	27	Warm and dry.
13	Eggs doing splendidly.	30	Strong north wind.
16	Warm and dry.	31	Clear and very hot; no wind.
18	Clear, warm, and very dry.	Apr. 1	Cloudy, and north wind.
21	Raining hard all day, but very warm.	6	Very cloudy, and a little rain.
22	Quite cool: strong north wind.	8	Clear and hot.
23	Warm and pleasant.	9	Do.
25	Strong north wind.	19	Gave the fish a mud bath.
26	Trout spawning slowly; eggs doing splendidly.	20	Fish doing better; looking much brighter.

TABLE I.—*Record of trout caught at McCloud River Station during the season of* 1884–'85.

Date.	Number caught.	Date.	Number caught.	Date.	Number caught.	Date.	Number caught.
1884.		1884.		1884.		1884.	
Sept. 24	6	Oct. 10	15	Nov. 4	17	Dec. 28	16
Sept. 25	17	Oct. 11	15	Nov. 7	20	1885.	
Sept. 26	11	Oct. 16	32	Nov. 8	15	Jan. 10	3
Sept. 27	7	Oct. 17	17	Nov. 10	15	Jan. 11	13
Sept. 28	3	Oct. 18	20	Nov. 11	10	Feb. 2	15
Sept. 29	4	Oct. 24	20	Nov. 13	3	Feb. 3	7
Sept. 30	4	Oct. 27	10	Nov. 26	5	Feb. 4	4
Oct. 2	8	Oct. 28	10	Nov. 29	12	Feb. 5	3
Oct. 3	8	Oct. 29	15	Dec. 21	2	Feb 6	9
Oct. 4	3	Oct. 30	10	Dec. 22	25		
Oct. 8	14	Oct. 31	10	Dec. 23	24	Total	496
Oct. 9	8	Nov. 3	10	Dec. 25	1		

TABLE II.—*Record of trout eggs taken at McCloud River Station during the season of* 1884–'85.

Date.	Females.	Eggs.	Date.	Females.	Eggs.	Date.	Females.	Eggs.
1884.			1885.			1885.		
Dec. 27	14	15,000	Feb. 6	6	6,500	Mar. 16	10	9,100
Dec. 28	35	35,200	Feb. 10	27	25,250	Mar. 20	6	5,000
1885.			Feb. 11	10	10,200	Mar. 21	10	10,150
Jan. 2	18	16,200	Feb. 14	5	†5,300	Apr. 1	9	7,000
Jan. 5	5	*5,000	Feb. 17	21	20,300	Apr. 9	5	4,300
Jan. 10	18	18,200	Feb. 22	6	†6,000	Apr. 16	6	3,000
Jan. 15	8	*8,000	Feb. 26	10	10,200	Apr. 24	2	2,000
Jan. 20	32	30,500	Mar. 5	5	*5,500	Apr. 29	3	3,000
Jan. 24	13	12,100	Mar. 8	11	10,200			
Jan. 28	7	*7,000	Mar. 13	3	*3,200	Total	324	313,600
Feb. 2	19	20,200						

*Hatched for river. †Hatched for ponds.

TABLE III.—*Distribution of trout eggs from McCloud River Station during the season of 1885.*

Date.	Sent to—	Number of eggs.
1885.		
Jan. 14	Prof. S. F. Baird, Washington, D. C	50,000
21	......do	16,000
25	......do	18,000
Feb. 4	......do	30,000
11	......do	12,000
19	......do	20,000
25	......do	25,000
25	Gordon Land, Denver, Colo	10,000
Mar. 4	Prof. S. F. Baird, Washington, D. C	20,000
12	.... do	10,000
23	A. M. Spangler, Philadelphia, Pa	10,000
30	Otto Gramm, Laramie City, Wyo	10,000
Apr. 6	B. E. B. Kennedy, Omaha, Nebr	15,000
	Total	246,000

TABLE IV.—*Temperatures of air and water at noon at McCloud River Station during the season of* 1884–'85.

Day of month.	June, 1884.		July, 1884.		Aug., 1884.		Sept., 1884.		Oct., 1884.		Nov., 1884.		Dec., 1884.		Jan., 1885.	
	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	68	58	82	60	88	60	80	58	58	54	80	53	52	48	48	46
2	68	58	82	60	88	60	80	58	58	54	70	53	46	48	48	46
3	78	60	82	60	88	60	84	58	68	53	74	53	48	46	50	48
4	78	60	82	60	90	60	74	56	66	53	68	53	52	46	52	48
5	78	60	84	60	91	60	68	56	66	53	66	53	48	44	56	48
6	76	58	80	60	92	60	60	56	70	53	60	53	46	44	58	48
7	75	58	72	60	92	60	60	56	72	53	62	53	46	44	60	50
8	74	58	80	60	92	60	62	56	66	53	60	53	42	44	64	50
9	74	56	82	60	90	60	60	56	60	53	62	53	40	44	64	50
10	62	56	82	60	94	60	58	56	60	52	60	53	44	44	60	50
11	62	56	82	60	92	60	56	56	66	52	60	53	46	44	62	50
12	68	56	84	60	96	60	64	56	64	52	60	53	48	44	64	50
13	58	58	82	60	92	60	54	56	66	52	60	54	42	44	50	50
14	66	58	84	60	86	60	58	56	58	52	58	54	44	44	44	50
15	68	58	80	60	84	60	52	56	64	52	50	54	40	44	50	50
16	74	60	72	60	82	60	56	56	70	52	48	53	30	44	54	52
17	75	60	82	60	82	60	60	58	72	52	50	53	34	44	60	52
18	82	62	74	60	86	60	64	58	73	52	53	52	42	44	58	52
19	82	62	78	60	88	60	70	58	74	52	54	52	46	44	54	52
20	84	62	84	60	84	60	72	57	70	52	55	51	44	44	50	52
21	86	60	84	60	80	60	74	57	73	52	48	51	50	44	56	52
22	82	60	84	60	90	60	70	57	76	52	50	51	55	45	50	52
23	72	58	84	60	90	60	68	57	78	52	48	51	58	46	52	52
24	56	58	86	60	89	60	66	57	80	52	48	50	64	46	54	51
25	72	60	84	60	86	60	64	57	76	52	52	50	54	46	58	51
26	70	60	86	60	80	60	60	55	72	52	50	50	60	46	56	51
27	76	60	84	60	86	60	60	55	78	52	48	50	54	46	50	51
28	78	60	86	60	88	60	60	55	78	52	46	50	44	44	54	51
29	76	60	88	60	88	60	60	55	80	53	48	50	44	44	52	51
30	82	60	88	60	90	60	60	55	80	53	48	51	48	44	56	51
31	....	....	90	60	90	60	....	....	82	53	....	....	50	44	58	51

IX.—REPORT ON THE PROPAGATION OF PENOBSCOT SALMON IN 1885-'86.

By Charles G. Atkins.

Operations at the Penobscot Station were conducted, as in previous years, without change of importance in methods or apparatus. The only addition to the fixtures requiring mention was the construction of a new spawn house at Dead Brook, and some improvements of the stream and banks in front of it.

The purchase of breeding salmon was begun June 1, and brought to a conclusion June 20. Between these dates salmon were received on fifteen days. The aggregate number purchased was 691, of which 81 perished in transit, from excessive heat of the river water. The remaining 610 were all placed in the inclosure at Dead Brook, where they suffered during the summer a further loss of 93. At the spawning season there were recovered 501, leaving 16 not accounted for; most of these probably died and escaped detection. The net result of the purchase of 691 salmon was therefore 72 per cent of those purchased, and 82 per cent of those placed alive in the inclosures. The corresponding percentages in 1884 were 69 and 75, showing a slight improvement. The cause of the deaths that occur in the inclosure is not yet ascertained. As usual, they occurred soon after the first fish were inclosed, very few dying after the first month.

The size of Penobscot salmon this year was small. The estimated average of those purchased for the station was 12.95 pounds. At the spawning season 283 females and 196 males were weighed and measured. The females averaged 12.75 pounds in weight before spawning, and 31.06 inches in length. The males averaged 10 pounds in weight and 31.2 inches in length. The females yielded an average of 3.19 pounds of eggs, equal to 8,667 in number.

The spawning of the salmon was accomplished at the usual date, beginning October 27 and closing November 5. After manipulation all the salmon (except 19, that were captured after the rest had been liberated) were towed down to the village of Orland and liberated in tide-water below the Orland dam. This has been practiced for several years. The total number of eggs obtained was estimated at 2,422,600; but from the data obtained by the count of rejected eggs and the measurement of the net stock the original number is computed to have been 2,454,058. These were placed without noteworthy incident in the hatchery at Craig's Brook.

The losses from lack of impregnation were greater than usual at this station, though by no means very large. They aggregated 113,371, or 4.6 per cent of the original number. There were 24,687 rejected for imperfections of another character. The total loss was thus 138,058, which reduced the available stock of eggs to 2,316,000, of which 1,000 were reserved for experimentation, and 2,315,000 shipped to the order of the contributors to the fund.

A *pro rata* division gave to the U. S. Commission, 1,254,000; to the Maine commission, 663,500; to the Massachusetts commission, 397,500. The actual division was as follows: to the U. S. Commission, 1,251,500; to the Maine commission, 663,500; to the Massachusetts commission, 400,000.

The transfer of the eggs was accomplished between January 4 and March 5, with exceedingly small loss, as shown in detail in the tabular statement below:

TABLE I.—*Transfer of Penobscot salmon eggs from Orland, Me., during January, February and March*, 1886.

Date.	Consignee.	Number of eggs— Belonging to Maine.	Belonging to Massachusetts.	Belonging to United States.	Total.	Condition on unpacking.	Dead on unpacking.
1886.							
Jan. 5	U. S. Fish Commission, Cold Spring Harbor, New York.			240,000	240,000	Best ever saw.	94
6	......do			260,000	260,000	Good	94
26	E. B. Hodge, Plymouth, N. H.		300,000		300,000	....do	30
27	.....do		80,000		80,000	....do	10
27	David Masterman, Weld, Me.	200,000			200,000	.. do	39
Feb. 3	Frank Gibbs, Bridgton, Me.	100,000			100,000	....do	12
3	E. B. Hodge, Plymouth, N. H.		20,000	*200,000	220,000	Very good	23
10	......do			*100,000	100,000		
10	A. J. Darling, Enfield, Me	160,000			160,000	Good	60
16	Charles G. Atkins, Grand Lake Stream, Maine.	200,000			200,000	... do	(†)
26	A. J. Darling, Enfield, Me	3,500		316,500	320,000	....do	100
Mar. 4	......do			135,000	135,000	....do	35
		663,500	400,000	1,251,500	2,315,000		

* 150,000 eggs were donated to Vermont, and 150,000 to New Hampshire; all sent to Plymouth to hatch.

† Very few.

TABLE II.—*Record of weather and temperature at Craig's Brook*, 1885–'86.

Date.	Temperature.		Direction of wind.	Remarks.
	Brook.	Aqueduct.		
1885.	°	°		
Oct. 26	....	....	WNW....	Clear and warm.
27	54	53	SW	Do.
28	54	53	Southerly.	Pleasant.
29	54	53	SE........	Cloudy; followed by rain.
30	54	53	NE	Heavy rain.
31	47	46	NW	Cloudy; strong wind.
Mean ...	51.8	51.6		
Nov. 1	45	44	Westerly.	Clear; air cold, changing to warm.
2	47	46	E	Rain and strong wind.
3	47	46	W	Pleasant.
4	46	45	WNW....	Cloudy, with strong wind.
5	49	48	SE........	Cloudy; some rain; warm.
6	49	48	SE........	Cloudy.
7	49	48	NE	Cloudy; followed by rain.
8	50	49	SE........	Rain.
9	49	48	SE........	Do.
10	48	47	WNW....	Clear and cold, with strong wind.
11	47	46	WNW....	Clear and windy.
12	47	46	S	Rain; warm.
13	47	46	S	Cloudy; not cold.
14	49	48	NNW	Cloudy and rainy.
15	....	....	....	Clear and pleasant.
16	....	45	W	Clear and windy.
17	46	45	WNW....	Do.
18	....	45	S	Cloudy and warm.
19	47	46	NE	Cloudy; followed by rain.
20	....	45	W	Clear and warm.
21	....	42	SW.......	Do.
22	....	....	....	Clear.
23	43	42	S	Do.
24	....	42	S	Clear and warm.
25	....	42	NE	Windy, cloudy, threatening.
26	....	42	NE	Cloudy, windy; a little snow.
27	....	39	W	Clear.
28	....	39	Westerly.	Clear, pleasant.
29	....	....	SW.......	Clear; lake frozen over for first time.
30	....	38	Easterly..	Clear and warm.
Mean ..	46.8	44.7		
Dec. 1	....	38	NE	Cloudy and very cold.
2	....	38	W	Clear; not very cold; a man crossed the lake on the ice.
3	40	38	NE	Cloudy; snow.
4	....	37	WNW....	Clear; pleasant.
5	....	36	E..........	Cloudy; heavy rain.
6	....	....	W	Clear; not very cold.
7	....	37	ENE	Cloudy; snow.
8	....	35	W	Clear and cold.
9	....	36	E..........	Snow, followed by rain.
10	....	38	S	Cloudy and rain: snow all gone.
11	....	38	WNW....	Clear and windy; ice in lake gone.
12	....	36	WNW....	Clear and windy; boat crossed the lake.
13	....	....	SW.......	Cloudy; rain.
14	....	36	S	Rain; cloudy.
15	....	36	NW	Clear and windy; little ice on lake.
16	....	34	W	Clear and cold.
17	....	33	NE	Clear, followed by cloudy weather; lake frozen over.
18	....	34	NE	Snow.
19	....	35	E..........	Snow and rain.
20	....	....	W	Clear and cold; good sleighing.
21	....	34	....	Clear and cold; a man crossed the lake on the ice.
22	....	33½	W	Clear and cold.
23	....	34	SE........	Pleasant.
24	....	36	W	Clear and warm.
25	....	33	NW	Clear and cold; good skating.
26	....	33	N	Cloudy and cold.
27	....	....	NE	Cloudy and windy, with snow.
28	....	33	W	Clear and cold.
29	....	34	W	Clear and windy; first team crossed the lake; ice 8 inches thick.
30	....	35	W	Clear and warm.
31	....	35	SE........	Cloudy and threatening.
Mean ..	....	34.1		

TABLE II.—*Record of weather and temperature at Craig's Brook*, 1885–'86—Continued.

Date.	Temperature.		Direction of wind.	Remarks.
	Brook.	Aqueduct.		
1886.	°	°		
Jan. 1	....	35	SE........	Cloudy and rain; snow all gone.
2	....	35	NE........	Cloudy.
3	....	....	....	
4	39	37	SE........	Do.
5	....	37	SE........	Showers.
6	....	37	SW........	Warm and pleasant.
7	....	35	NW........	A rough day.
8	....	34	NW........	Cold.
9	....	34	NE........	Snow, with very strong wind.
10	....	....	NW........	Cold.
11	....	34	W........	Air,—10°: snow 4 inches deep.
12	....	34	WNW....	Clear; air,—15°, and low all day.
13	....	34	W........	Clear; air,—23° at 8.30 a. m.
14	....	34	W........	Cloudy; not very cold.
15	....	34	W........	Cloudy and moderate.
16	....	....	W........	Clear and pleasant.
17	....	34	....	Clear.
18	....	34	WNW....	Do.
19	....	34	N........	Cloudy; snow and rain.
20	....	34	W........	Snow, followed by clear weather.
21	....	35	E........	Snow.
22	....	35	NE........	Do.
23	....	35	W........	Clear.
24	....	....	....	Clear; air—15°.
25	....	34	....	Do.
26	....	35	....	Clear and warm.
27	....	35	....	Cloudy and warm.
28	....	35	....	Hail storm.
29	....	35	....	Hail storms; trees loaded with ice.
30	....	35	....	Clear.
Mean..	....	34.4		
Feb. 1	....	33	W........	Clear and cold.
2	....	34	....	
3	....	34	....	
4	....	34	....	
5	....	34	....	
6	....	34	....	
7	....	35	....	
8	....	35	....	
9	....	35	....	
10	....	34	....	
11	....	35	....	
12	....	36	....	
13	....	36	SE........	A great freshet.
14	....	36	W........	
15	....	36	W........	
16	....	36	NW........	
17	....	36	W........	
18	....	36	SW........	Clear and warm.
19	....	36	S........	Cloudy and warm.
20	....	36	W........	Cloudy.
21	....	35	W........	
22	....	35	W........	
23	....	35	SW........	
24	....	35	W........	
25	....	35	W........	
26	....	34	SE........	
27	....	34	NW........	
28	....	34	NW........	
Mean..	....	34.9		

BUCKSPORT, ME., *August* 20, 1886.

X.—REPORT ON THE PROPAGATION OF SCHOODIC SALMON IN 1885-'86.

By Charles G. Atkins.

On my first visit to the station, September 15, I found everything in good order and the preparation for fall work in a satisfactory stage. Mr. Munson, the foreman, who had been at work without help since September 1, had among other items of work set the stakes for the main nets, and gathered 190 bushels of moss, of which 175 bushels had been dried in the sun. The addition of 15 bushels more of green moss would give us an ample store for packing purposes. The approach of the spawning season was heralded by the appearance on the 15th of three salmon at the bridge across the stream. Two days later the setting of the nets across the stream was completed.

Excavations in the gravel by female salmon were to be seen as early as October 22, and from that date forward in increasing numbers. On the 24th the fishing pounds were completed, being five days earlier than in 1884, and six days earlier than in 1883. The plan of previous years was followed without material change.

For the first five nights the catch was small, the aggregate being 121. On the night of October 29, we took 56 salmon, and the next night 107. The latter number was the maximum for this season, the nearest approach to it being 99 taken on the night of November 8. As early as November 1 it had become apparent from the relative number of female fish (aggregating 195, against 123 males), that the season was far advanced and was likely to yield less than an average number of fish, and on the 18th we closed operations with an aggregate catch of 611 females, 199 males, and 1 salmon of unknown sex, a total of 811, the smallest catch since the organization of the station. Considered by itself this fact might reasonably cause apprehension as to the future supply of fish and eggs, but it is offset by the well-attested abundance of young salmon of several stages of growth in Grand Lake Stream and about the outlet of the lake for several years past.

The fish caught were equal in length to those of 1884, and exceeded those of 1883 by a little more than an inch. In weight and fecundity there was a falling off from 1884, but a gain as compared with 1883. The data for the three years afford the following comparison:

Year.	Average length.		Average weight.		Fecundity, average number of eggs per gravid female.
	Males.	Females.	Males.	Females.	
	Inches.	*Inches.*			
1883	20.00	19.2	3.20	3.40	1,620
1884	21.03	20.3	4.06	4.11	2,350
1885	21.05	20.6	3.65	3.61	1,720

The fish were, in general, healthy, there being a remarkable absence of external sores, which are sometimes to be seen. Out of 578 female salmon manipulated, 97 were afflicted with the ordinary ovarian disease, which displays itself in the presence of white or otherwise discolored and plainly defective eggs when extruded from the fish.

The total number of eggs obtained, as fixed by a computation based on the number rejected and the number packed for shipment, was 994,355. The ratio of impregnation, as later computed from the known number picked out from time to time up to March 4 (35,304), and more especially those picked out after concussion (92,351), was very nearly 90 per cent. This is an unusually low ratio, even for Schoodic salmon. It may be attributed in part to the scarcity of males, which led on several occasions to an insufficient milting of the eggs. The record shows, for instance, that the eggs taken November 9, numbering 110,967, on which there was a loss of 24,553, or 22 per cent, through lack of impregnation, were milted by using the milt repeatedly, straining it off from one lot of eggs, much dilated with mucus and water, and applying it in that condition to the next lot. Experimentally, I have sometimes obtained excellent results in this way, but it is evident that great care must be exercised, and that repeated use of the milt should only be resorted to when the live fish fail.

The weather was remarkably mild all through October and November. The record of air temperature shows no figure lower than 29° F., until November 18, when the mercury fell to 26°. The lowest water temperature observed previous to November 17 was 42½°. This contributed largely to the comfort of the force, and enabled us to move all the fish after the conclusion of the spawning to a point well up the lake without the interference of ice, which has some seasons closed in upon us before the conclusion of the work. It is probable, also, that the high temperature of the water hastened the maturity of the fish, though they were in fact more backward than was expected, a small proportion of them being ripe when first caught and many remaining unripe for a long time in the inclosures.

The entire crop of eggs was placed for development in the river hatchery instead of being divided as usual between the river and cove houses. In spite of the high temperature prevailing in November, the water was, by the first week in December, cooled down to 34° F., and the general development of the eggs was not so greatly accelerated as had been anticipated. All the eggs remained in the river house till February 15, when a portion of them were moved to the cove house in anticipation of packing and shipment.

The removal of the defective eggs (127,655 in all) reduced the stock to 866,700, of which 641,000 were shipped to the order of the parties contributing, as follows:

Party.	Amount of contribution.	Computed share.	Eggs actually delivered.
United States	$578 01	222,000	222,000
Maine	500 00	192,000	189,000
Massachusetts	300 00	115,000	115,000
New Hampshire	300 00	115,000	115,000
	1,678 01	644,000	641,000

A detailed statement of the transfer will be found in Table IV, subjoined.

From the reserved 225,700, which was 9,005 in excess of the legal minimum, there were lost but 428 eggs and 463 fry, and the remaining 224,809 were liberated in Grand Lake between June 14 and 23, 1886.

TABLE I.—*Record of fishing at Grand Lake Stream, Maine, during October and November*, 1885.

Day (24 hours) ending at 7 a. m.	Day weather.	Night weather.	Height of Grand Lake.	Temperature at 7 a. m.		Adult Schoodic salmon.								Parr.	Togue.	Brook trout.	Remarks.
						Daily catch.				Daily summary.							
				Air.	Water.	Males.	Females.	Unknown.	Total.	Males.	Females.	Unknown.	Total.				
1885.			*Ft. In.*	°	°												
Oct. 25	Mostly clear; wind light, NW.	Clear and calm	1 11	34	50½	10	6	......	16	10	6	......	16	2	1	1	All gates open except one.
26	Clear; wind light, W. and NW.	Clear and calm; toward morning foggy.	....	30	50	17	12	......	29	27	18	......	45	3	....	2	Chubs and suckers; a few daily.
27	Clear, warm; wind light, southerly.	Clear till 1, after that cloudy; wind southerly, not felt at fishing ground.	....	43	51	14	4	......	18	41	22	......	63	....	1	2	
28	Clear, warm; wind light, southwesterly.	Calm; clear in evening, cloudy toward morning.	....	41	51	14	16	......	30	55	38	......	93	2	3	1	
29	Cloudy, threatening; wind light, E.	Cloudy; wind light, southerly.	1 10	50½	51½	11	17	......	28	66	55	......	121	2	8	1	One pickerel.
30	Cloudy, threatening; wind light, southerly.	Rain from 8 p. m. nearly all night; evening calm, morning variable winds.	2 0	48	51	20	36	......	56	86	91	......	177	....	2	....	
31	Rain, with moderate to strong northerly wind all day.	Cloudy; moon and stars occasionally visible; wind strong N., all night; no rain.	2 0	31	46½	24	83	......	107	110	174	......	284	....	2	1	Two pickerel.
Nov. 1	Cloudy with strong N. wind all day; a little snow in a. m.	Clouds break at 10½ p. m., clear till morning; wind at sunset N., strong; at 10½ N., light, and so continuing all night.	2 0	29	44	13	21	......	34	123	195	......	318	1	6	....	
2	Clear; wind N., gentle.	Evening clear with gentle north wind; after midnight cloudy with southeasterly wind.	2 0	36½	45	7	5	......	12	130	200	......	330	1	....	1	Five pickerel.
3	Cloudy; slight rain; wind E. to SE., gentle.	Rain from dark till 12½ with slight intermissions with E. or SE. wind; cleared at 2; cloudy again at 4; wind dead after 2, light SE. in morning.	2 1	44½	46	11	10	......	21	141	210	......	351	2	2	2	Several pickerel.
4	Light clouds; wind W., light.	Cloudy, calm	2 2	34	45	10	16	......	26	151	226	......	377	3	2	1	

5	Mostly clear; wind W., light	Half clear till 4 a. m; wind W. and NW., very light.	2	2½	35½	45	5	29	......	34	156	255	......	411	1	2	....	
6	Mostly cloudy; wind SE., light.	Cloudy; rain after 12; nearly calm.	......	......	37	......	6	28	......	34	162	283	......	445	....	1	2	All gates shut except sluice-gate and one other.
7	Cloudy, some rain; wind NE., light.	Cloudy; calm; foggy toward morning.	2	2	38	45	10	41	......	51	172	324	......	496	2	2	4	Drop-net set.
8	Light rain intermittent; wind E., light.	Rainy all night; wind E	......	......	52	47	5	54	......	59	177	378	......	555	....	1	....	
9	Rainy; wind light, variable.	Rainy all night with occasional heavy gushes; wind uncertain, light.	2	4	43½	47	7	92	......	99	184	470	......	654	4	3	....	One eel, 3 pounds 4 ounces.
10	Rain all day; wind E., S., and NW.	Evening rainy with brisk NW. wind till midnight; thereafter calm and clear till morning.	2	5½	31	46	2	70	1	73	186	540	1	727	....	3	....	One whitefish.
11	A. m. clear with gentle W. wind; p. m. cloudy, wind inconstant, S. and NW.	Cloudy, except from 10 to 3; wind strong NW. all night.	2	6	33	44	4	38	......	42	190	578	1	769	2	....	....	
12	Slight snow in morning; a. m. cloudy; p. m. mostly clear; wind strong NW. all day, moderating toward night.	Clear all night; very light variable winds in evening, most of night calm; ground froze some.	......	......	29	42½	3	6	......	9	193	584	1	778	....	....	....	
13	Mostly clear; wind W. and SW.; light.	Evening clear and calm	2	6½	36	43	4	14	......	18	197	598	1.	796	....	2	1	
14	Cloudy; wind E	Cloudy, rain after 1; wind E.	2	7	39	43½	0	0	......	6	197	604	1	802	....	3	....	
15	Light rain; wind NE..	Cloudy, wind SW. and W ...	2	7	40	44	1	2	......	3	198	606	1	805	....	....	....	
16	Clear; wind W., light..	Clear; wind W., light	......	......	30	43	1	4	......	5	199	610	1	810	....	....	....	
17	Clear; wind W	Clear; wind W	......	......	......	......	0	0	......	0	199	610	1	810	....	....	....	
18	....do	......do	2	9½	26	40	0	1	......	1	199	611	1	811	....	....	....	

TABLE II.—*Summary of spawning operations at Grand Lake Stream, Maine, during October and November*, 1885.

Date.	Fish at first handling.								Females spawned.			Eggs taken.		
	Total.	Males.	Females.					Sex unknown.	First time.	Second time.	Females yielding some defective eggs.	Weight.		Number.
			Total.	Unripe.	Ripe.	Spent.	Diseased.							
1885.												*Lbs.*	*Oz.*	
Oct. 27	61	41	20	15	2	3	0	0	1	......	1	1	5½	
29	57	25	33	33	0	0	0	0	0	......	......	.....	.....	11,000
30	56	20	36	36	0	0	0	0	0	......	......	.....	.....	
31	107	24	83	80	3	0	0	0	5	......	1	3	5	
Nov. 2	46	20	26	17	9	0	0	0	19	6	......	11	14	25,000
3	19	11	10	8	2	0	0	0	8	18	4	8	0	18,561
4	26	10	16	12	4	0	0	0	9	9	......	6	12	18,458
5	34	5	29	13	13	3	0	0	26	9	......	13	1	30,475
6	34	6	28	11	16	1	0	0	47	21	......	28	0	65,558
7	77	13	64	30	31	3	0	0	67	81	14	50	8	115,000
8	63	6	57	38	19	0	0	0	48	27	7	33	1	81,879
9	69	3	66	35	30	0	1	0	57	46	11	45	6	110,967
10	73	2	70	30	34	4	2	1	65	56	7	50	11	114,656
11	42	4	38	15	22	1	0	0	94	60	28	71	13	160,301
12	9	3	6	0	3	3	0	0	66	94	17	50	12	117,000
13	18	4	14	7	4	3	0	0	25	64	7	24	13	59,000
14	6	0	6	0	5	1	0	0	26	25	0	18	11	39,000
16	6	1	5	0	0	4	1	0	14	26	0	11	9	24,000
17	0	0	0	0	0	0	0	0	0	8	0	1	5	2,700
18	1	0	1	0	1	0	0	0	1	0	0		6	800
	806	198	608	380	198	26	4	1	578	546	97	430	12	994,355

TABLE III.—*Measurements of Schoodic salmon at Grand Lake Stream, Maine*, 1885.

Date.	Males.							Gravid females.						
	Number weighed and measured.	Weight.			Length.			Number weighed and measured.	Weight.			Length.		
		Average.	Heaviest.	Lightest.	Average.	Longest.	Shortest.		Average.	Heaviest.	Lightest.	Average.	Longest.	Shortest.
1885.		*Lbs.*	*Lbs.*	*Lbs.*	*In.*	*In.*	*In.*		*Lbs.*	*Lbs.*	*Lbs.*	*In.*	*In.*	*In.*
Oct. 27	41	3.36	5.06	1.50	21.0	24.0	14.5	17	3.42	4.62	2.44	19.8	24.0	15.0
29	25	4.08	5.12	2.12	21.9	24.0	17.5	31	3.54	5.50	2.12	20.2	23.5	18.0
30	20	3.81	5.00	1.62	21.5	24.0	16.0	36	3.50	5.00	2.44	20.5	23.0	17.5
31	24	3.57	5.00	1.37	20.8	24.0	15.5	83	3.51	5.75	1.87	20.4	24.0	15.5
Nov. 2	20	3.70	5.37	2.25	21.4	24.0	18.5	26	3.76	5.12	2.50	21.3	25.0	18.5
3	11	3.45	5.25	2.25	20.4	25.0	18.0	10	3.20	3.87	2.50	20.0	21.0	10.5
4	10	3.71	5.00	2.75	21.3	23.5	20.0	16	3.34	5.56	2.75	19.9	23.5	18.0
5	5	3.72	4.19	2.94	20.9	22.0	19.5	26	3.70	5.50	2.75	21.0	23.0	18.5
6	6	3.78	4.94	2.25	21.4	23.5	18.0	27	3.81	6.19	2.50	20.7	24.5	18.0
7	13	3.74	6.87	1.94	21.1	25.5	16.5	61	3.60	5.69	2.25	20.6	24.5	18.0
8	5	3.15	4.31	2.06	20.2	23.0	17.0	57	3.59	5.00	1.50	20.5	23.0	18.0
9	3	3.03	4.94	1.12	20.0	23.5	15.5	66	3.84	5.19	2.37	20.8	23.0	17.5
10	2	3.55	5.19	3.00	20.4	23.0	20.5	64	3.55	5.44	2.25	20.4	24.0	18.5
11	4	3.66	4.31	2.50	21.1	22.5	18.0	37	3.89	6.12	2.31	21.5	24.0	18.5
12	3	3.29	5.19	2.31	20.0	23.5	18.0	4	3.77	3.37	2.44	19.6	20.0	19.0
13	4	3.92	4.50	3.00	21.2	22.5	19.5	11	3.76	5.12	3.00	21.8	22.5	19.0
14	......	......	......	......	......	......	......	5	3.05	3.56	2.69	20.2	22.0	18.5
16	2	3.81	4.00	3.62	22.2	22.5	22.0	......	......	......	......	......	......	......
	198	3.65	6.87	1.12	21.05	25.5	14.5	577	3.61	6.19	1.50	20.6	25.0	15.0

TABLE IV.—*Statement of the transfer of Schoodic (landlocked) salmon eggs from Grand Lake Stream, Maine, in* 1886.

Date.	Consignee.	Number of eggs.					Date of arrival.	Condition on unpacking.	Dead on unpacking.
		Share of United States.	Share of Maine.	Share of Massachusetts.	Share of New Hampshire.	Total.			
1886.									
Feb. 22	E. A. Brackett, Winchester, Mass.	......	......	80,000	......	80,000	....	Excellent.	40
22	George A. Seagle, Wytheville, Va.	23,000	......	......	......	23,000	Feb. 27	Good	37
22	Dr. R. O. Sweeny, Saint Paul, Minn.	19,000	......	......	......	19,000	....	....	......
22	Walter D. Marks, Paris, Mecosta County, Michigan.	14,000	......	......	......	14,000	Feb. 26	Good	0
Mar. 8	E. B. Hodge, Plymouth, N. H.	......	......	......	80,000	80,000	Mar. 11	....do	28
8	Frank Gibbs, Bridgton, Me.	......	20,000	......	......	20,000	Mar. 10	....do	15
8	William Buller, Corry, Pa.	19,000	......	......	......	19,000	Mar. 11	....do	12
8	John Pierce, Denver, Colo.	14,000	......	......	......	14,000	Mar. 14	....do	10
9	E. B. Hodge, Plymouth, N. H.	*20,000	......	......	35,000	55,000	Mar. 12	....do	13
9	David Masterman, Weld, Me.	......	73,000	......	......	73,000	Mar. 12	....do	10
9	F. Mather, Cold Spring Harbor, New York.†	40,000	......	......	......	40,000	Mar. 12	....do	43
10	A. J. Darling, Enfield, Me.	......	48,000	......	......	48,000	Mar. 11	....do	25
10	E. A. Brackett, Winchester, Mass.	......	......	35,000	......	35,000	Mar. 12	Excellent.	22
15	O. A. Dennen, Kineo, Me.	......	48,000	......	......	48,000	Mar. 19	Good	55
15	E. G. Blackford, Fulton Market, New York city.‡	34,000	......	......	......	34,000	Mar. 18	....do	76
15	F. N. Clark, Northville, Mich.	29,000	......	......	......	29,000	Mar. 19	First-class	100
15	Otto Gramm, Laramie, Wyo.	10,000	......	......	......	10,000	....	....	......
		222,000	189,000	115,000	115,000	641,000			

* 10,000 of these were for the State of Vermont, the remainder for New Hampshire.

† These eggs were to be reshipped, 20,000 to Herr Von Behr for the German Fischerei-Verein, and 20,000 to the National Fish Culture Association, South Kensington, England.

‡ Forwarded to Cold Spring Harbor, New York.

TABLE V.—*Observations on temperature, &c., at Grand Lake Stream, Maine, from September 2, 1885, to June 20, 1886.*

Date.	Temperature at 7 a. m.					Height of Grand Lake.	Rain.		Snow.	
	Air.	Water.					Hour when measured.	Inches in rain-gauge.	Hour when measured.	Inches of new snow.
		River or lake.	River house.	West aqueduct.	South aqueduct.					
1885.	°	°	°	°	°	*Ft. In.*				
Sept. 2	61	63		53		2 6				
3	53	62½		53						
5	54½	63½		53			7 a. m.	0½		
6	49	61		53						
7	47			53						
8	52	62½		53		2 5½				
9	52½	63		53						
10	47	60½		52½		2 4½	7 a. m.	0¾		
12	45	61		51½		2 4				
13	55	62		52	51½					
14	62	62		52		2 3				
15	66	62½		52	51½					
17	54	62		53	52	2 2				
18	55	61		53						
19	55½	62		53	53	2 1½				
20	53			52½	53					
21	44	61		52	52½					
22	55	62		52	52	2 0				
23	60	62		52	52		10 a. m.	2¼		
24	38	58½		52	51	2 1				
25	37	56								
27	56	56½		49½	50½	2 1				
28	46	58		50	50½					
29	55	60		50	50½					
30	46	60		50	51					
Mean	58.9	62.5		52.1	51.6					
Oct. 1	50	60		50	51					
2	51	60		50	51	2 1				
3	55	61		50	51					
4	60	60½		51	52		7 a. m.	⅝		
5	50	60		51	52		7 a. m.	⅜		
6	42	58½		50	51					
7	38	56		50	51		8 a. m.	½		
8										
9	35	54		48	49	1 11				
10	31	52		47½	48½					
11	31½			47	48					
12	32	47½		47	48	1 11				
13	30									
14	45	48		46	47					
15	50	50		47	47		7 a. m.	1⅓		
16	44	51		48	48					
20	53	53½		48	48	1 10½				
21	50	52		48	48					
22	56	54		48½	49		7 a. m.	¼		
23	39			48	49					
24										
25	34	50½		47	47	1 10½				
26	30	50		46	46½					
27	43	51		46½	46	1 10				
28	41	51	51	46½	46½					
29	50½	51½	51½	47	47	1 10				
30	48	51	51	47	47	2 0	7 a. m.	1¼		
31	31	46½	46½	46	46	2 0	7 a. m.	⅞		
Mean	43.2	53.5	50	48	48.6					
Nov. 1	29	44	44	45	45	2 0				
2	36½	45	45	44	44	2 0				
3	40	46	46	44½	44½	2 1				
4	34	45	44½	44½	44½	2 2				
5	35½	45	44½	44	44½	2 2½	7 a. m.	½		
6	37		45			2 2½				
7	38	45	45							
8	52	47	47							
9	43½	47	47	46	46	2 4	5 p. m.			
10	31	46	46			2 5½				
11	32	44	43½			2 6				
12	29	42½								

TABLE V.—*Observations on temperature, &c.*—Continued.

Date.	Temperature at 7 a. m.					Height of Grand Lake.	Rain.		Snow.	
	Air.	Water.					Hour when measured.	Inches in rain-gauge.	Hour when measured.	Inches of new snow.
		River or lake.	River house.	West aqueduct.	South aqueduct.					
1885.	°	°	°	°	°	*Ft. In.*				
Nov. 13	36	43	43			2 6½				
14	39	43½	43½	44	44	2 7	7 a. m.	½		
15	40	44	44			2 7	7 a. m.	⅝		
16	30	43								
17										
18	26	40	40	42	42	2 9½				
19	34	40	40			2 10	5 p. m.	⅞		
20	22	38½	38							
21	22½	38	37½			2 11				
22	31	38	38						7 a. m.	⅜
23	21	38	38							
24	18	38	38							
25	23									
26	25½	36½	37	42	39½	3 1½				
27	20		36							
28	19	36½	36	40	39					
29	18	36	36							
30	20½	35½	35	39	38½	3 2				
Mean	30.5	41.8	41.4	43.2	42.9					
Dec. 1	14½	35	35	40	39½					
2	23		35							
3	21	35	35	40	38½	3 1½				
4	17		34½						7 a. m.	1
5	16	34½	34						11 a. m.	1¼
6	14½		34						7 a. m.	¾
7	15		34			3 2			7 a. m.	5
8	3½	33	33	38	39				7 a. m.	2½
9	20		33½							
10	50	34	34			3 3½			7 a. m.	¾
11	30	34					7 a. m.	1		
12	13		33½							
13	14		33							
14	34	33½	33				11 a. m.	⅝	7 a. m.	1
15	26½		33½							
16	7		32½	38½	38	3 4				
17	2		32½							
18	— 3½		32½							
19	29		33							
20	28½	33½	33			3 4½			7 a. m.	4
21	6		33							
23	22	33								
24	38		33½				7 a. m.	⅜		
25	8		33							
26	6	32½	32½			3 6				
27	11		32½	37	36				4 p. m.	4½
28	15		32½							
29	23½		33							
30	13		33½							
31	20	33½	34	38	37	3 7½				
Mean	17.9	33.8	33.5	38.6	38					
1886.										
Jan. 1	36½		34							
2	34						7 a. m.	⅜		
3	32	34½	34	38	36	3 8				
4	34		34							
5	39		34							
6	40½	34½	34½			3 10	8 a. m.	1⅛		
7	17		33½							
8	— 3½		33							
9	4		32½						5 p. m.	7
10	16½	33½	33	34½	35					
11	— 8		32½							
12	—18		32½							
13	—30		32½							
14	0	33½	32½	35½	34½					
15	1½		32½							
16	6		33							

TABLE V.—*Observations on temperature, &c.*—Continued.

Date.	Temperature at 7 a. m.					Height of Grand Lake.	Rain.		Snow.	
	Air.	Water.					Hour when measured.	Inches in rain-gauge.	Hour when measured.	Inches of new snow.
		River or lake.	River house.	West aqueduct.	South aqueduct.					
1886.	°	°	°	°	°	*Ft. In.*				
Jan. 17	29		33½							
18	16		33½							
19	5		34							
20	21		34						7 a. m.	6
21	7	34	34	37	35½					
22	26		34						7 a. m.	2½
23	28		34						5 p. m.	1¼
24	—13		33							
25	—20		33							
26	23		33						7 a. m.	6
27	9		33							
28	22		33							
29	29	34½	33½	37	38				8 a. m.	5½
30	27		33½							
31	26½		33						7 a. m.	6
Mean	14.6	33.7	33.3	36.5	35.8					
Feb. 1	28		32½							
2	8		32½							
3	— 8		32½							
4	—13		32½							
5	—18		32½	36½	38					
6	—15½		33							
7	— 7		33							
8	4		33							
9	11		33							
10			33½	37	37½					
11	10½		33½							
12	19		34							
13	42		34							
14	37		34	34½	33½		7 a. m.	2		
15	31		34							
16	28½	34	34	33½	34	4 4				
17	3		34	34	34½					
18	18									
19	12½		34	34	34½	4 4½				
20	32	34	34	34½	35				7 a. m.	4
21	— 2		33½	35	35					
22	— 9		33½	35	35					
23	19½		34	35	35				8 a. m.	½
24	— 6		33½	35	35					
25	—10		33	35½	35				8 a. m.	17
26	28		33½	36	35½					
27	4		33	36	35½					
28	4		33	36	35					
Mean	9.4	34	33.4	33.2	35.2					
Mar. 1	— 7½		33	36	35					
2	9		33½	36	35					
3	19		33½	36½	35					
4	29		34	37	35½					
5	28½		34	37	35½					
6	23	34½	34	37	35					
7	9		34	37	35					
8	— 2		33½	37	35					
9	10		33	37	35					
10	—17		32½	37	35½					
11	— 1		33	37	35½					
12	30	34	34	37½	35½	4 6				
15	4		34	37½	36					
16	24		34½	37½	36					
17	18½		33½	37½	36					
18	3	34	33½	37	36					
19	17		33½	37	36				7 a. m.	5½
20	26		34	36½	35½					
21	23		33½	36	35					
22	28		33½	36	35	4 6				
23	27½		34	36	35					
24	21		34½	36	35				7 a. m.	10

TABLE V.—*Observations on temperature, &c.*—Continued.

Date.	Temperature at 7 a. m.					Height of Grand Lake.	Rain.		Snow.	
	Air.	Water.					Hour when measured.	Inches in rain-gauge.	Hour when measured.	Inches of new snow.
		River or lake.	River house.	West aqueduct.	South aqueduct.					
1886.	°	°	°	°	°	*Ft. In.*				
Mar. 25	11	34½	34½	35½	36					
26	29		34½	36	36½					
27	27			36½	37					
28	20			36½	37					
29	18			36½	37½					
30	31			35½	37					
31	34½			35½	36½	4 6½				
Mean	17	34.2	33.7	36.6	35.7					
Apr. 1	45	35		36	36	4 7				
2	21			35½	35½					
3	27½			35½	35					
4	26			35	35					
5	29	35½		35½	35	4 6½				
6	31			35	35					
7	25			35	35					
8	30			35	35				7 a. m.	1
9	28			35	35					
10	24½			35	35					
11	26			35	35	4 7				
12	21			35½	35					
13	38	35		35	35					
14	40									
15	32			34½	34½					
16	34			34½	34½	4 8½				
17	36½			34½	34½					
18	40			35	34½					
19	42	36		35½	34½	4 10				
20	41½			36½	34½					
21	36½	36		37½	35½	5 ½				
22	40			39	36					
23	41			40	36½	5 3				
24	44			40	36½					
25	28½	38½		39½	36½					
26	29			40	37½	5 8				
27	27			40	38					
28	41			40½	38	5 9				
29	41½	40½		41½	39½					
30	42			41½	39½	5 10				
Mean	33.6	35.2		36.8	35.4					
May 1	39½	41		42	40	5 11½				
2	44			42	40					
3	47			42	40½	6 ½				
4	46			42½	41					
5	47½			42½	41½					
6	51	41½		43½	42	6 1½				
7	50			43½	42					
8	51			43½	42					
9							10 a.m.	1¼		
10	39	44		43	42	6 2½				
11	45			43	42					
12	45			43	42					
13	44½			43	42½					
14	47			43	42½					
15	40			43½	43					
16	42½			43½	43½		5 p. m.	¾		
17	49	46		44	43½	6 3¾				
18	48			44	43½					
19	48			44	43½					
20	45			44	44					
21	50			45	45		6 a. m.	⅞		
22	53			45	44½					
23	59			44½	44½					
24	54½	47½		44½	44½	6 3				
25	55			45	45½					
26	47			45	45		7 a. m.	⅘		
27	46			44½	45½					
28	54			44½	45		7 a. m.	⅞		

TABLE V.—*Observations on temperature, &c.*—Continued.

Date.	Temperature at 7 a. m.					Height of Grand Lake.	Rain.		Snow.	
	Air.	Water.					Hour when meas-ured.	Inches in rain-gauge.	Hour when meas-ured.	Inches of new snow.
		River or lake.	River house.	West aque-duct.	South aque-duct.					
1886.	°	°	°	°	°	*Ft. In.*				
May 29	53	50	....	44½	45	6 2½	....	....	....	....
30	60	....	....	45	45½	....	....	....	....	....
31	54½	....	....	45½	45½	....	....	....	....	....
Mean	51.5	45	....	43.7	43.3	....	....	....	....	....
June 1	58	54½	....	46	46	6 ½	....	....	....	....
2	61	....	....	46	46	....	4 p. m.	⅛	....	....
3	56½	....	....	46	47	....	....	....	....	....
4	54	57	....	46	47	6	....	....	....	....
5	55½	....	....	46	47	....	....	....	....	....
6	59	....	....	46	47½	....	....	....	....	....
8	60	....	....	46½	47½	....	....	....	....	....
9	61	....	....	46½	47½	....	....	....	....	....
10	64½	59	....	46½	48	5 7½	....	....	....	....
11	58½	....	....	46½	48	....	....	....	....	....
12	54	....	....	46½	48½	....	....	....	....	....
14	53	....	....	46½	48¼	....	....	....	....	....
15	55	60½	....	46½	48½	5 2	....	....	....	....
19	56	....	....	47	50	....	....	....	....	....
20	57	62	....	47½	50¼	4 10½	....	....	....	....
Mean	57.7	58.6	....	47.7	47.8	....	....	....	....	....

BUCKSPORT, ME., *August* 20, 1886.

XI.—REPORT ON AN OYSTER INVESTIGATION IN NEW YORK WITH THE STEAMER LOOKOUT.

BY EUGENE G. BLACKFORD.

The steamer Lookout was subject to my orders this season from the 15th to the 26th of August, 1885, inclusive, and during this time we were able to visit seven different localities, making eight trips, as follows: Montauk Point, Greenport, the Kills, Execution Light, Port Jefferson, Prince's Bay, and two trips up the Hudson River.

MONTAUK POINT AND GREENPORT.—The first trip was to the eastern end of Long Island, for which locality we started on the morning of Saturday, the 15th of August. The vessel reached Shelter Island late in the evening and remained at anchor in Dering's Harbor until Monday morning, the 17th of August, when a visit was made to the oyster regions in the neighborhood of Montauk Point. I had been informed that some of the ponds near the Point contained quantities of oysters of fine quality, but while we found some oysters they were very few in number and quite flavorless. And we were not even able to find old shells to any extent, indicating that there ever had been oysters there in any quantity. These ponds are, with hardly an exception, cut off from the ocean, except during great storms, when the waves dash across the intervening sand strips and now and then cut passage-ways through, so that, until these passage-ways close up again, there is communication between the waters of the ponds and those of the ocean. The waters of the ponds are thus at times quite salt and then again only slightly brackish, and they are in this latter condition most of the time, depending for their supply of water upon the rain shed from the surrounding sand-hills or the water from the ocean percolating through the underlying strata. There is consequently, in all probability, very little food in these ponds of a proper character to sustain any large number of oysters, and that is undoubtedly why we were able to obtain but few specimens. What might be accomplished in the way of oyster culture, by opening permanent water-ways into these ponds, is of course a matter of mere conjecture.

Early on Tuesday morning we took Mr. J. M. Monsell, of Greenport, on board as pilot, and proceeded to examine some of the planted beds belonging to members of the Greenport Oyster Company. The land under water controlled by this company lies close along the shores of the bay near the village of Greenport and where there is a fine tidal current flowing most of the time; consequently the oysters get plenty of food, and show this by an exceedingly fine growth. At least all of those we examined showed a very great increase in size since they were laid down in December, 1884. In many instances this increase was from 2 to 2½ inches in length, and proportionately in width. For many years past the only oysters obtained from Peconic Bay and vicinity were of the class known as single oysters, found scattered here and there on the sand, and among the pebbles of various portions of the bottom of the bay, and gathered principally by the clammers when raking for clams, or by the scollopers when after scollops. But it was known, by the great beds of old dead oyster-shells found here and there throughout the bay, that formerly the bay was well supplied with this bivalve, and laws were passed by the legislature of the State in 1883 authorizing the towns located upon the bay to appoint commissioners to survey such lands under water as were thought suitable for oyster cultivation, and to deed such lands, in small allotments, to those desirous of planting and cultivating oysters. Our pilot, Mr. Monsell, was one of the commissioners thus appointed by the town of Southold, and after the land had been surveyed in several localities, most of it was taken up by those living in the immediate vicinity, and then, in order to facilitate work, these parties formed themselves into oyster companies. There are consequently four or five plots of land, of greater or less extent, now under cultivation in Peconic Bay, all of which have been planted with a greater or less number of oysters within a year past, and everywhere the growth has been all that could be desired; but it is yet too early in the history of the enterprise to enable any one to tell whether or not the oysters will fatten, and be well flavored as well as grow fast.

While the outlook is thus very bright for the planters in the Peconic Bay region, so far as the mere growth of the oysters is concerned, they have one very serious evil against which to contend, and that is the starfish. In certain sections we found these pests in immense numbers, and they undoubtedly are responsible for the dead shell-beds of the bay and for the fact that so few oysters are found native in these waters. Against these animals the planters will have to make war incessantly or they will not have any oysters to need protection. But if by concerted action the planters get rid of the major part of the starfish, and then by constant watching and working keep them in subjection, it would seem as if Peconic Bay might become an exceedingly rich oyster region, especially as the bottom is comparatively stable, and there are thousands of acres where the soil is, for oyster culture, equal to anything the most ardent oysterman could desire. Most of the oysters employed for seed on the beds in the bay are brought from Connecticut; a few, however, are brought from other localities. Some of the planters are loading part of their beds with old shells for the purpose of catching spat, and thus obviating the necessity of foreign importation. But so far there has been very little set noticed.

THE KILLS.—Our trip to the Kills on the 19th was undertaken principally to obtain, if possible, evidence of the injury to the oysters in that locality from the pouring of sludge, acid, and oily refuse into the waters in the vicinity. A number of dredgings were made in Arthur's Kill, as far south as Northwest Reach, and in the Kill von Kull at the mouth of Newark Bay. One or two dredgings were also made a short distance up in Newark Bay. At Northwest Reach the temperature of the water was 78° and the density, at half ebb, 1.014. Two hauls were made. In the first the dredge was down three minutes, and twenty-eight oysters were obtained. There were some last year's set, and the growth of all was fair. We found no direct evidence of oil upon the water or of oily refuse upon the bottom, but there were a large number of dead shells, the inmates of which had evidently died only recently, and all the shells, both living and dead, were covered with a green slime. The oysters were also very green and had a rank odor and an oily taste. In the second dredge there were a few oysters set on old bricks, stones, &c. The oysters were in the same condition as those in the first dredge, and there were many dead shells, the animals of which, as before, had been recently killed. Three dredgings were then made along in front of Coe's phosphate factory, and from these we obtained respectively one hundred, one hundred and eighty-six, and eighty-nine oysters. Most of the oysters were well-shaped and of fair growth, and there was a small amount of set. There were a great many shells of recently killed oysters, and all the shells were very slimy. The oysters themselves were thin and very green. From these dredgings we obtained a number of pieces of a brittle material, which is said to be the hardened refuse material from the oil-works, which after being cast into the water sinks to the bottom, and in many cases covers up large numbers of oysters. None of these pieces appeared, however, to be of recent origin. In the mouth of Newark Bay, where the temperature was 78° and the density 1.013, we obtained in three dredgings the respective number of eighteen, six, and four oysters. There were some shells, all of which, as well as the oysters, were slimy, and the oysters were thin and green. Farther up the bay we found the oysters to be of a similar character. We did not find as many shells here as in Arthur's Kill, nor any oily refuse. The oystermen claim, however, that upon a great many days during the past season the water has been covered with acid and oil waste from the factories located along the shores, and it looks very decidedly as if we must look to this cause for the destruction of the most of those oysters whose empty shells we found so abundantly.

EXECUTION LIGHT-HOUSE ROCK.—This locality was visited on the 20th, the steamer reaching the bed about 11 o'clock a. m., and leaving it about 3 p. m. In the morning the tide was on the ebb, and we found the temperature of the water to be 74° and the density 1.0192. In the afternoon the tide had turned and the temperature rose to 76° and the density was 1.0186. A great many dredgings were made on different parts of the bed, but principally on the north side in from 6 to 8 fathoms of water. A goodly number of oysters were obtained at each haul, but not near so many as we undoubtedly should have obtained had our dredging apparatus been somewhat differently arranged and more suitable for use in deep water and from a steamer. The oysters were all in good condition for the time of year and depth of water, and there were very few enemies found, only two starfish and a few drills. A large number of spider-crabs were also taken. The amount of refuse gathered was considerable, but nothing like in quality what we found when we visited this bed last season. This is undoubtedly due to the working of the oystermen upon the bed and to the unquestionable fact that there has not been, for some reason, much dumping upon the bed this year. Taken as a whole, the condition of the bed seems to be much improved, although there was not much young growth to be found among the oysters taken.

HUDSON RIVER.—The trips up the Hudson were made on the 21st and the 25th of August, with Mr. Garrett Van Pelt as pilot. On the first day the steamer went as far up the river as Spuyten Duyvil Creek and then returned to New York Bay, where we examined the beds in the immediate vicinity of Little and Bedloe's Islands. The first dredging was made in Stryker's Bay, the water being of a temperature of 76° and of a density, near the last of the ebb, of 1.0036. A great many shells were obtained and from seventy-five to one hundred oysters, most of them being of good size. The meats, however, were all thin and of a green color. There were a good many pieces of wood taken from the bed and various kinds of refuse. This bed extends from where the water is about 4 fathoms deep to near the shore, where it is about 6 feet in depth. At the sugar-house bed a few shells were obtained and two live oysters. This has been a good bed, but has been overworked. Some mud was found among the oysters and considerable refuse. The meats were thin and green. The depth of water was about 2½ fathoms. At Fort Washington Point, in 17 feet of water, a few large oysters were obtained, and a good many small ones of last year's set. There were also some dead shells and a good deal of refuse material. At Englewood bed we made our last dredging in the river for the day. The temperature was 76° and the density 1.0024. The dredgings were made in from 2 to 4 fathoms of water, and we obtained sixty-two oysters of good size and in fair condition. There were a large number of shells and some refuse material. Upon our return to the bay we found the water so rough that only one dredging was made on each bed, the first at Little Island, on the east side, from which we obtained four oysters, and the second on the northeast side of Bedloe's Island, from which we obtained three specimens. There were quite a number of shells taken at both places, and both oysters and shells were quite slimy and of a bad odor. The meats were all thin and very green. The temperature of the water was 76° and the density 1.0076. It was not long after the beginning of the flood, and the depth was about 3 fathoms in both places.

On the 25th the first dredging was made on the Irvington bed in 14 feet of water. The tide was hardly one-quarter ebb, and we found the density accordingly somewhat greater than on the first day at Englewood, it being 1.0028 and the temperature 73°. We obtained fifty-three oysters and some shells. Most of the oysters showed traces of green coloration; otherwise they were in fair condition. There was not much refuse material taken from this bed. This bed is next to the last one up the river; but the one near Nyack, while a very large and prolific bed, lies in too shoal water to be dredged from the steamer, so we were obliged to pass it by or rather not go up to it. At Round Rock bed only seven oysters were obtained, together with some shells, but no refuse. It is not a large bed, and, like all the Hudson River beds, lies close to the shore. The meats of the oysters obtained here showed hardly any traces of green coloration. Density, 1.003; temperature 73°. At Dobb's Ferry, close to the dock, in 2½ fathoms of water, twenty-five oysters were obtained, with many shells and some refuse. All the oysters were small and the meats slightly green. Density, 1.0031; temperature, 73°. At Hastings the bed is long and narrow, skirting the shore for some distance below the wharf. The water on the outer edge of the bed was only 9 feet deep, so we could not dredge it very satisfactorily, and obtained only twelve oysters. There were many shells and rocks and some refuse. The oysters appeared to be thrifty and in good condition. They showed little, if any, green color. Density, 1.0032; temperature, 73°. Willow bed is also long and narrow, but in deeper water. We made our dredgings in 2¼ fathoms, and obtained five oysters, some refuse, and a large number of shells. The meats were thin and quite green. Density, 1.004; temperature, 73°.

Off Yonkers we obtained twenty oysters at a depth of 2¼ fathoms. There were a good many shells, but little refuse. Most of the oysters were of fair size and in very good condition, with very little of the green coloration. Density, 1.004; temperature, 73°. The Lame Man's bed, which is next south of Willow bed, is one of the best beds in the river, and great quantities of seed are obtained from it. We obtained two hundred and two oysters from it, all of which were of good size and shape. The meats, however, while being pretty well filled, were of a somewhat greenish tint. A good many clean dead shells were also obtained, and five hard crabs. Density, 1.0045. At Mount St. Vincent bed about two-thirds of the take consisted of dead shells, most of which were quite clean. We obtained one hundred and fifty oysters, the meats being in fair condition, but with a faint tinge of green. Density, 1.0047. At Riverside bed we obtained more oysters than from any other place on the river. In the first dredge there were three hundred and ten, in the second one hundred and forty, in the third two hundred and forty, and in the fourth one hundred and seventy oysters, respectively. There was very little refuse material, but a good many dead shells, most of which were pretty clean. The meats of the living oysters were in fair condition with very little signs of green coloration. Density, 1.005. The last bed examined was a small one called the Fisherman's bed. We found very few oysters, getting only five specimens, but a considerable number of shells. The meats were poor and considerably colored. Density, 1.005. All of the beds of the Hudson are worked for the purpose of obtaining seed with which to plant other beds, as the oysters on these beds do not fatten well until they are transplanted, although a good many are used directly from the beds, but such are almost entirely used for local consumption. The greater number of oystermen who work these beds come from the neighborhood of Staten Island, although some of the East River planters also obtain seed here. This is not as common now, however, as it was some years ago.

PORT JEFFERSON HARBOR.—The visit to Port Jefferson Harbor was made on Saturday, the 22d, and the Lookout lay at anchor in the harbor over Sunday, the 23d. On Monday morning early we started for the beds with Mr. C. J. Robbins as pilot. Most of the bottom of the harbor is leased by private parties and is planted, but year before last the trustees of the town voted to grant no new leases and no renewals of leases for the present, and as some of the leases expired last season there are certain grounds in the harbor that are now free to any who wish to work upon them. Such grounds, however, are of comparatively small extent and of no practical value, as all oysters were taken from them before the leases expired. Our work was accordingly on those grounds that are still under lease, and we found most of the beds to be well cared for and in good condition, although the growth is not so great as in many other localities along our coast. We made a large number of dredgings, some being on oysters nearly ready for market, and others on those only recently planted. The largest number taken at any one haul was one hundred and forty-two, on land leased and worked by the Port Jefferson and Setauket Oyster Company, but the dredge was seldom left upon the bottom for more than one or two minutes at a time, as we were not after numbers so much as to ascertain the growth and quality of those that had been planted. The growth, as already stated, we did not find to be great, but the quality was excellent for the time of year. We found no starfish or winkles, and, what surprised us much more, we obtained only two or three drills in all of our dredgings in the harbor. Most of the seed in the harbor comes from the Connecticut beds, but some is brought from Great South Bay, although it does not do so well as the Connecticut stock. The seed is generally from one to three years old, and 300 or 400 bushels per acre are used. The water in the harbor over the beds is from 2 to 4 or 5 fathoms in depth, and we found it to be of an average temperature of 73½°, and a density on the young flood of 1.0196. Outside of the harbor we found the temperature to be 73° and the density 1.020. We dredged for some time outside the harbor in 5 to 6 fathoms of water on bottom which had been shelled two years ago, but we obtained only shells, the oysters having been entirely destroyed by the stars, or at least the starfish got the benefit of any doubt there might have been in the matter.

PRINCE'S BAY.—On the 26th we made a visit with Mr. Van Pelt as pilot to the beds along the Long Island shore of New York Bay, and to those along the southeastern shore of Staten Island. On account of the unfavorable weather we did not make so many dredgings as we should have done had the weather been pleasant. Near Owl's Head Landing, just off from Bay Ridge, Long Island, we found the temperature of the water, at half ebb, to be 75°, and of a density of 1.016. The oysters obtained were of good size and in fair number, but they were all thin and green, and the shells were quite slimy. There were a good many old shells, and some of last season's set. There was also some refuse material, but not of any account. The bed here was dredged in 2½ fathoms of water, and used to be quite prolific. If properly cared for, it would now undoubtedly furnish a good many oysters for planting. In the edge of the channel near the Narrows, known as the Swash Channel, in 2 fathoms of water, we obtained some good-sized oysters, but they were not very abundant nor very thrifty. Like those at Owl's Head they were thin and green, and the shells covered with a green slime. There was also considerable refuse material, showing that there is more dumping here than along certain portions of the Long Island shore. In Prince's Bay the temperature of the water was found to be 75°, and the density on the latter portion of the ebb 1.017. A number of dredgings were made on different planted beds, and the oysters were found to be generally in fair condition, although in many cases the flavor was not pleasant. In the region where dredging is being carried on to widen and deepen the channel into Raritan Bay, we found that a good deal of damage had been done by the mud, which had been stirred up from the bottom, spreading out and settling over the planted oysters. In some instances, at least, the dredgings, instead of being carried out to sea, as they should be, have been dumped upon the planted territory, causing considerable damage by burying and thus smothering the oysters. The dredge, when thrown down over these old beds, is soon filled with a filthy mass of black mud, in many instances smelling quite strongly of kerosene. The beds in this neighborhood, when undisturbed by these dredgings, are well cared for and profitable; but each season the flavor of the oysters is getting poorer on account of the increase of filth and waste matters which are thrown into the bay.

NEW YORK, N. Y., *September* 28, 1885.

XII.—REPORT OF OPERATIONS AT SAINT JEROME OYSTER-BREEDING STATION DURING 1885.

By W. deC. Ravenel.

By the first of June I had the ponds ready for the reception of spawn, but it was not until the 20th that ripe oysters were found in sufficient numbers to commence spawning regularly. From then until the end of August oysters were opened every day, and when ripe oysters were found the fertilized eggs were put in ponds 1, 2, 4, and 5. Although young oysters were found twenty-eight days after the introduction of the first lot of spawn into the ponds, only about six or seven hundred oysters were on the collectors when they were taken up in October.

The variation of density of the water in the ponds was very slight, not over .0003; and under ordinary conditions the variation between the bay and ponds averaged about .0004.

From the results obtained I think it of the greatest importance that the ponds used in artificial oyster culture should have the full rise and fall of the tide, which is impossible when the water has to be filtered to prevent the escape of the artificial spawn and the introduction of natural spawn.

Ponds 4 and 5, from which most of the spat was obtained, were the only ones where any considerable change of water existed, pond 4 being directly connected with the bay, and the condition of the soil around pond 5 being such as to allow the water to pass through it freely. Evidence in support of this can be found in pond 3, where 20 bushels of spawning oysters were put, and where poorer results were obtained than in any other pond except No. 1, which had the least circulation of any, water having to pass to it through ponds 2, 3, and 4.

The sand filters attached to the flumes became so foul in two or three days that no water could pass through them, and were so constructed that they could not be cleaned; they were changed, however, several times during the season, but soon became clogged again.

I had hoped from the improved condition of the ponds that the collectors would be free of sediment, but, with the exception of pond 5, their condition was much the same as in the previous season. Those in pond 5 were perfectly clean, which was due to the free circulation and the condition of the soil.

The collectors upon which the best results were obtained were mortar-coated slate, placed in wire trays, these trays resting on trestles 8 inches in height, the under surface of the slate being always clean. Another excellent and cheap collector was made of plastering-laths nailed together, about twenty-four in a bundle; these were either allowed to float around in the ponds or sunk by tying a weight of some kind to them.

Several times during the spawning season for four or five consecutive days no ripe oysters could be found, after which time nearly all the oysters taken from the same places would be perfectly ripe. Though it is impossible to assert that oysters spawn more than once during the season, still it seems improbable, if there were ripe oysters at the time I refer to, that none could be found.

During the year the bar at the entrance of Saint Jerome Creek has been removed, and a channel 140 feet wide and with a depth of 9 feet at low water has been dredged to the mouth of the south prong under the directions of Col. S. T. Abert, United States engineer.

There no longer exists any reason why steamers plying between Baltimore and Washington could not stop in here, giving the station direct communication with those cities; and I hope that every effort will be made to induce a steamer to stop at the wharf just built, where a landing can be made under all conditions of the weather.

RIDGE, MD., *May* 17, 1886.

Table of temperatures, weather, and density of water at Saint Jerome Station from January 1, 1885, to June 30, 1885, inclusive.

NOTE.—Thermometer No. 5308 was in use throughout the year. Salinometer No. 5319 was in use from January 1 to April 16, inclusive, except as indicated by the asterisk, in which cases No. 5317 was used. From April 16 to June 30, inclusive, Salinometer No. 5317 was used exclusively.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water of oyster ponds.		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°	
January 1, 8 a. m	Low	Cloudy	NE.	50	48	1.0134	49	1.0124	48	1.0124	46	1.0134	46	1.0134	44	1.0140
January 1, 2 p. m	High	Rain	NE.	40	44	1.0140	46	1.0134	41	1.0134	44	1.0140	44	1.0140	42	1.0140
January 2, 9 a. m	Low	Clear	N.	26	33	1.0136	33	1.0130	30½	1.0140	32	1.0140	32	1.0140	32	1.0140
January 2, 3 p. m	High	Clear	N.	30	31	1.0136	36	1.0130	35	1.0124	36	1.0136	35	1.0136	36	1.0140
January 3, 10 a. m	Low	Clear	NE.	20	32	1.0138	30½	1.0134	30½	1.0140	30½	1.0140	30½	1.0142	30½	1.0142
January 3, 4 p. m *	High	Clear	NE.	30	30½	1.0132	30½	1.0134	30½	1.0130	30½	1.0134	30½	1.0140	30½	1.0140
January 4, 11 a. m	Low	Rainy	NE.	32	31	1.0134	32	1.0132	32	1.0134	32	1.0134	32	1.0134	32	1.0134
January 4, 5 p. m	High	Rainy	NE.	34	34	1.0134	33	1.0134	33	1.0130	33	1.0138	32	1.0140	32	1.0140
January 5, 12 m	Low	Cloudy	NE.	34	36	1.0134	36	1.0110	34	1.0120	35	1.0134	36	1.0132	36	1.0138
January 5, 5 p. m	High	Cloudy	W.	35	36	1.0134	36	1.0114	36	1.0130	36	1.0138	36	1.0138	36	1.0138
January 6, 12.30 p. m	Low	Rain	SW.	49	42	1.0114	42	1.0112	42	1.0112	43	1.0120	42	1.0124	43	1.0124
January 6, 5.30 p. m	High	Rain	SW.	50	45	1.0112	45	1.0100	45	1.0112	43	1.0122	43	1.0128	45	1.0128
January 7, 6 a. m	High	Clear	NW.	42	45	1.0114	43	1.0114	43	1.0110	45	1.0120	45	1.0120	45	1.0124
January 7, 1 p. m	Low	Clear	NW.	46	45	1.0122	45	1.0120	45	1.0114	45	1.0122	45	1.0130	45	1.0130
January 8, 6.30 a. m	High	Clear	NW.	45	38	1.0120	40	1.0110	38	1.0110	38	1.0142	38	1.0144	38	1.0144
January 8, 1.30 p. m	Low	Clear	W.	58	45	1.0124	43	1.0118	43	1.0120	45	1.0122	45	1.0130	47	1.0144
January 9, 7 a. m	High	Clear	NW.	50	39	1.0130	38	1.0130	33	1.0130	40	1.0138	40	1.0138	41	1.0140
January 9, 2 p. m	Low	Clear	W.	62	45	1.0130	48	1.0126	46	1.0124	46	1.0130	43	1.0132	48	1.0136
January 10, 7.30 a. m	High	Clear	NW.	41	39	1.0136	38	1.0130	38	1.0128	37	1.0138	39	1.0142	39	1.0142
January 10, 2.30 p. m	Low	Clear	NW.	38	40	1.0134	41	1.0130	40	1.0110	39	1.0138	40	1.0136	40	1.0140
January 11, 8.30 a. m	High	Clear	SW.	45	42	1.0138	42	1.0138	42	1.0138	42	1.0142	42	1.0142	42	1.0142
January 11, 3 p. m	Low	Clear	SW.	48	41	1.0138	41	1.0134	41	1.0132	42	1.0140	42	1.0140	42	1.0142
January 12, 9.30 a. m	High	Clear	W.	60	47	1.0132	48	1.0132	48	1.0132	47	1.0132	47	1.0136	48	1.0136
January 12, 3.30 p. m	Low	Clear	W.	59	49	1.0130	51	1.0130	49	1.0128	48	1.0132	48	1.0134	48	1.0134
January 13, 10 a. m	High	Clear	NW.	45	43	1.0136	42	1.0134	43	1.0134	42	1.0140	41	1.0138	43	1.0140
January 13, 4 p. m	Low	Clear	NW.	44	44	1.0138	46	1.0136	42	1.0134	42	1.0142	42	1.0144	42	1.0144
January 14, 10.30 a. m	High	Clear	NE.	34	40	1.0138	39	1.0142	38	1.0142	39	1.0142	38	1.0142	38	1.0144
January 14, 4.30 p. m	Low	Clear	E.	39	41	1.0140	40	1.0140	41	1.0140	42	1.0142	42	1.0142	42	1.0144
January 15, 11 a. m	High	Rain	SE.	42	38	1.0138	39	1.0133	38	1.0136	38	1.0140	37	1.0138	39	1.0140
January 15, 5 p. m	Low	Rain	W.	45	40	1.0122	41	1.0130	41	1.0130	40	1.0132	39	1.0138	39	1.0140
January 16, 12 m	High	Cloudy	W.	60	42	1.0130	42	1.0124	42	1.0124	43	1.0134	44	1.0136	42	1.0136
January 16, 6 p. m	Low	Clear	SW.	54	47	1.0128	48	1.0128	48	1.0128	47	1.0124	45	1.0132	45	1.0136
January 17, 6.30 a. m	Low	Clear	NW.	44	45	1.0130	44	1.0131	45	1.0131	43	1.0138	42	1.0142	42	1.0142
January 17, 12.30 p. m	High	Clear	NW.	34	44	1.0131	44	1.0131	44	1.0134	42	1.0140	42	1.0140	42	1.0144
January 18, 7.20 a. m	Low	Clear	NW.	25	35	1.0136	35	1.0110	35	1.0110	37	1.0136	38	1.0136	38	1.0138
January 18, 1.23 p. m	High	Clear	NW.	31	35	1.0136	34	1.0110	36	1.0110	38	1.0136	37	1.0136	38	1.0138

Table of temperatures, weather, and density of water at Saint Jerome Station from January 1, 1885, to June 30, 1885, inclusive—Continued.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water of oyster ponds.		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°	
January 19, 8.15 a. m.	Low	Clear	NE.	30	30	1.0140	30	1.0138	30	1.0136	30	1.0142	30	1.0142	30	1.0154
January 19, 2.17 p. m.	High	Clear	NE.	34	35	1.0136	35	1.0130	35	1.0130	36	1.0142	36	1.0144	35	1.0144
January 20, 9.04 a. m.	Low	Clear	NE.	28	30	1.0138	30	1.0134	30	1.0132	31	1.0136	32	1.0138	32	1.0140
January 20, 3.09 p. m.	High	Cloudy	SE.	35	35	1.0138	33	1.0136	33	1.0136	34	1.0130	34	1.0130	33	1.0130
January 21, 10 a. m.	Low	Clear	NE.	45	35	1.0138	35	1.0136	35	1.0136	35	1.0138	35	1.0140	35	1.0142
January 21, 4 p. m.	High	Clear	NE.	42	37	1.0136	37	1.0124	37	1.0124	38	1.0140	38	1.0140	38	1.0142
January 22, 11 a. m.	Low	Clear	N.	18	30	1.0140	31	1.0136	31	1.0136	31	1.0144	31	1.0142	31	1.0150
January 22, 5 p. m.	High	Clear	NW.	20	30	1.0140	31	1.0130	31	1.0130	31	1.0140	31	1.0140	31	1.0144
January 23, 11.45 a. m.	Low	Clear	W.	26	31	1.0146	31	1.0110	31	1.0110	31	1.0126	31	1.0136	31	1.0150
January 23, 5.30 p. m.	High	Cloudy	S.	30	31	1.0128	31	1.0100	31	1.0120	31	1.0120	31	1.0124	31	1.0114
January 24, 6.15 a. m.	High	Rain	W.	30	33	1.0090	33	*1.0114	33	1.0118	34	1.0120	34	1.0062	34	1.0040
January 24, 12.45 p. m.	Low	Cloudy	NW.	40	35	*1.0040	35	*1.0112	35	*1.0122	34	1.0122	34	1.0092	34	1.0080
January 25, 7.30 a. m.	High	Cloudy	SW.	48	37	*1.0080	37	*1.0120	37	*1.0122	38	1.0122	37	1.0122	37	1.0122
January 25, 2 p. m.	Low	Cloudy	SW.	52	37	1.0114	38	1.0104	37	*1.0030	40	*1.0040	40	1.0124	40	1.0124
January 26, 8.50 a. m.	High	Clear	NW.	36	34	1.0116	34	1.0112	34	1.0112	35	1.0122	35	1.0122	35	1.0124
January 26, 3 p. m.	Low	Clear	NW.	36	35	*1.0110	35	*1.0106	36	*1.0106	37	1.0114	38	1.0126	39	1.0126
January 27, 9.50 a. m.	High	Clear	E.	32	33	1.0118	33	1.0116	33	1.0116	33	1.0120	33	1.0122	33	1.0122
January 27, 4 p. m.	Low	Clear	SE.	36	37	1.0116	38	1.0106	38	1.0118	36	1.0118	36	1.0126	36	1.0128
January 28, 10.50 a. m.	High	Sleet	NW.	32	35	1.0120	35	1.0116	35	1.0120	37	1.0122	37	1.0122	36	1.0122
January 28, 5 p. m.	Low	Clear	N.	33	32	1.0118	31	1.0118	31	1.0112	30½	1.0120	30	1.0124	30	1.0124
January 29, 11.50 a. m.	High	Clear	W.	18	30	1.0122	30	1.0112	30	1.0118	30	1.0118	30	1.0120	30	1.0122
January 29, 6.15 p. m.	Low	Clear	W.	32	34	1.0122	34	1.0120	35	1.0122	35	1.0122	35	1.0122	35	1.0130
January 30, 12.40 p. m.	High	Clear	W.	44	35	1.0126	37	1.0126	37	1.0126	36	1.0122	35	1.0126	35	1.0130
January 30, 7 p. m.	Low	Cloudy	W.	48	38	1.0124	39	1.0100	38	1.0110	35	1.0122	37	1.0124	37	1.0126
January 31, 7 a. m.	Low	Clear	E.	38	33	1.0122	34	1.0116	33	1.0116	34	1.0128	34	1.0122	34	1.0128
January 31, 1.15 p. m.	High	Cloudy	E.	48	39	1.0120	40	1.0112	40	1.0124	40	1.0126	38	1.0126	38	1.0126
February 1, 8 a. m.	Low	Clear	SW.	37	37	1.0120	38	1.0112	37	1.0114	36	1.0122	35	1.0122	35	1.0124
February 1, 2.20 p. m.	High	Clear	NW.	44	40	1.0122	40	1.0120	40	1.0120	38	1.0124	37	1.0124	42	1.0124
February 2, 8.56 a. m.	Low	Clear	NW.	25	30	1.0116	32	1.0110	31	1.0110	30	1.0112	30	1.0112	30	1.0116
February 2, 2.56 p. m.	High	Clear	NW.	38	33	1.0122	33	1.0120	34	1.0120	35	1.0124	35	1.0126	35	1.0130
February 3, 9.40 a. m.	Low	Clear	SW.	45	33	1.0124	36	1.0122	34	1.0122	33	1.0124	33	1.0124	34	1.0124
February 3, 3.40 p. m.	High	Clear	SE.	44	38	1.0128	36	1.0126	37	1.0126	37	1.0128	37	1.0126	38	1.0126
February 4, 10.30 a. m.	Low	Clear	E.	42	37	1.0124	37	1.0124	36	1.0124	38	1.0124	38	1.0126	38	1.0128
February 4, 4.40 p. m.	High	Clear	E.	45	38	1.0128	39	1.0126	38	1.0126	38	1.0126	38	1.0124	38	1.0124
February 5, 11.20 a. m.	Low	Clear	NE.	42	42	1.0122	40	1.0122	42	1.0120	40	1.0124	40	1.0126	40	1.0126
February 5, 5.20 p. m.	High	Clear	NE.	40	44	1.0124	42	1.0126	43	1.0126	39	1.0126	39	1.0126	40	1.0130
February 6, 12.20 p. m.	Low	Cloudy	NE.	31	35	1.0123	35	1.0126	35	1.0126	36	1.0124	37	1.0126	36	1.0128
February 6, 5.55 p. m.	High	Clear	NNW.	30	34	1.0126	34	1.0126	33	1.0125	34	1.0126	35	1.0126	35	1.0126
February 7, 7 a. m.	High	Clear	E.	25	32	1.0123	32	1.0120	33	1.0122	32	1.0126	33	1.0126	34	1.0123

February 7, 1.15 p. m	Low	Clear	E.	34	34	1.0124	33	1.0126	34	1.0128	35	1.0126	34	1.0126	34	1.0126
February 8, 8 a. m	High	Cloudy	SW.	38	36	1.0122	36	1.0122	36	1.0122	35	1.0122	34	1.0122	35	1.0124
February 8, 2.20 p. m	Low	Clear	NE.	42	40	1.0124	42	1.0124	40	1.0124	40	1.0126	40	1.0126	38	1.0124
February 9, 9 a. m	High	Cloudy	E.	38	37	1.0122	37	1.0122	37	1.0122	37	1.0124	36	1.0122	37	1.0124
February 9, 3.30 p. m	Low	Cloudy	NE.	42	37	1.0122	37	1.0122	37	1.0122	37	1.0124	36	1.0124	37	1.0124
February 10, 10 a. m	High	Rain	NW.	40	37	1.0122	36	1.0122	36	1.0122	37	1.0122	38	1.0122	38	1.0122
February 10, 4.20 p. m	Low	Cloudy	NW.	30	36	1.0122	37	1.0120	38	1.0120	38	1.0122	38	1.0122	38	1.0122
February 11, 10.40 a. m	High	Clear	NW.	12	30½	1.0124	30½	1.0112	30½	1.0112	30½	1.0122	30½	1.0124	30½	1.0124
February 11, 5.25 p. m	Low	Clear	NW.	22	30½	1.0124	30½	1.0124	30½	1.0128	30½	1.0128	30½	1.0128	30½	1.0128
February 12–23 *a*																
February 24, 9 a. m	High	Cloudy	SE.	25	32	1.0116	31	1.0114	31	1.0114	31	1.0120	33	1.0120	33	1.0120
February 24, 3 p. m	Low	Snow	SE.	30	32	1.0114	31	1.0112	31	1.0112	32	1.0118	33	1.0120	33	1.0120
February 25, 10 a. m	High	Cloudy	NE.	32	32	1.0116	31	1.0114	31	1.0114	32	1.0118	32	1.0118	32	1.0118
February 25, 4 p. m	Low	Clear	E.	34	32	1.0112	32	1.0110	32	1.0110	32	1.0114	32	1.0114	32	1.0118
February 26, 11 a. m	High	Cloudy	NE.	34	32	1.0116	31	*1.0092	31	*1.0100	32	1.0118	32	1.0122	32	1.0122
February 26, 5 p. m	Low	Snow	NE.	34	32	*1.0098	31	*1.0094	31	*1.0102	31	1.0116	32	1.0116	32	1.0122
February 27, 12 m	High	Clear	SW.	34	33	*1.0104	32	*1.0098	32	*1.0098	33	1.0120	33	1.0120	34	1.0122
February 27, 6 p. m	Low	Clear	W.	38	33	*1.0026	32	*1.0108	32	*1.0108	31	1.0112	33	1.0116	33	1.0122
February 28, 7 a. m	Low	Clear	SE.	38	34	*1.0082	34	*1.0082	34	*1.0080	35	1.0126	35	1.0122	35	1.0122
February 28, 1 p. m	High	Clear	SW.	52	37	*1.0050	37	*1.0076	35	*1.0070	37	1.0120	38	1.0122	37	1.0122
March 1, 8 a. m	Low	Cloudy	SW.	44	36	*1.0104	36	*1.0068	36	*1.0068	36	*1.0102	37	1.0120	37	1.0120
March 1, 2 p. m	High	Rain	SW.	52	37	*1.0100	38	*1.0088	37	1.0088	37	1.0116	37	1.0118	37	1.0118
March 2, 9 a. m	Low	Clear	NW.	32	37	*1.0010	35	*1.0020	36	*1.0020	37	*1.0040	36	*1.0106	36	1.0118
March 2, 3 p. m	High	Clear	NW.	44	38	*1.0076	37	*1.0078	37	*1.0078	38	1.0104	39	1.0116	38	1.0120
March 3, 10 a. m	Low	Clear	NW.	38	36	*1.0070	37	*1.0070	35	*1.0076	36	*1.0070	37	1.0112	37	1.0120
March 3, 4 p. m	High	Clear	NW.	52	38	1.0100	39	1.0116	37	1.0110	39	1.0100	39	1.0118	41	1.0120
March 4, 11 a. m	Low	Clear	SW.	68	47	1.0104	48	1.0100	48	1.0100	47	1.0110	46	1.0112	49	1.0118
March 4, 5 p. m	High	Clear	E.	48	48	1.0112	46	1.0104	47	1.0106	43	1.0120	42	1.0122	42	1.0124
March 5, 12 m	Low	Clear	NW.	51	45	1.0110	46	1.0100	46	1.0103	45	1.0118	45	1.0118	45	1.0120
March 5, 6 p. m	High	Clear	NW.	45	44	1.0116	44	1.0102	44	1.0100	40	1.0122	39	1.0122	41	1.0122
March 6, 7 a. m	High	Clear	E.	34	42	1.0114	41	1.0118	41	1.0118	39	1.0120	39	1.0122	39	1.0124
March 6, 1 p. m	Low	Clear	E.	54	45	1.0116	47	1.0116	47	1.0116	50	1.0114	50	1.0116	49	1.0120
March 7, 8 a. m	High	Clear	SE.	40	41	*1.0100	41	*1.0080	40	*1.0080	40	1.0118	41	1.0120	42	1.0124
March 7, 2 p. m	Low	Clear	SE.	54	43	1.0116	42	1.0110	42	1.0114	42	1.0116	43	1.0120	43	1.0124
March 8, 9 a. m	High	Cloudy	E.	40	41	1.0118	40	1.0118	40	1.0118	41	1.0120	41	1.0122	42	1.0122
March 8, 3 p. m	Low	Cloudy	E.	40	42	1.0116	43	1.0114	43	1.0112	43	1.0118	42	1.0120	42	1.0122
March 9, 10 a. m	High	Clear	NW.	50	32	1.0114	34	1.0116	32	1.0116	37	1.0120	37	1.0124	37	1.0124
March 9, 4 p. m	Low	Clear	SW.	44	41	1.0116	40	1.0110	40	1.0112	41	1.0118	42	1.0122	42	1.0124
March 10, 11 a. m	High	Clear	W.	50	43	1.0114	42	1.0110	42	1.0110	47	1.0120	46	1.0122	47	1.0128
March 10, 5 p. m	Low	Clear	E.	48	41	1.0116	41	1.0118	40	1.0120	40	1.0122	40	1.0124	40	1.0124
March 11, 12 m	High	Clear	SE.	54	42	1.0120	42	1.0118	42	1.0118	42	1.0122	44	1.0124	42	1.0128
March 11, 6 p. m	Low	Cloudy	SW.	36	40	1.0120	40	1.0116	41	1.0114	41	1.0120	41	1.0124	41	1.0128
March 12 *b*																
March 13, 7 a. m	Low	Snow	NE.	28	32	1.0120	32	1.0116	32	1.0120	32	1.0120	32	1.0128	32	1.0130
March 13, 1.30 p. m	High	Snow	NE.	30	34	1.0126	34	1.0126	34	1.0124	34	1.0130	34	1.0130	34	1.0130
March 14, 8.30 a. m	Low	Clear	NW.	40	39	1.0120	36	1.0120	36	1.0122	38	1.0124	37	1.0130	37	1.0130
March 14, 2 p. m	High	Clear	NW.	42	38	1.0122	38	1.0120	37	1.0120	39	1.0124	39	1.0130	39	1.0130
March 15, 9 a. m	Low	Rain	SW.	44	42	1.0120	42	1.0120	42	1.0120	42	1.0120	42	1.0122	42	1.0124
March 15, 2.20 p. m	High	Rain	SW.	48	44	1.0122	44	1.0122	46	1.0122	47	1.0124	47	1.0124	47	1.0122
March 16, 9.15 a. m	Low	Clear	SW.	50	44	1.0124	48	1.0122	44	1.0122	48	1.0126	46	1.0130	44	1.0140

a The ponds and canal froze up, and the bay froze out 100 yards. No records were kept again until February 24, when it began to thaw.

b No record kept.

Table of temperatures, weather, and density of water at Saint Jerome Station from January 1, 1885, to June 30, 1885, inclusive—Continued.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water of oyster ponds.		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°	
March 16, 2.30 p. m	High	Clear	SW.	52	43	1.0122	41	1.0122	44	1.0124	45	1.0128	42	1.0132	43	1.0132
March 17, 9.30 a. m	Low	Clear	NW.	28	32	1.0120	32	1.0120	32	1.0120	32	1.0122	32	1.0128	32	1.0128
March 17, 3 p. m	High	Cloudy	NW.	26	32	1.0122	32	1.0122	32	1.0122	32	1.0126	32	1.0128	32	1.0130
March 18, 9.50 a. m	Low	Clear	NW.	26	36	1.0124	36	1.0126	36	1.0126	37	1.0130	37	1.0130	37	1.0130
March 18, 3.20 p. m	High	Clear	NW.	32	38	1.0128	39	1.0128	37	1.0128	38	1.0132	37	1.0132	37	1.0132
March 19, 10 a. m	Low	Cloudy	SW.	31	37	1.0124	37	1.0124	37	1.0124	37	1.0130	37	1.0130	37	1.0130
March 19, 3.30 p. m	High	Cloudy	NW.	31	36	1.0124	35	1.0124	35	1.0124	35	1.0128	35	1.0132	35	1.0132
March 20, 10 a. m	Low	Clear	NW.	30	30	1.0124	30	1.0124	30	1.0124	30	1.0124	30	1.0128	30	1.0130
March 20, 3.40 p. m	High	Clear	NW.	20	30	1.0124	30	1.0124	30	1.0122	30	1.0128	30	1.0132	31	1.0132
March 21, 10.30 a. m	Low	Clear	NW.	30	31	1.0124	31	1.0124	31	1.0124	31	1.0128	31	1.0130	31	1.0132
March 21, 4.10 p. m	High	Clear	W.	30	32	1.0124	32	1.0124	32	1.0124	32	1.0132	32	1.0130	32	1.0134
March 22, 11 a. m	Low	Snow	NE.	20	31	1.0120	31	1.0118	31	1.0120	31	1.0128	31	1.0120	31	1.0122
March 22, 4.50 p. m	High	Snow	NE.	20	31	1.0120	31	1.0120	31	1.0118	31	1.0126	31	1.0124	31	1.0128
March 23, 12 m	Low	Cloudy	NW.	24	31	1.0130	31	1.0120	31	1.0120	31	1.0130	31	1.0130	31	1.0134
March 23, 5.50 p. m	High	Clear	NW.	22	32	1.0130	31	*1.0100	31	*1.0100	31	1.0128	31	1.0128	31	1.0134
March 24, 1.15 p. m	Low	Clear	W.	40	34	1.0130	35	1.0100	36	1.0110	36	1.0122	36	1.0130	36	1.0130
March 24, 7.20 p. m	High	Clear	SW.	33	36	1.0126	36	1.0116	36	1.0118	35	1.0130	35	1.0130	35	1.0132
March 25, 8.45 a. m	High	Clear	NW.	49	35	1.0126	38	1.0122	38	1.0122	36	1.0134	37	1.0134	38	1.0134
March 25, 2.45 p. m	Low	Clear	NW.	51	42	1.0126	43	*1.0100	43	*1.0102	43	1.0130	42	1.0130	42	1.0130
March 26, 9.50 a. m	High	Clear	NE.	50	47	1.0128	47	1.0126	47	1.0126	46	1.0130	45	1.0132	50	1.0132
March 26, 3.30 p. m	Low	Clear	SE.	48	49	1.0116	47	1.0116	47	1.0114	48	1.0124	47	1.0128	49	1.0128
March 27, 10.25 a. m	High	Clear	SW.	52	51	1.0128	51	1.0126	51	1.0124	51	1.0126	52	1.0130	52	1.0124
March 27, 4.50 p. m	Low	Cloudy	SW.	56	52	1.0122	52	1.0122	52	1.0122	52	1.0126	52	1.0124	52	1.0124
March 28, 11.17 a. m	High	Cloudy	SW.	54	52	1.0124	52	1.0124	52	1.0124	52	1.0126	52	1.0128	52	1.0128
March 28, 5.40 p. m	Low	Rain	E.	51	52	1.0126	54	1.0126	54	1.0126	52	1.0126	52	1.0128	54	1.0124
March 29, 12 m	High	Clear	NW.	34	38	1.0128	38	1.0128	38	1.0128	38	1.0128	38	1.0132	38	1.0134
March 29, 6.40 p. m	Low	Clear	NW.	44	42	1.0130	42	1.0130	42	1.0130	43	1.0128	43	1.0132	42	1.0134
March 30, 7.45 a. m	Low	Clear	SW.	40	41	1.0128	42	1.0130	42	1.0130	42	1.0124	42	1.0132	42	1.0134
March 30, 1.10 p. m	High	Clear	SW.	45	46	1.0128	46	1.0128	44	1.0126	44	1.0130	46	1.0136	45	1.0134
March 31, 9 a. m	Low	Clear	SW.	50	50	1.0126	52	1.0126	52	1.0126	51	1.0126	50	1.0123	51	1.0128
March 31, 2 p. m	High	Clear	SE.	60	54	1.0122	55	1.0124	55	1.0124	56	1.0126	56	1.0128	55	1.0128
April 1, 10 a. m	Low	Clear	SW.	60	58	1.0128	57	1.0118	56	1.0118	56	1.0126	53	1.0120	57	1.0130
April 1, 3.30 p. m	High	Clear	SW.	64	58	1.0128	57	1.0126	59	1.0126	59	1.0120	59	1.0126	59	1.0128
April 2, 11 a. m	Low	Clear	SW.	65	57	1.0126	58	1.0126	57	1.0126	57	1.0128	57	1.0128	57	1.0128
April 2, 4.30 p. m	High	Clear	SW.	65	58	1.0126	58	1.0126	57	1.0126	58	1.0130	58	1.0128	59	1.0130
April 3, 12 m	Low	Clear	SW.	68	60	1.0126	58	1.0124	58	1.0124	59	1.0128	59	1.0128	58	1.0128
April 3, 6 p. m	High	Cloudy	SW.	62	58	1.0126	57	1.0126	57	1.0126	55	1.0128	57	1.0130	58	1.0130
April 4, 12.30 p. m	Low	Cloudy	SW.	43	53	1.0128	54	1.0128	53	1.0128	53	1.0126	51	1.0130	51	1.0130
April 4, 6.30 p. m	High	Clear	NW.	43	52	1.0128	51	1.0123	50	1.0123	50	1.0132	50	1.0132	50	1.0132

April 5, 7 a. m	High	Clear	NW.	45	44	1.0128	44	1.0128	46	1.0128	44	1.0130	46	1.0130	44	1.0132
April 5, 1 p. m	Low	Clear	W.	55	49	1.0128	50	1.0128	57	1.0128	50	1.0130	54	1.0130	55	1.0130
April 6, 7.45 a. m	High	Clear	NW.	53	54	1.0130	54	1.0130	54	1.0130	55	1.0132	53	1.0132	52	1.0134
April 6, 1.45 p. m	Low	Clear	NW.	70	58	1.0128	59	1.0128	59	1.0126	60	1.0128	59	1.0128	60	1.0132
April 7, 8.30 a. m	High	Clear	SE.	55	55	1.0126	55	1.0126	55	1.0128	55	1.0128	56	1.0128	56	1.0130
April 7, 2.30 p. m	Low	Clear	SE.	63	55	1.0128	55	1.0128	55	1.0128	55	1.0128	56	1.0128	56	1.0130
April 8, 9.20 a. m	High	Cloudy	W.	62	62	1.0120	59	1.0124	58	1.0128	62	1.0122	62	1.0124	58	1.0128
April 8, 3.15 p. m	Low	Rain	W.	65	64	1.0120	62	1.0120	62	1.0120	62	1.0124	62	1.0124	62	1.0126
April 9, 10 a. m	High	Clear	NW.	42	62	1.0130	49	1.0120	48	1.0120	48	1.0134	49	1.0134	48	1.0134
April 9, 4 p. m	Low	Clear	NW.	44	54	1.0120	53	1.0110	50	1.0110	48	1.0130	48	1.0132	51	1.0134
April 10, 11 a. m	High	Clear	E.	42	45	1.0124	45	1.0124	46	1.0128	46	1.0124	45	1.0120	45	1.0128
April 10, 5 p. m	Low	Clear	E.	42	48	1.0122	48	1.0130	46	1.0130	46	1.0124	46	1.0128	45	1.0122
April 11, 12 m	High	Rain	SW.	44	41	1.0118	43	1.0120	43	1.0112	43	1.0112	44	1.0114	44	1.0120
April 11, 6 p. m	Low	Cloudy	SW.	45	46	1.0120	47	1.0120	47	1.0120	46	1.0120	46	1.0120	46	1.0120
April 12, 12.30 p. m	High	Clear	NW.	54	52	1.0110	52	1.0110	53	1.0110	54	1.0110	55	1.0114	54	1.0112
April 12, 6.30 p. m	Low	Clear	NE.	54	52	1.0112	54	1.0106	54	1.0108	54	1.0112	56	1.0114	56	1.0114
April 13, 1 p. m	High	Cloudy	NW.	48	52	1.0110	52	1.0110	52	1.0110	55	1.0110	53	1.0110	54	1.0110
April 13, 7 p. m	Low	Cloudy	NW.	49	52	1.0110	54	1.0110	53	1.0103	52	1.0114	48	1.0110	52	1.0110
April 14, 8 a. m	Low	Clear	NW.	38	41	1.0116	42	1.0116	42	1.0118	41	1.0118	42	1.0118	41	1.0118
April 14, 1.30 p. m	High	Clear	NW.	44	51	1.0112	51	1.0110	52	1.0110	47	1.0100	48	1.0110	51	1.0110
April 15, 8.30 a. m	Low	Clear	SW.	45	48	1.0110	48	1.0110	48	*1.0100	48	*1.0094	48	*1.0094	48	*1.0092
April 15, 2.15 p. m	High	Cloudy	SW.	50	49	*1.0094	49	*1.0094	49	*1.0094	49	*1.0092	49	*1.0092	49	*1.0092
April 16, 9.30 a. m	Low	Clear	NE.	55	50	1.0098	50	1.0098	50	1.0098	49	1.0098	49	1.0106	49	1.0106
April 16, 3.20 p. m	High	Clear	E.	65	55	1.0098	56	1.0098	57	1.0096	55	1.0094	57	1.0098	58	1.0104
April 17, 10 a. m	Low	Clear	E.	52	50	1.0100	50	1.0100	53	1.0100	49	1.0100	50	1.0100	50	1.0100
April 17, 4 p. m	High	Clear	E.	53	52	1.0096	54	1.0096	52	1.0096	52	1.0096	54	1,0096	52	1.0096
April 18, 11 a. m	Low	Clear	E.	64	54	1.0096	54	1.0096	54	1.0096	53	1.0096	54	1.0098	54	1.0096
April 18, 5 p. m	High	Clear	SE.	60	54	1.0096	54	1.0096	54	1.0096	54	1.0098	54	1.0096	56	1.0096
April 19, 11.40 a. m	Low	Clear	E.	69	55	1.0094	56	1.0094	57	1.0098	57	1.0090	57	1.0088	57	1.0096
April 19, 5.30 p. m	High	Clear	SE.	63	58	1.0094	58	1.0096	58	1.0094	57	1.0096	58	1.0098	59	1.0096
April 20, 12.30 p. m	Low	Clear	SE.	65	65	1.0088	65	1.0088	65	1.0092	64	1.0094	64	1.0092	64	1.0096
April 20, 6.15 p. m	High	Clear	SW.	60	65	1.0088	65	1.0088	66	1.0086	67	1.0094	62	1.0092	65	1.0086
April 21, 7.45 a. m	High	Clear	S.	60	65	1.0080	65	1.0080	66	1.0080	67	1.0080	62	1.0086	65	1.0088
April 21, 1.30 p. m	Low	Clear	SE.	70	65	1.0084	65	1.0084	65	1.0080	65	1.0080	65	1.0080	65	1.0084
April 22, 9 a. m	High	Clear	S.	69	65	1.0084	65	1.0090	65	1.0090	62	1.0090	61	1.0084	61	1.0084
April 22, 3 p. m	Low	Clear	SE.	82	69	1.0080	72	1.0080	74	1.0080	72	1.0080	70	1.0076	71	1.0080
April 23, 10 a. m	High	Clear	SE.	70	66	1.0086	66	1.0082	63	1.0082	62	1.0076	62	1.0080	62	1.0082
April 23, 4 p. m	Low	Clear	SE.	76	73	1.0076	73	1.0078	72	1.0080	68	1.0082	74	1.0076	74	1.0076
April 24, 10.40 a. m	High	Clear	S.	70	66	1.0088	66	1.0088	66	1.0086	65	1.0082	65	1.0086	65	1.0082
April 24, 4.30 p. m	Low	Cloudy	SE.	78	69	1.0084	68	1.0086	68	1.0084	67	1.0084	67	1.0084	67	1.0084
April 25, 11.20 a. m	High	Clear	SW.	70	70	1.0082	69	1.0080	69	1.0080	70	1.0080	68	1.0080	68	1.0080
April 25, 5.20 p. m	Low	Cloudy	SW.	70	67	1.0084	68	1.0080	68	1.0080	68	1.0080	68	1.0082	67	1.0084
April 26, 12 m	High	Rain	SW.	60	65	1.0080	70	1.0076	70	1.0072	68	1.0080	67	1.0080	67	1.0084
April 26, 6 p. m	Low	Cloudy	SW.	61	67	1.0078	67	1.0080	70	1.0072	67	1.0080	67	1.0080	68	1.0080
April 27, 1 p. m	High	Clear	NW.	75	65	1.0090	67	1.0082	67	1.0084	67	1.0090	67	1.0088	67	1.0092
April 27, 7 p. m	Low	Clear	SW.	69	64	1.0080	65	1.0084	65	1.0084	65	1.0090	65	1.0088	65	1.0092
April 28, 8 a. m	Low	Cloudy	SW.	60	65	1.0090	65	1.0082	64	1.0082	66	1.0082	65	1.0082	65	1.0090
April 28, 2 p. m	High	Rain	SW.	65	66	1.0090	66	1.0090	65	1.0090	65	1.0090	65	1.0090	65	1.0090
April 29, 9 a. m	Low	Clear	NW.	50	55	1.0100	55	1.0098	55	1.0098	55	1.0100	55	1.0098	55	1.0102
April 29, 3 p. m	High	Clear	NW.	64	62	1.0092	65	1.0090	62	1.0090	60	1.0100	60	1.0100	60	1.0100
April 30, 9.45 a. m	Low	Clear	N.	70	59	1.0098	59	1.0098	59	1.0097	59	1.0100	59	1.0100	59	1.0100
April 30, 3.30 p. m	High	Cloudy	SW.	65	62	1.0036	63	1.0096	63	1.0098	62	1.0100	63	1.0100	62	1.0100

Table of temperatures, weather, and density of water at Saint Jerome Station from January 1, 1885, to June 30, 1885, inclusive—Continued.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water of oyster ponds. *a*		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°	
May 1 *b*																
May 2, 11 a. m	Low	Clear	NW.	65	60	1.0094	60	1.0094	61	1.0094	59	1.0094	59	1.0098	61	1.0100
May 2, 4.30 p. m	High	Clear	NW.	57	62	1.0093	60	1.0094	59	1.0090	59	1.0096	59	1.0096	59	1.0100
May 3, 11.30 a. m	Low	Cloudy	SE.	60	62	1.0096	62	1.0092	62	1.0092	62	1.0096	62	1.0094	63	1.0100
May 3, 5 p. m	High	Cloudy	SW.	58	62	1.0096	62	1.0094	62	1.0094	63	1.0094	63	1.0096	63	1.0100
May 4, 12 m	Low	Clear	W.	70	62	1.0100	63	1.0094	62	1.0094	63	1.0094	62	1.0096	63	1.0100
May 4, 6 p. m	High	Clear	NW.	60	62	1.0092	62	1.0094	63	1.0094	62	1.0094	62	1.0094	63	1.0098
May 5, 7 a. m	High	Cloudy	NW.	65	65	1.0094	63	1.0094	65	1.0094	64	1.0096	64	1.0100	64	1.0100
May 5, 8 p. m	Low	Clear	NW.	70	64	1.0094	64	1.0094	64	1.0094	63	1.0096	63	1.0100	63	1.0100
May 6, 8 a. m	High	Cloudy	SW.	67	65	1.0096	65	1.0100	65	1.0100	65	1.0096	65	1.0100	65	1.0100
May 6, 2 p. m	Low	Cloudy	SW.	63	66	1.0096	66	1.0098	66	1.0098	66	1.0100	66	1.0098	66	1.0100
May 7, 9 a. m	High	Rain	SE.	68	67	1.0098	67	1.0094	66	1.0098	66	1.0096	66	1.0100	66	1.0100
May 7, 2.30 p. m	Low	Rain	NW.	70	67	1.0098	67	1.0094	67	1.0094	67	1.0093	67	1.0098	67	1.0100
May 8, 10 a. m	High	Cloudy	NW.	70	67	1.0094	68	1.0094	68	1.0094	68	1.0092	68	1.0096	68	1.0098
May 8, 3.30 p. m	Low	Clear	NW.	65	68	1.0094	68	1.0094	68	1.0094	68	1.0096	68	1.0096	68	1.0098
May 9 *b*																
May 10, 11 a. m	High	Clear	E.	58	64	1.0098	64	1.0098	61	1.0098	64	1.0100	64	1.0102	64	1.0102
May 10, 4.30 p. m	Low	Clear	E.	60	64	1.0096	64	1.0094	64	1.0094	64	1.0096	64	1.0096	64	1.0102
May 11, 11.30 a. m	High	Clear	NW.	58	64	1.0100	64	1.0100	64	1.0100	64	1.0100	64	1.0102	64	1.0102
May 11, 5.15 p. m	Low	Clear	SW.	60	67	1.0092	67	1.0094	67	1.0094	67	1.0094	67	1.0096	67	1.0096
May 12, 12 m	High	Clear	SW.	59	64	1.0098	64	1.0098	64	1.0098	64	1.0098	64	1.0100	64	1.0102
May 12, 6 p. m	Low	Cloudy	SW.	53	64	1.0100	64	1.0100	64	1.0100	64	1.0100	64	1.0100	64	1.0100
May 13, 12.30 p. m	High	Rain	E.	57	58	1.0096	58	1.0096	58	1.0100	58	1.0100	56	1.0102	56	1.0102
May 13, 6.30 p. m	Low	Rain	NE.	56	58	1.0096	58	1.0096	58	1.0096	56	1.0100	56	1.0100	56	1.0102
May 14, 7.30 a. m	Low	Cloudy	NE.	60	65	1.0094	67	1.0074	67	1.0084	67	1.0094	65	1.0094	65	1.0096
May 14, 1.30 p. m	High	Clear	NE.	61	65	1.0086	65	1.0090	65	1.0090	65	1.0090	65	1.0092	65	1.0096
May 15, 8.45 a. m	Low	Clear	NE.	66	65	1.0096	65	1.0095	65	1.0096	65	1.0098	65	1.0098	65	1.0100
May 15, 2.30 p. m	High	Clear	NE.	70	67	1.0094	67	1.0096	67	1.0096	68	1.0098	67	1.0098	67	1.0100
May 16, 10 a. m	Low	Clear	E.	72	60	1.0094	65	1.0094	65	1.0090	65	1.0094	65	1.0096	65	1.0100
May 16, 4.30 p. m	High	Clear	E.	75	65	1.0094	66	1.0094	66	1.0090	67	1.0092	65	1.0096	65	1.0098
May 17, 10.30 a. m	Low	Cloudy	E.	58	69	1.0086	68	1.0088	68	1.0088	68	1.0090	68	1.0090	68	1.0090
May 17, 5 p. m	High	Rain	E.	56	65	1.0096	65	1.0092	65	1.0092	65	1.0098	65	1.0096	65	1.0100
May 18, 11 a. m	Low	Clear	NE.	70	64	1.0096	64	1.0092	64	1.0092	64	1.0092	64	1.0094	64	1.0093
May 18, 5.30 p. m	High	Clear	NE.	70	68	1.0090	68	1.0092	68	1.0092	68	1.0094	68	1.0094	68	1.0094
May 19, 12 m	Low	Clear	SW.	78	72	1.0082	72	1.0082	72	1.0080	72	1.0082	72	1.0084	72	1.0086
May 19, 6 p. m	High	Clear	SW.	70	72	1.0086	72	1.0082	71	1.0082	74	1.0086	72	1.0086	72	1.0086
May 20, 1 p. m	Low	Clear	SW.	78	72	1.0082	73	1.0082	73	1.0082	72	1.0084	72	1.0086	72	1.0086
May 20, 7 p. m	High	Cloudy	SW.	72	72	1.0082	74	1.0082	74	1.0082	74	1.0082	74	1.0082	74	1.0082
May 21, 8 a. m	High	Cloudy	SW.	78	77	1.0076	77	1.0080	77	1.0080	76	1.0084	74	1.0084	74	1.0084

May 21, 2 p. m	Low	Rain	SW.	72	75	1.0080	74	1.0080	74	1.0080	74	1.0082	74	1.0082	74	1.0084
May 22, 9 a. m	High	Rain	E.	72	72	1.0080	72	1.0080	72	1.0080	72	1.0082	72	1.0082	72	1.0082
May 22, 3 p. m	Low	Rain	SE.	70	71	1.0082	71	1.0080	72	1.0080	72	1.0080	71	1.0082	71	1.0082
May 23, 10 a. m	High	Clear	SW.	78	77	1.0080	77	1.0080	77	1.0089	76	1.0080	74	1.0080	78	1.0080
May 23, 4 p. m	Low	Clear	SW.	72	74	1.0080	74	1.0080	74	1.0080	76	1.0080	77	1.0080	78	1.0080
May 24, 10.30 a. m	High	Clear	E.	68	78	1.0088	78	1.0088	68	1.0086	67	1.0080	69	1.0088	69	1.0088
May 24, 4.30 p. m	Low	Rain	SE.	65	69	1.0086	69	1.0086	69	1.0086	69	1.0086	69	1.0088	69	1.0088
May 25, 11 a. m	High	Clear	E.	72	68	1.0088	68	1.0088	68	1.0084	68	1.0088	68	1.0084	68	1.0088
May 25, 5 p. m	Low	Clear	SE.	75	68	1.0082	73	1.0084	73	1.0080	73	1.0080	73	1.0084	73	1.0084
May 26, 11.40 a. m	High	Clear	NE.	80	75	1.0080	75	1.0080	75	1.0080	75	1.0080	75	1.0080	75	1.0080
May 26, 5.40 p. m	Low	Cloudy	NE.	78	76	1.0080	76	1.0080	76	1.0080	76	1.0080	76	1.0080	76	1.0080
May 27, 12.20 p. m	High	Rain	E.	76	73	1.0084	73	1.0084	73	1.0084	73	1.0082	73	1.0084	73	1.0081
May 27, 6.20 p. m	Low	Rain	E.	72	73	1.0084	73	1.0082	73	1.0082	73	1.0082	73	1.0084	73	1.0084
May 28, 1 p. m	High	Cloudy	NE.	75	73	1.0080	72	1.0080	72	1.0080	72	1.0082	72	1.0082	72	1.0082
May 28, 7 p. m	Low	Cloudy	E.	72	72	1.0080	73	1.0080	73	1.0080	73	1.0080	73	1.0080	73	1.0080
May 29, 7.40 a. m	Low	Rain	E.	66	66	1.0082	66	1.0084	66	1.0084	66	1.0084	66	1.0084	66	1.0084
May 29, 1.40 p. m	High	Rain	E.	65	65	1.0082	65	1.0082	65	1.0082	65	1.0084	65	1.0084	65	1.0084
May 30, 8.30 a. m	Low	Cloudy	E.	71	70	1.0082	70	1.0082	70	1.0080	70	1.0080	70	1.0082	70	1.0084
May 30, 2.30 p. m	High	Cloudy	E.	72	70	1.0082	70	1.0082	70	1.0084	70	1.0082	70	1.0082	77	1.0084
May 31, 9.20 a. m	Low	Cloudy	E.	76	76	1.0070	77	1.0070	77	1.0070	77	1.0066	79	1.0070	77	1.0070
May 31, 3.20 p. m	High	Rain	E.	74	77	1.0070	77	1.0070	78	1.0070	79	1.0070	79	1.0070	79	1.0072
June 1, 10 a. m	Low	Clear	NW.	76	76	1.0080	76	1.0080	78	1.0082	76	1.0074	76	1.0074	79	1.0074
June 1, 4 p. m	High	Clear	NE.	74	76	1.0080	76	1.0080	77	1.0080	78	1.0080	77	1.0080	78	1.0080
June 2 *b*																
June 3, 10.30 a. m	Low	Clear	SW.	80	77	1.0070	79	1.0070	79	1.0070	77	1.0070	79	1.0070	79	1.0072
June 3, 4.30 p. m	High	Clear	SW.	76	78	1.0070	77	1.0070	77	1.0070	76	1.0070	75	1.0074	75	1.0074
June 4, 11.45 a. m	Low	Clear	SW.	86	78	1.0068	78	1.0068	78	1.0068	80	1.0066	80	1.0068	77	1.0070
June 4, 5.45 p. m	High	Clear	SW.	80	83	1.0060	82	1.0064	82	1.0064	82	1.0064	83	1.0060	83	1.0066
June 5, 1 p. m	Low	Clear	SW.	80	82	1.0064	82	1.0064	84	1.0062	81	1.0070	80	1.0066	77	1.0074
June 5, 6.30 p. m	High	Stormy	SW.	70	82	1.0064	82	1.0064	82	1.0064	81	1.0070	80	1.0070	77	1.0074
June 6, 1.45 p. m	Low	Clear	E.	65	68	1.0080	66	1.0086	66	1.0086	67	1.0088	67	1.0092	66	1.0092
June 6, 7.15 p. m	High	Clear	SW.	68	80	1.0066	80	1.0070	80	1.0070	80	1.0070	80	1.0070	80	1.0076
June 7, 8 a. m	High	Clear	SW.	74	74	1.0080	74	1.0080	74	1.0080	73	1.0082	73	1.0086	73	1.0080
June 7, 2 p. m	Low	Clear	SW.	78	78	1.0074	78	1.0074	78	1.0074	77	1.0074	77	1.0074	77	1.0082
June 8, 9 a. m	High	Clear	SW.	74	76	1.0080	76	1.0080	77	1.0074	76	1.0080	76	1.0084	76	1.0088
June 8, 3 p. m	Low	Rain	SW.	72	75	1.0074	75	1.0074	75	1.0070	77	1.0078	76	1.0080	74	1.0082
June 9, 10 a. m	High	Clear	NW.	68	70	1.0084	70	1.0084	70	1.0084	71	1.0086	71	1.0092	71	1.0092
June 9, 4 p. m	Low	Clear	NE.	72	77	1.0076	77	1.0076	78	1.0044	77	1.0076	76	1.0080	77	1.0080
June 10, 11 a. m	High	Clear	SW.	70	73	1.0090	72	1.0090	74	1.0076	72	1.0090	72	1.0090	74	1.0088
June 10, 5 p. m	Low	Clear	SW.	70	74	1.0084	74	1.0084	74	1.0086	73	1.0086	71	1.0090	71	1.0090
June 11, 12 m	High	Clear	SE.	75	77	1.0082	77	1.0082	77	1.0082	75	1.0084	74	1.0086	75	1.0088
June 11, 6 p. m	Low	Clear	SE.	72	78	1.0082	77	1.0080	77	1.0080	74	1.0086	76	1.0082	78	1.0084
June 12, 1 p. m	High	Clear	SE.	76	79	1.0080	79	1.0080	79	1.0072	79	1.0084	78	1.0082	75	1.0084
June 12, 7 p. m	Low	Clear	SE.	70	78	1.0080	78	1.0080	78	1.0080	71	1.0084	76	1.0084	75	1.0084
June 13, 8.15 a. m	Low	Clear	E.	74	74	1.0088	74	1.0082	73	1.0082	73	1.0086	74	1.0088	73	1.0090
June 13, 2.30 p. m	High	Clear	SE.	78	80	1.0080	79	1.0080	79	1.0080	79	1.0082	79	1.0082	79	1.0082
June 14, 9.15 a. m	Low	Clear	SE.	80	80	1.0082	80	1.0080	84	1.0070	80	1.0086	83	1.0078	78	1.0090
June 14, 3.30 p. m	High	Clear	SW.	87	78	1.0082	79	1.0080	79	1.0080	76	1.0086	80	1.0078	78	1.0090

a This column represents the four ponds near the cottage. The density and temperature of the water in Pond 5 is found to be identical with those of the mouth of the lower large pond.

b No record kept.

Table of temperatures, weather, and density of water at Saint Jerome Station from January 1, 1885, to June 30, 1885, inclusive—Continued.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water of oyster ponds.*a*		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°	
June 15, 10.15 a. m	Low	Clear	W.	88	86	1.0076	86	1.0076	88	1.0076	87	1.0076	87	1.0072	86	1.0080
June 15, 4.30 p. m	High	Clear	SE.	86	85	1.0076	85	1.0078	85	1.0078	85	1.0084	81	1.0082	84	1.0072
June 16, 11 a. m	Low	Clear	SE.	89	88	1.0060	89	1.0062	89	1.0072	89	1.0072	89	1.0076	89	1.0072
June 16, 5.15 p. m	High	Clear	SE.	86	85	1.0080	89	1.0066	87	1.0072	84	1.0084	84	1.0086	86	1.0084
June 17, 12 m	Low	Rain	N.	75	72	1.0094	72	1.0076	71	1.0092	74	1.0096	74	1.0094	70	1.0104
June 17, 6 p. m	High	Clear	N.	75	77	1.0088	79	1.0084	79	1.0084	75	1.0094	75	1.0094	75	1.0094
June 18, 7 a. m	High	Clear	SE.	70	70	1.0102	70	1.0080	70	1.0102	71	1.0100	70	1.0102	70	1.0100
June 18, 1 p. m	Low	Clear	SE.	75	70	1.0102	70	1.0102	70	1.0102	70	1.0102	70	1.0102	70	1.0102
June 19, 8 a. m	High	Clear	S.	75	75	1.0094	74	1.0094	75	1.0094	76	1.0092	78	1.0090	76	1.0094
June 19, 2 p. m	Low	Clear	S.	80	82	1.0082	82	1.0082	82	1.0082	81	1.0084	81	1.0084	86	1.0080
June 20, 8.30 a. m	High	Clear	SE.	75	77	1.0094	78	1.0090	78	1.0090	77	1.0094	78	1.0092	78	1.0090
June 20, 2.30 p. m	Low	Clear	SE.	82	79	1.0090	79	1.0090	79	1.0090	80	1.0090	77	1.0092	77	1.0094
June 21, 9.10 a. m	High	Clear	SW.	78	75	1.0094	75	1.0092	75	1.0092	76	1.0092	76	1.0090	74	1.0094
June 21, 3 p. m	Low	Clear	SW.	80	83	1.0086	83	1.0076	80	1.0086	83	1.0084	82	1.0086	82	1.0086
June 22, 10 a. m	High	Clear	NW.	79	77	1.0092	77	1.0090	77	1.0090	77	1.0090	77	1.0094	77	1.0094
June 22, 3.45 p. m	Low	Rain	NW.	82	83	1.0086	83	1.0086	83	1.0086	82	1.0088	80	1.0088	79	1.0090
June 23, 11 a. m	High	Clear	NW.	65	68	1.0,01	70	1.0088	73	1.0098	71	1.0104	74	1.0100	71	1.0104
June 23, 5 p. m	Low	Clear	NW.	65	70	1.0100	77	1.0098	76	1.0098	70	1.0100	73	1.0100	73	1.0100
June 24, 12 m	High	Clear	W.	70	70	1.0106	70	1.0094	70	1.0104	74	1.0100	74	1.0098	78	1.0094
June 24, 6 p. m	Low	Clear	W.	70	72	1.0104	76	1.0086	74	1.0102	72	1.0106	72	1.0106	74	1.0104
June 25, 1 p. m	High	Rain	SE.	70	72	1.0098	74	1.0068	74	1.0098	72	1.0100	73	1.0100	73	1.0098
June 25, 7 p. m	Low	Cloudy	SE.	70	70	1.0100	72	1.0072	73	1.0109	70	1.0100	67	1.0102	72	1.0102
June 26, 8 a. m	Low	Cloudy	SE.	75	74	1.0100	74	1.0084	74	1.0090	72	1.0102	74	1.0094	75	1.0094
June 26, 2 p. m	High	Cloudy	SE.	77	76	1.0094	78	1.0080	76	1.0094	78	1.0094	77	1.0092	80	1.0094
June 27, 8.30 a. m	Low	Rain	SE.	78	78	1.0094	77	1.0084	77	1.0094	76	1.0098	76	1.0098	78	1.0094
June 27, 2.30 p. m	High	Clear	SE.	80	78	1.0096	79	1.0090	78	1.0096	78	1.0098	78	1.0100	78	1.0100
June 28, 9 a. m	Low	Clear	W.	80	81	1.0088	84	1.0070	81	1.0086	81	1.0086	81	1.0088	81	1.0088
June 28, 3 p. m	High	Rain	NW.	80	82	1.0086	78	1.0080	82	1.0086	81	1.0088	81	1.0088	81	1.0088
June 29, 9.30 a. m	Low	Clear	W.	78	79	1.0094	82	1.0080	80	1.0088	78	1.0094	77	1.0094	80	1.0094
June 29, 3.30 p. m	High	Clear	NW.	82	74	1.0102	79	1.0074	78	1.0096	76	1.0096	77	1.0094	76	1.0098
June 30, 10 a. m	Low	Clear	NW.	65	77	1.0092	75	1.0082	74	1.0100	74	1.0100	74	1.0100	74	1.0100
June 30, 4 p. m	High	Clear	NW.	72	72	1.0092	72	1.0082	73	1.0092	72	1.0092	72	1.0092	72	1.0092

a This column represents the four ponds near the cottage. The density and temperature of the water in Pond 5 is found to be identical with those of the mouth of the lower large pond.

Table of temperatures, weather, and density of water at Saint Jerome Station from July 1, 1885, to October 31, 1885, inclusive.

NOTE.—From July 1 to September 10, inclusive, Salinometer No. 5317 was used except as indicated by the asterisk, when No. 5319 was used. From September 11 to October 31, inclusive, Salinometer No. 5319 was used except as indicated by the asterisk, when No. 5317 was used.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water at oyster ponds I, II, III.		Water at oyster pond IV.		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°		°	
July 1, 11 a. m	Low	Clear	NW.	75	70	1.0100	70	1.0100	74	1.0084	70	1.0100	70	1.0100	70	1.0100	70	1.0100
July 1, 5 p. m	High	Clear	NW.	75	70	1.0100	72	1.0094	73	1.0084	72	1.0098	72	1.0098	72	1.0098	72	1.0100
July 2, 12 m	Low	Cloudy	SW.	70	70	1.0100	75	1.0094	75	1.0084	77	1.0094	77	1.0100	75	1.0100	75	1.0094
July 2, 6 p. m	High	Rain	SW.	78	77	1.0104	73	1.0094	74	1.0088	74	1.0104	74	1.0098	72	1.0098	74	1.0104
July 3, 7 a. m	High	Clear	SW.	75	72	1.0102	71	1.0094	70	1.0088	72	1.0104	72	1.0102	72	1.0102	71	1.0104
July 3, 1 p. m	Low	Clear	SW.	80	77	1.0096	78	1.0092	79	1.0088	78	1.0096	77	1.0100	77	1.0094	78	1.0096
July 4, 8 a. m	High	Cloudy	SW.	78	80	1.0104	75	1.0104	75	1.0088	75	1.0094	75	1.0104	75	1.0100	75	1.0104
July 4, 2 p. m	Low	Clear	SW.	81	75	1.0099	80	1.0090	84	1.0078	84	1.0090	80	1.0090	80	1.0090	85	1.0090
July 5, 9 a. m	High	Cloudy	SW.	78	79	1.0096	79	1.0092	79	1.0086	78	1.0090	78	1.0096	78	1.0098	79	1.0098
July 5, 2.30 p. m	Low	Rain	S.	78	83	1.0088	83	1.0082	85	1.0070	83	1.0088	83	1.0086	83	1.0088	85	1.0088
July 6, 9.30 a. m	High	Clear	S.	78	80	1.0090	79	1.0094	81	1.0082	80	1.0030	80	1.0090	80	1.0090	83	1.0092
July 6, 3 p. m	Low	Clear	S.	80	80	1.0088	85	1.0082	83	1.0070	83	1.0088	83	1.0086	83	1.0086	83	1.0088
July 7, 10 a. m	High	Clear	SE.	80	81	1.0090	82	1.0084	82	1.0080	82	1.0090	82	1.0090	81	1.0088	82	1.0090
July 7, 3.30 p. m	Low	Clear	E	84	82	1.0090	81	1.0090	82	1.0080	84	1.0088	87	1.0090	85	1.0086	82	1.0090
July 8, 10.30 a. m	High	Clear	NE.	82	83	1.0092	84	1.0080	84	1.0078	83	1.0088	84	1.0030	83	1.0092	81	1.0096
July 8, 4 p. m	Low	Clear	NE.	86	86	1.0084	86	1.0082	86	1.0082	84	1.0088	83	1.0088	83	1.0088	89	1.0082
July 9, 11 a. m	High	Clear	W.	90	83	1.0088	86	1.0084	87	1.0070	83	1.0092	85	1.0086	86	1.0086	84	1.0090
July 9, 5 p. m	Low	Clear	W.	92	88	1.0084	86	1.0082	86	1.0070	86	1.0088	83	1.0088	84	1.0088	84	1.0090
July 10, 12 m	High	Cloudy	SW.	90	85	1.0090	86	1.0082	84	1.0072	86	1.0090	83	1.0090	83	1.0092	83	1.0090
July 10, 6 p. m	Low	Rain	SW.	84	86	1.0092	84	1.0088	82	1.0078	84	1.0094	82	1.0092	83	1.0092	83	1.0092
July 11, 7 a. m	Low	Cloudy	NE.	75	75	1.0100	76	1.0098	76	1.0099	76	1.0100	77	1.0100	75	1.0102	74	1.0102
July 11, 1 p. m	High	Cloudy	NE.	80	80	1.0100	78	1.0096	78	1.0090	78	1.0096	78	1.0096	78	1.0096	78	1.0102
July 12, 8 a. m	Low	Clear	SE.	75	78	1.0098	78	1.0090	78	1.0088	78	1.0098	78	1.0100	78	1.0102	78	1.0102
July 12, 2 p. m	High	Clear	SE.	80	78	1.0096	79	1.0090	79	1.0088	79	1.0096	79	1.0100	78	1.0102	78	1.0102
July 13, 9 a. m	Low	Cloudy	E.	75	75	1.0106	75	1.0100	78	1.0095	75	1.0102	74	1.0106	75	1.0100	76	1.0104
July 13, 3 p. m	High	Cloudy	E.	78	76	1.0104	76	1.0098	76	1.0096	77	1.0102	77	1.0102	76	1.0104	76	1.0104
July 14, 10 a. m	Low	Clear	W.	75	78	1.0090	80	1.0088	80	1.0084	78	1.0086	78	1.0100	78	1.0100	80	1.0096
July 14, 4 p. m	High	Clear	W.	78	83	1.0092	82	1.0092	81	1.0086	82	1.0090	81	1.0090	81	1.0090	80	1.0094
July 15, 11 a. m	Low	Clear	E.	84	83	1.0090	83	1.0092	83	1.0088	83	1.0096	82	1.0096	83	1.0096	83	1.0096
July 15, 5 p. m	High	Clear	E.	80	83	1.0092	83	1.0086	84	1.0086	82	1.0092	80	1.0094	80	1.0094	84	1.0088
July 16, 11.45 a. m	Low	Clear	S.	86	83	1.0090	82	1.0092	83	1.0088	83	1.0096	83	1.0093	83	1.0096	83	1.0096
July 16, 5.30 p. m	High	Clear	S	84	85	1.0088	87	1.0082	87	1.0082	86	1.0084	85	1.0088	85	1.0088	88	1.0086
July 17, 12.30 p. m	Low	Clear	SW.	96	85	1.0086	87	1.0090	87	1.0084	86	1.0090	85	1.0094	85	1.0092	88	1.0092
July 17, 6.30 p. m	High	Clear	SW.	86	83	1.0092	83	1.0088	83	1.0088	82	1.0092	87	1.0096	82	1.0096	84	1.0094
July 18, 7.30 a. m	High	Clear	S.	88	83	1.0092	83	1.0088	83	1.0088	82	1.0090	82	1.0090	82	1.0094	92	1.0094
July 18, 1.30 p. m	Low	Clear	SE.	94	92	1.0070	87	1.0084	92	1.0076	88	1.0034	88	1.0082	88	1.0082	95	1.0076

Table of temperatures, weather, and density of water at Saint Jerome Station from July 1, 1885, *to October* 31, 1885, *inclusive*—Continued.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water at oyster ponds I, II, III.		Water at oyster pond IV.		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°		°	
July 19, 8.30 a. m.	High	Clear	SW.	89	88	1.0088	89	1.0082	89	1.0082	87	1.0090	87	1.0090	87	1.0090	87	1.0090
July 19, 2.30 p. m.	Low	Cloudy	SW.	90	87	1.0090	89	1.0082	87	1.0082	89	1.0090	87	1.0090	87	1.0090	87	1.0090
July 20, 9.15 a: m.	High	Clear	SW.	85	87	1.0100	84	1.0090	82	1.0090	85	1.0094	83	1.0098	81	1.0096	83	1.0096
July 20, 3.15 p. m.	Low	Clear	SW.	88	86	1.0090	87	1.0086	87	1.0080	86	1.0092	87	1.0086	87	1.0090	87	1.0092
July 21, 10 a. m	High	Clear	SW.	89	88	1.0090	87	1.0088	87	1.0084	86	1.0086	87	1.0086	87	1.0090	87	1.0088
July 21, 4 p. m	Low	Clear	SW.	86	87	1.0070	91	1.0082	90	1.0076	89	1.0090	89	1.0090	89	1.0090	89	1.0090
July 22, 11 a. m	High	Clear	SE.	89	90	1.0082	93	1.0074	93	1.0072	89	1.0088	90	1.0088	90	1.0084	93	1.0080
July 22, 4.45 p. m	Low	Cloudy	S.	89	90	1.0080	90	1.0080	91	1.0072	88	1.0090	89	1.0090	86	1.0092	89	1.0084
July 23, 12 m	High	Cloudy	SE.	86	86	1.0090	86	1.0086	86	1.0076	85	1.0092	85	1.0092	85	1.0092	86	1.0096
July 23, 5.45 p. m.	Low	Cloudy	SE.	85	85	1.0100	86	1.0092	85	1.0090	84	1.0100	84	1.0098	85	1.0098	86	1.0104
July 24, 12.45 p. m.	High	Clear	SE.	87	87	1.0090	88	1.0090	88	1.0086	85	1.0096	86	1.0096	85	1.0096	88	1.0090
July 24, 6.45 p. m	Low	Clear	SE.	85	89	1.0090	86	1.0098	88	1.0092	86	1.0094	87	1.0092	89	1.0092	87	1.0094
July 25, 7.45 a. m.	Low	Clear	SW.	85	85	1.0094	86	1.0092	85	1.0090	85	1.0096	87	1.0094	84	1.0096	86	1.0096
July 25, 1.45 p. m	High	Cloudy	SW.	90	89	1.0038	89	1.0088	91	1.0080	89	1.0088	89	1.0088	88	1.0090	90	1.0090
July 26, 8.45 a. m.	Low	Cloudy	SW.	90	85	1.0084	85	1.0092	86	1.0090	85	1.0096	86	1.0094	87	1.0096	86	1.0096
July 26, 2.30 p. m	High	Rain	SW.	90	92	1.0084	92	1.0082	93	1.0082	91	1.0090	93	1.0082	93	1.0082	91	1.0084
July 27, 9.30 a. m.	Low	Cloudy	SE.	78	83	1.0084	84	1.0082	83	1.0082	84	1.0090	83	1.0082	83	1.0082	82	1.0092
July 27, 3.30 p. m	High	Rain	E.	80	83	1.0092	83	1.0090	83	1.0086	82	1.0090	83	1.0094	84	1.0096	83	1.0098
July 28, 10.15 a. m.	Low	Clear	SE.	84	82	1.0094	84	1.0094	82	1.0094	84	1.0094	83	1.0094	83	1.0094	83	1.0092
July 28, 4.15 p. m	High	Cloudy	SE.	85	85	1.0090	86	1.0092	86	1.0090	84	1.0094	83	1.0094	83	1.0094	83	1.0094
July 29, 11 a. m	Low	Cloudy	SE.	84	78	1.0100	79	1.0100	78	1.0094	80	1.0096	78	1.0100	78	1.0098	78	1.0100
July 29, 5 p. m	High	Rain	SW.	84	84	1.0094	83	1.0092	84	1.0094	83	1.0100	83	1.0100	82	1.0102	84	1.0100
July 30, 12 m	Low	Clear	E.	84	87	1.0092	85	1.0094	84	1.0094	85	1.0094	85	1.0094	85	1.0094	87	1.0092
July 30, 6 p. m	High	Clear	E.	84	84	1.0094	84	1.0096	84	1.0094	85	1.0092	83	1.0094	83	1.0096	83	1.0096
July 31, 12.30 p. m	Low	Clear	E.	85	83	1.0096	84	1.0094	85	1.0092	83	1.0096	88	1.0092	87	1.0090	89	1.0082
July 31, 6.30 p. m	High	Clear	E.	85	87	1.0088	87	1.0092	87	1.0092	85	1.0094	86	1.0090	85	1.0090	85	1.0096
August 1, 1 p. m	Low	Cloudy	E.	87	86	1.0092	87	1.0090	88	1.0092	86	1.0092	85	1.0092	85	1.0092	89	1.0090
August 1, 7 p. m	High	Cloudy	E.	85	85	1.0094	87	1.0096	86	1.0092	84	1.0092	84	1.0090	83	1.0098	86	1.0090
August 2, 7.30 a. m.	High	Clear	SW.	85	85	1.0090	86	1.0094	86	1.0092	87	1.0094	84	1.0090	85	1.0094	87	1.0094
August 2, 1.30 p. m	Low	Clear	W.	85	85	1.0094	86	1.0096	86	1.0092	87	1.0092	87	1.0090	85	1.0094	87	1.0094
August 3, 8 a. m	High	Cloudy	SW.	82	85	1.0100	85	1.0100	86	1.0102	86	1.0100	84	1.0102	84	1.0104	84	1.0104
August 3, 2 p. m	Low	Rain	SW.	85	82	1.0094	83	1.0096	83	1.0094	82	1.0094	82	1.0100	82	1.0100	82	1.0100
August 4, 8.30 a. m.	High	Clear	NW.	82	76	1.0106	76	1.0106	76	1.0106	77	1.0104	76	1.0106	78	1.0100	80	1.0100
August 4, 2.30 p. m	Low	Clear	W.	82	84	1.0094	83	1.0100	84	1.0094	82	1.0098	83	1.0100	84	1.0100	84	1.0100
August 5, 9 a. m	High	Clear	NW.	84	81	1.0098	81	1.0098	80	1.0100	80	1.0104	81	1.0102	82	1.0104	76	1.0110
August 5, 3 p. m	Low	Clear	NW.	85	86	1.0094	87	1.0088	87	1.0088	85	1.0098	85	1.0098	83	1.0096	84	1.0096
August 6, 9.30 a. m.	High	Clear	NE.	71	82	1.0098	79	1.0100	80	1.0100	79	1.0102	82	1.0100	80	1.0106	79	1.0102
August 6, 3.30 p. m.	Low	Clear	NE.	74	79	1.0106	82	1.0104	82	1.0100	82	1.0106	79	1.0108	78	1.0110	80	1.0108
August 7, 10 a. m	High	Rain	NE.	74	74	1.0118	74	1.0116	75	1.0108	76	1.0116	74	1.0116	74	1.0116	74	1.0118

August 7, 4 p. m	Low	Rain	NE.	74	74	1.0114	74	1.0110	76	1.0114	74	1.0112	74	1.0114	74	1.0114	74	1.0110
August 8, 11 a. m ...	High ...	Rain	E.	78	74	1.0110	74	1.0114	74	1.0104	74	1.0106	76	1.0110	78	1.0106	74	1.0110
August 8, 5 p. m	Low	Cloudy .	E.	77	74	1.0110	75	1.0110	75	1.0110	74	1.0112	74	1.0112	74	1.0112	74	1.0110
August 9, 11.30 a. m..	High ...	Clear ...	SE.	82	80	1.0100	77	1.0100	71	1.0100	79	1.0106	79	1.0110	79	1.0110	78	1.0112
August 9, 5.30 p. m..	Low	Clear ...	SE.	80	81	1.0098	82	1.0092	82	1.0098	83	1.0098	80	1.0104	78	1.0110	82	1.0098
August 10, 12 m	High ...	Clear ...	SE.	83	80	1.0106	84	1.0092	83	1.0096	83	1.0096	84	1.0106	83	1.0104	83	1.0096
August 10, 6 p. m ...	Low	Clear ...	SE.	81	81	1.0098	83	1.0092	82	1.0098	82	1.0098	82	1.0104	78	1.0110	82	1.0098
August 11, 7 a. m	Low	Clear ...	SE.	80	85	1.0094	87	1.0090	83	1.0100	85	1.0096	85	1.0094	84	1.0092	84	1.0100
August 11, 1 p. m	High ...	Clear ...	SW.	84	85	1.0092	83	1.0100	83	1.0100	84	1.0098	83	1.0102	84	1.0094	86	1.0090
August 12, 8 a. m	Low	Clear ...	SE.	80	83	1.0098	83	1.0092	84	1.0090	82	1.0092	82	1.0096	82	1.0102	87	1.0090
August 12, 2.15 p. m..	High ...	Clear ...	SE.	84	86	1.0090	87	1.0094	85	1.0092	87	1.0090	85	1.0094	84	1.0098	87	1.0096
August 13, 9 a. m	Low	Clear ...	SW.	85	84	1.0100	84	1.0098	84	1.0084	84	1.0090	85	1.0094	84	1.0098	86	1.0096
August 13, 3.30 p. m..	High ...	Cloudy .	W.	86	88	1.0092	88	1.0090	87	1.0088	88	1.0090	87	1.0090	88	1.0094	87	1.0094
August 14, 10.30 a. m.	Low	Clear ...	SE.	84	84	1.0096	84	1.0096	84	1.0088	84	1.0096	82	1.0100	81	1.0102	86	1.0094
August 14, 5 p. m	High ...	Cloudy .	SE.	86	84	1.0096	84	1.0096	82	1.0090	83	1.0094	82	1.0098	82	1.0098	87	1.0094
August 15, 11 a. m ...	Low	Clear ...	NE.	76	75	1.0110	77	1.0102	75	1.0106	76	*1.0112	76	*1.0110	75	*1.0112	78	*1.0112
August 15, 5.30 p. m..	High ...	Clear ...	NE.	72	75	*1.0112	76	*1.0104	74	*1.0108	75	*1.0112	76	*1.0112	74	*1.0114	74	*1.0114
August 16, 12 m	Low	Clear ...	SE.	78	74	1.0110	75	1.0104	75	1.0110	75	1.0110	74	1.0110	74	1.0110	75	1.0110
August 16, 6 p. m	High ...	Clear ...	SE.	78	77	1.0110	76	1.0104	76	1.0106	77	1.0110	77	1.0110	77	1.0106	81	1.0102
August 17, 7 a. m	High ...	Clear ...	SE.	76	74	1.0110	75	1.0104	75	1.0110	74	1.0110	74	1.0110	75	1.0110	75	1.0110
August 17, 1 p. m	Low	Clear ...	SE.	77	77	1.0110	76	1.0104	76	1.0106	77	1.0110	77	1.0110	77	1.0110	78	1.0102
August 18 *a*	....	....	......	.....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....
August 19, 8.30 a. m..	High ...	Clear ...	NW.	78	77	1.0110	76	1.0106	76	1.0110	77	1.0102	77	1.0110	77	1.0110	81	*1.0112
August 19, 2.30 p. m..	Low	Cloudy .	NW.	76	74	1.0104	75	1.0106	75	1.0110	74	1.0110	74	1.0110	75	1.0102	75	1.0102
August 20, 9.30 a. m..	High ...	Clear ...	NE.	78	75	1.0110	76	1.0098	76	1.0110	76	1.0110	76	1.0110	76	1.0110	77	1.0108
August 20, 3.30 p. m..	Low	Clear ...	SW.	80	82	1.0102	82	1.0104	82	1.0100	82	1.0092	82	1.0106	81	1.0104	83	1.0098
August 21, 10.30 a. m.	High ...	Clear ...	SE.	80	80	1.0100	80	1.0106	80	1.0106	81	1.0100	81	1.0102	81	1.0104	83	1.0100
August 21, 4.30 p. m..	Low	Clear ...	SE.	78	80	1.0100	80	1.0106	80	1.0106	80	1.0100	80	1.0102	81	1.0104	83	1.0100
August 22, 11 a. m ...	High ...	Clear ...	W.	85	86	1.0098	86	1.0100	86	1.0092	86	1.0098	85	1.0092	86	1.0092	88	1.0098
August 22, 5 p. m	Low	Clear ...	SE.	80	85	1.0100	84	1.0098	85	1.0098	85	1.0100	86	1.0100	86	1.0100	84	1.0104
August 23, 12 m	High ...	Clear ...	SE.	88	86	1.0098	86	1.0098	84	1.0102	85	1.0100	85	1.0100	85	1.0102	88	1.0094
August 23, 6 p. m	Low	Cloudy .	SE.	84	85	1.0100	86	1.0098	86	1.0098	86	1.0098	86	1.0098	85	1.0100	84	1.0102
August 24, 7.30 a. m..	Low	Clear ...	W.	90	87	1.0100	87	1.0098	87	1.0098	86	1.0096	89	1.0096	87	1.0100	87	1.0100
August 24, 1.30 p. m..	High ...	Clear ...	SW.	94	83	1.0106	83	1.0100	83	1.0100	83	1.0104	85	1.0100	82	1.0102	83	1.0100
August 25, 8.30 a. m..	Low	Clear ...	W.	88	86	1.0098	85	1.0080	86	1.0100	86	1.0098	86	1.0098	85	1.0098	86	1.0100
August 25, 2.30 p. m..	High ...	Clear ...	W.	90	88	1.0096	87	1.0096	88	1.0096	88	1.0094	88	1.0098	87	1.0096	88	1.0096
August 26, 9 a. m	Low	Clear ...	NW.	66	72	*1.0120	74	*1.0100	74	*1.0120	74	*1.0112	71	*1.0122	71	*1.0120	73	*1.0110
August 26, 3 p. m	High ...	Clear ...	NW.	69	72	*1.0120	74	*1.0100	74	*1.0120	71	*1.0112	74	*1.0122	71	*1.0120	73	*1.0110
August 27, 9.45 a. m..	Low	Clear ...	SE.	69	71	*1.0126	72	*1.0124	69	*1.0126	69	*1.0120	70	*1.0122	70	*1.0124	73	*1.0128
August 27, 3.45 p. m..	High ...	Clear ...	SE.	70	72	*1.0118	74	*1.0120	74	*1.0116	72	*1.0118	74	*1.0118	74	*1.0118	76	*1.0110
August 28, 10.15 a. m.	Low	Clear ...	SE.	73	75	*1.0114	75	*1.0120	76	*1.0118	76	*1.0118	76	*1.0118	76	*1.0114	77	*1.0112
August 28, 4 p. m	High ...	Clear ...	SE.	76	75	*1.0120	75	*1.0120	75	*1.0122	77	*1.0116	74	*1.0120	74	*1.0118	78	*1.0110
August 29, 10.30 a. m.	Low	Clear ...	W.	78	73	*1.0120	74	*1.0124	74	*1.0124	73	*1.0120	72	*1.0124	72	*1.0122	71	*1.0116
August 29, 4.30 p. m..	High ...	Clear ...	SW.	77	73	*1.0120	74	*1.0124	74	*1.0124	73	*1.0120	72	*1.0120	72	*1.0122	71	*1.0116
August 30, 11 a. m	Low	Cloudy .	SW.	80	78	1.0110	77	*1.0114	77	1.0088	76	*1.0114	78	1.0110	77	1.0108	78	1.0104
August 30, 5 p. m	High ...	Rain	SW.	76	78	1.0110	78	*1.0114	77	1.0088	78	*1.0114	77	1.0110	78	1.0108	78	1.0104
August 31, 12 m	Low	Cloudy .	E.	78	79	1.0108	79	1.0108	79	1.0110	78	1.0108	77	1.0104	77	1.0104	83	1.0102
August 31, 6 p. m	High ...	Clear ...	SE.	76	79	1.0108	78	1.0110	78	1.0108	78	1.0108	78	1.0104	77	1.0104	83	1.0102
September 1, 1 p. m ..	Low	Clear ...	E.	80	81	1.0108	81	1.0106	81	1.0106	81	1.0108	81	1.0108	85	1.0102	85	1.0096
September 1, 7 p. m ..	High ...	Clear ...	SE.	76	80	1.0108	80	1.0106	80	1.0106	80	1.0102	80	1.0106	80	1.0106	81	1.0108

a No record kept.

Table of temperatures, weather, and density of water at Saint Jerome Station from July 1, 1885, *to October* 31, 1885, *inclusive*—Continued.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water at oyster ponds I, II, III.		Water at oyster pond IV.		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°		°	
September 2, 8 a. m. ..	High ...	Clear ...	NW.	66	70	*1.0120	71	*1.0114	73	*1.0114	70	*1.0120	70	*1.0120	71	*1.0120	71	*1.0120
September 2, 2 p. m. ..	Low	Clear ...	NW.	70	70	*1.0120	74	*1.0100	73	*1.0114	70	*1.0112	71	*1.0114	71	*1.0120	71	*1.0120
September 3, 9 a. m. ..	High ...	Clear ...	SW.	67	72	*1.0114	71	*1.0102	71	*1.0122	72	*1.0114	70	*1.0118	71	*1.0120	70	*1.0118
September 3, 3 p. m. ..	Low ...	Clear ...	SW.	69	74	*1.0118	75	*1.0112	75	*1.0112	75	*1.0114	72	*1.0120	73	*1.0120	75	*1.0114
September 4, 10 a. m. .	High ...	Clear ...	SW.	80	77	*1.0116	80	1.0098	77	*1.0112	77	*1.0112	78	*1.0110	74	*1.0110	79	*1.0108
September 4, 4 p. m. ..	Low	Clear ...	SW.	80	79	*1.0112	80	1.0098	78	*1.0110	78	*1.0110	78	*1.0112	77	*1.0112	80	*1.0112
September 5, 10.30 a. m	High ...	Clear ...	SW.	80	77	*1.0110	76	1.0100	77	*1.0110	76	*1.0110	77	*1.0110	77	*1.0108	78	*1.0108
September 5, 4.30 p. m	Low ..	Stormy	NW.	76	77	*1.0110	77	1.0100	77	*1.0110	77	*1.0110	77	*1.0110	77	*1.0108	78	*1.0108
September 6, 11 a. m. .	High ...	Clear ...	NE.	70	67	*1.0108	70	1.0100	67	*1.0108	70	*1.0116	74	*1.0110	70	*1.0120	70	*1.0120
September 6, 5 p. m. ..	Low	Clear ..	NE.	66	67	*1.0108	70	*1.0108	70	*1.0118	74	*1.0116	70	*1.0118	70	*1.0120	70	*1.0120
September 7, 11.30 a. m	High ...	Clear ...	SE.	68	73	*1.0116	74	1.0098	72	*1.0116	72	*1.0116	72	*1.0114	72	*1.0114	74	*1.0110
September 7, 5.30 p. m	Low	Clear ...	SE.	66	73	*1.0116	74	1.0098	72	*1.0116	72	*1.0116	72	*1.0114	72	*1.0114	74	*1.0110
September 8, 12 m ...	High ...	Clear ...	SE.	78	75	*1.0112	74	1.0100	72	*1.0112	72	*1.0112	73	*1.0112	73	*1.0112	75	*1.0112
September 8, 6 p. m. ..	Low	Clear ...	SE.	69	73	*1.0114	75	1.0096	75	*1.0114	73	*1.0114	72	*1.0114	72	*1.0112	72	*1.0112
September 9, 1 p. m. ..	High ...	Cloudy .	W.	85	88	1.0090	85	1.0078	83	1.0100	83	1.0100	80	*1.0104	81	*1.0102	81	*1.0102
September 9, 7 p. m. ..	Low ...	Cloudy .	W.	80	80	1.0104	84	1.0090	82	*1.0104	82	*1.0104	80	*1.0104	78	*1.0106	78	*1.0108
September 10, 8 a. m	Low	Clear ...	NE.	76	75	1.0100	75	1.0098	75	1.0100	75	1.0100	76	*1.0114	76	*1.0114	76	*1.0110
September 10, 2 p. m. .	High ...	Cloudy .	NE.	78	74	*1.0116	76	1.0098	76	*1.0112	75	*1.0114	74	*1.0114	76	*1.0114	76	*1.0114
September 11, 9 a. m. .	Low	Clear ...	NE.	66	69	1.0122	70	1.0102	70	1.0116	70	1.0116	70	1.0112	70	1.0120	70	1.0122
September 11, 2.30 p. m	High ...	Clear ...	NE.	70	70	1.0122	70	1.0102	70	1.0116	70	1.0116	70	1.0120	70	1.0120	70	1.0120
September 12, 9.45 a. m	Low	Clear ...	E.	70	72	1.0120	72	1.0108	72	1.0108	71	1.0120	71	1.0120	71	1.0116	74	1.0116
September 12, 3.15 p. m	High ...	Clear ...	E.	72	73	1.0116	73	1.0108	76	1.0116	73	1.0116	72	1.0116	72	1.0116	75	1.0116
Sept. 13, 10.45 a. m. ...	Low	Clear ...	NE.	79	71	1.0110	71	1.0120	71	1.0120	71	1.0120	72	1.0120	72	1.0120	72	1.0120
September 13, 4 p. m. ..	High ...	Clear ..	SE.	78	71	1.0110	76	1.0108	71	1.0110	71	1.0120	71	1.0120	71	1.0120	72	1.0120
Sept. 14, 11.45 a. m. ...	Low	Clear ...	SE.	80	78	1.0114	81	1.0108	81	1.0108	78	1.0110	78	1.0110	78	1.0110	80	1.0110
September 14, 4.50 p. m	High ...	Clear ...	SE.	82	78	1.0114	80	1.0108	80	1.0108	80	1.0110	80	1.0110	81	1.0110	82	1.0110
Sept. 15, 12.45 p. m	Low	Clear ...	SE.	86	80	1.0110	80	1.0112	79	1.0112	79	1.0112	80	1.0112	80	1.0110	81	1.0110
September 15, 6 p. m. ..	High ...	Clear ...	SE.	80	80	1.0110	79	1.0112	79	1.0112	79	1.0112	79	1.0112	80	1.0110	82	1.0110
September 16, 7 a. m. ..	High ...	Clear ...	NE.	78	76	1.0114	77	1.0112	77	1.0112	76	1.0116	71	1.0116	76	1.0116	76	1.0116
September 16, 2 p. m. ..	Low	Clear ...	NE.	85	76	1.0114	77	1.0112	77	1.0112	76	1.0116	76	1.0110	79	1.0116	76	1.0116
September 17, 8 a. m. ..	High ...	Clear ...	NW.	67	70	1.0124	70	1.0122	72	1.0122	71	1.0120	72	1.0120	72	1.0120	72	1.0120
September 17, 2.30 p. m	Low	Clear ...	NW.	71	75	1.0118	75	1.0116	75	1.0116	73	1.0122	73	1.0118	73	1.0118	77	1.0112
September 18, 9 a. m. ..	High ...	Clear ...	W.	75	70	1.0112	70	1.0118	72	1.0112	71	1.0116	71	1.0116	72	1.0116	72	1.0116
September 18, 3 p. m. ..	Low	Cloudy .	SW.	78	71	1.0112	72	1.0118	72	1.0118	71	1.0116	71	1.0116	71	1.0116	72	1.0116
September 19, 10 a. m. .	High ...	Clear ...	W.	74	75	1.0118	74	1.0116	75	1.0116	75	1.0116	75	1.0114	77	1.0110	75	1.0120
September 19, 4 p. m. ..	Low	Cloudy .	NE.	82	76	1.0116	75	1.0118	75	1.0114	75	1.0114	75	1.0118	75	1.0116	78	1.0112
September 20, 11 a. m. .	High ...	Clear ...	E.	72	78	1.0114	77	1.0116	76	1.0116	77	1.0114	77	1.0112	79	1.0110	79	1.0110
September 20, 5 p. m. ..	Low ...	Cloudy .	E.	70	77	1.0114	76	1.0114	76	1.0116	76	1.0116	77	1.0114	79	1.0112	79	1.0110
September 21, 12 m. ..	High ...	Clear ...	NE.	72	66	1.0120	66	1.0124	67	1.0122	68	1.0122	68	1.0120	68	1.0120	68	1.0120

September 21, 6 p. m..	Low	Cloudy .	NE.	70	68	1.0120	68	1.0120	68	1.0120	68	1.0120	68	1.0120	68	1.0120	68	1.0120
September 22, 7 a. m..	Low	Rain....	NE.	64	67	1.0122	67	1.0122	67	1.0122	67	1.0122	67	1.0122	67	1.0122	69	1.0108
September 22, 1 p. m..	High ...	Rain....	NE.	66	67	1.0122	67	1.0122	67	1.0122	67	1.0122	67	1.0122	67	1.0122	67	1.0122
September 23, 8 a. m..	Low	Clear ...	NW.	54	60	1.0130	58	1.0138	58	1.0138	58	1.0140	56	1.0130	60	1.0130	60	1.0138
September 23, 2 p. m..	High ...	Clear ...	NW.	62	62	1.0130	63	1.0126	63	1.0126	62	1.0126	63	1.0126	63	1.0126	67	1.0122
September 24, 8.30 a.m	Low	Clear ...	SE.	67	63	1.0124	61	1.0124	61	1.0124	61	1.0126	62	1.0126	63	1.0126	63	1.0124
September 24, 2.30 p.m	High ...	Clear ...	SW.	70	66	1.0122	66	1.0122	66	1.0120	66	1.0120	65	1.0120	66	1.0120	68	1.0116
September 25, 9 a. m..	Low ...	Clear ...	W.	72	67	1.0120	67	1.0122	67	1.0122	66	1.0120	69	1.0116	69	1.0112	72	1.0114
September 25, 3 p. m..	High ...	Clear ...	NW.	74	72	1.0116	71	1.0118	70	1.0118	70	1.0118	73	1.0114	73	1.0112	73	1.0116
September 26, 9.30 a.m	Low	Clear ...	NW.	72	71	1.0120	71	1.0126	69	1.0126	68	1.0126	68	1.0120	69	1.0120	68	1.0122
September 26, 3.30 p.m	High ...	Clear ..	W.	75	69	1.0116	71	1.0116	72	1.0116	71	1.0114	71	1.0116	72	1.0116	73	1.0116
September 27, 10 a. m.	Low	Clear ...	SW.	74	72	1.0116	72	1.0116	71	1.0116	71	1.0116	71	1.0118	71	1.0118	71	1.0118
September 27, 4 p. m..	High ...	Clear ...	W.	76	71	1.0120	72	1.0120	72	1.0120	72	1.0120	71	1.0120	70	1.0120	73	1.0120
Sept. 28, 10.30 a. m...	Low	Clear ...	NE.	74	72	1.0112	73	1.0112	73	1.0112	74	1.0110	74	1.0110	74	1.0110	76	1.0106
September 28, 4.30 p.m	High ...	Clear ...	NE.	75	75	1.0112	75	1.0110	75	1.0110	75	1.0114	74	1.0114	73	1.0120	75	1.0114
September 29, 11 a. m.	Low	Clear ...	E.	80	71	1.0116	71	1.0122	71	1.0122	71	1.0122	69	1.0122	69	1.0122	73	1.0120
September 29, 5.15 p.m	High ...	Clear ...	E.	78	75	1.0110	75	1.0110	75	1.0110	73	1.0112	72	1.0114	72	1.0114	73	1.0114
September 30, 12 m...	Low	Clear ...	E.	80	72	1.0114	72	1.0114	72	1.0114	71	1.0114	71	1.0114	71	1.0114	73	1.0112
September 30, 6.30 p.m	High ...	Clear ...	E.	70	74	1.0110	75	1.0110	74	1.0110	74	1.0110	72	1.0114	73	1.0114	70	1.0118
October 1, 7.30 a. m ..	High ...	Cloudy .	E.	70	70	1.0114	70	1.0114	72	1.0114	71	1.0116	69	1.0118	69	1.0118	70	1.0118
October 1, 1 p. m.....	Low	Clear ...	SE.	75	72	1.0116	71	1.0116	72	1.0116	72	1.0118	67	1.0122	67	1.0122	70	1.0120
October 2, 8.30 a. m ..	High ...	Cloudy .	E.	70	67	1.0120	67	1.0120	67	1.0120	67	1.0120	68	1.0118	68	1.0118	68	1.0118
October 2, 2 p. m.....	Low	Cloudy .	E.	72	71	1.0118	71	1.0116	71	1.0116	71	1.0116	71	1.0114	71	1.0118	71	1.0118
October 3, 9.30 a. m ..	High ...	Cloudy .	SW.	75	70	*1.0100	70	*1.0100	70	*1.0100	70	*1.0088	70	*1.0108	70	*1.0108	70	*1.0108
October 3, 3 p. m.....	Low	Cloudy .	SE.	78	75	*1.0102	74	*1.0100	74	*1.0100	71	*1.0104	76	*1.0100	74	*1.0106	75	*1.0104
October 4, 10.30 a. m..	High ...	Cloudy .	E.	75	70	1.0106	70	1.0110	70	1.0108	71	1.0118	71	1.0114	71	1.0114	73	1.0108
October 4, 4 p. m.....	Low	Cloudy .	E.	65	70	1.0112	70	1.0112	71	1.0112	71	1.0120	68	1.0120	68	1.0122	69	1.0120
October 5, 11.30 a. m..	High ...	Clear ...	NW.	65	69	1.0116	68	1.0120	68	1.0120	68	1.0120	68	1.0120	68	1.0120	68	1.0120
October 5, 5 p. m.....	Low	Clear ...	NW.	66	68	1.0120	68	1.0122	68	1.0122	65	1.0122	65	1.0124	65	1.0124	64	1.0126
October 6, 12.30 p. m..	High ...	Cloudy .	NE.	59	61	1.0120	61	1.0130	61	1.0130	61	1.0130	61	1.0130	61	1.0130	63	1.0128
October 6, 6.30 p. m...	Low	Rain....	NE.	58	61	1.0130	61	1.0130	61	1.0130	61	1.0130	61	1.0130	61	1.0130	61	1.0130
October 7, 7.30 a. m...	Low	Clear ...	NE.	60	62	1.0126	62	1.0122	62	1.0122	63	1.0124	62	1.0124	62	1.0126	63	1.0126
October 7, 1.30 p. m...	High ...	Clear ...	NE.	60	61	1.0130	62	1.0128	62	1.0128	62	1.0126	61	1.0130	61	1.0130	64	1.0122
October 8, 8.30 a. m...	Low	Clear ...	NE.	59	60	1.0124	60	1.0122	60	1.0122	60	1.0124	60	1.0124	60	1.0122	60	1.0124
October 8, 2.30 p. m...	High ...	Overcast	NE.	61	60	1.0124	60	1.0122	60	1.0122	60	1.0122	60	1.0122	60	1.0124	60	1.0124
October 9, 9.30 a. m...	Low	Cloudy .	NE.	60	60	1.0124	60	1.0122	60	1.0122	60	1.0124	60	1.0122	60	1.0124	60	1.0124
October 9, 3 p. m	High ...	Cloudy .	NE.	61	60	1.0124	61	1.0120	61	1.0120	60	1.0122	60	1.0124	60	1.0124	60	1.0124
October 10, 10 a. m...	Low	Clear ...	NW.	62	60	1.0130	59	1.0122	59	1.0122	59	1.0126	60	1.0126	60	1.0128	62	1.0122
October 10, 4 p. m....	High ...	Clear ...	SW.	65	61	1.0124	60	1.0124	60	1.0124	60	1.0130	61	1.0122	61	1.0120	61	1.0126
October 11, 11 a. m...	Low	Clear ...	E.	70	61	1.0130	61	1.0130	61	1.0130	63	1.0124	63	1.0130	63	1.0130	63	1.0128
October 11, 5 p. m....	High ...	Cloudy	E.	70	64	1.0120	64	1.0120	64	1.0120	64	1.0122	63	1.0126	63	1.0128	64	1.0128
October 12, 12 m	Low	Stormy .	SE.	70	61	1.0122	61	1.0120	61	1.0120	61	1.0124	61	1.0122	61	1.0120	61	1.0122
October 12, 6 p. m....	High ...	Stormy .	SE.	67	61	1.0126	61	1.0120	61	1.0120	61	1.0122	61	1.0120	61	1.0126	61	1.0122
October 13, 1 p. m....	Low	Cloudy	SE.	67	63	1.0120	63	1.0112	63	1.0112	63	1.0112	63	1.0114	63	1.0116	63	1.0122
October 13, 7 p. m....	High ...	Clear ...	SW.	65	63	1.0120	63	1.0112	63	1.0112	63	1.0112	63	1.0112	63	1.0116	63	1.0122
October 14, 8 a. m....	High ...	Clear ...	NW.	60	62	1.0122	61	1.0122	61	1.0122	61	1.0118	61	1.0120	61	1.0120	62	1.0122
October 14, 1.30 p. m.	Low	Clear ...	W.	67	62	1.0120	62	1.0116	62	1.0116	61	1.0114	61	1.0122	60	1.0130	60	1.0130
October 15, 9 a. m....	High ...	Clear ...	SW.	60	59	1.0120	60	1.0120	60	1.0120	59	1.0120	59	1.0130	59	1.0128	59	1.0130
October 15, 2.30 p. m.	Low	Clear ...	W.	65	60	1.0128	60	1.0112	60	1.0112	60	1.0102	60	1.0126	60	1.0126	60	1.0128
October 16, 10 a. m ..	High ..	Clear ...	E.	70	61	1.0128	61	1.0128	61	1.0126	60	1.0120	61	1.0128	61	1.0130	61	1.0130
October 16, 3.30 p. m.	Low	Clear ...	SE.	70	62	1.0122	62	1.0126	62	1.0126	62	1.0126	62	1.0128	62	1.0124	62	1.0128
October 17, 11 a. m ..	High ...	Clear ...	SW.	67	62	1.0128	62	1.0128	62	1.0128	62	1.0124	62	1.0128	62	1.0130	62	1.0128

Table of temperatures, weather, and density of water at Saint Jerome Station from July 1, 1885 to October 31, 1885, inclusive—Continued.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water at oyster ponds I, II, III.		Water at oyster pond IV.		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°		°	
October 17, 4.30 p. m.	Low	Clear ...	SW.	68	67	1.0122	67	1.0118	67	1.0118	68	1.0122	67	1.0120	67	1.0120	71	1.0122
October 18, 11.30 a. m.	High ...	Clear ...	S.	72	67	1.0118	67	1.0118	67	1.0118	67	1.0120	67	1.0124	67	1.0124	68	1.0122
October 18, 5 p. m....	Low	Clear ...	S.	70	69	1.0122	69	1.0124	69	1.0124	69	1.0120	69	1.0120	69	1.0122	71	1.0130
October 19, 12 m	High ...	Clear ...	SE.	72	69	1.0126	69	1.0122	69	1.0122	68	1.0130	68	1.0130	68	1.0130	68	1.0130
October 19, 5.30 p. m.	Low	Clear ...	SE.	70	69	1.0126	68	1.0124	68	1.0124	68	1.0122	68	1.0126	68	1.0126	70	1.0128
October 20, 12.30 p. m.	High ...	Clear ..	SW.	72	70	1.0130	67	1.0124	67	1.0124	67	1.0130	67	1.0124	67	1.0130	68	1.0130
October 20, 6 p. m....	Low	Cloudy .	SW.	70	69	1.0122	69	1.0122	69	1.0122	68	1.0122	69	1.0122	69	1.0122	70	1.0126
October 21, 1 p. m....	High ...	Rain....	SW.	69	59	1.0132	60	1.0122	60	1.0122	61	1.0126	58	1.0132	58	1.0136	60	1.0138
October 21, 7 p. m....	Low	Clear ...	NW.	62	59	1.0132	59	1.0122	59	1.0122	59	1.0126	59	1.0130	59	1.0136	59	1.0138
October 22, 7.30 a. m..	Low	Clear ...	NW.	46	57	1.0138	56	1.0124	56	1.0124	53	1.0120	53	1.0148	52	1.0148	53	1.0144
October 22, 1.30 p. m..	High ...	Clear ...	NW.	58	61	1.0130	59	1.0128	59	1.0128	59	1.0130	57	1.0140	59	1.0130	60	1.0138
October 23, 8 a. m....	Low	Clear ...	NE.	40	58	1.0140	58	1.0138	58	1.0138	58	1.0138	58	1.0140	58	1.0140	58	1.0140
October 23, 2 p. m....	High ...	Clear ...	E.	58	58	1.0138	58	1.0138	58	1.0138	58	1.0140	60	1.0140	60	1.0140	60	1.0140
October 24, 8.30 a. m..	Low	Clear ...	NE.	46	58	1.0140	58	1.0136	58	1.0136	58	1.0138	58	1.0140	58	1.0140	57	1.0144
October 24, 2.30 p. m.	High ...	Clear ...	NE.	50	59	1.0138	60	1.0136	60	1.0136	59	1.0140	60	1.0142	60	1.0144	60	1.0144
October 25, 9 a. m....	Low	Clear ...	NE.	48	60	1.0142	59	1.0138	59	1.0138	59	1.0142	59	1.0144	59	1.0146	60	1.0146
October 25, 3 p. m....	High ...	Clear ...	NE.	62	60	1.0142	61	1.0140	61	1.0140	61	1.0142	60	1.0142	61	1.0144	62	1.0144
October 26, 9.30 a. m..	Low	Clear ...	SE.	60	61	1.0140	61	1.0132	61	1.0132	61	1.0136	61	1.0136	61	1.0138	63	1.0136
October 26, 3.30 p. m.	High ...	Clear ...	S.	62	63	1.0140	62	1.0136	62	1.0136	61	1.0140	61	1.0142	62	1.0142	63	1.0144
October 27, 10.30 a. m.	Low	Clear ...	SE.	65	62	1.0140	63	1.0130	63	1.0130	61	1.0130	61	1.0140	62	1.0140	64	1.0136
October 27, 4.30 p. m.	High ...	Cloudy .	SE.	68	63	1.0140	63	1.0136	63	1.0136	62	1.0140	62	1.0142	63	1.0142	64	1.0142
October 28, 11.15 a. m.	Low	Clear ...	SE.	68	64	1.0132	65	1.0132	65	1.0132	65	1.0132	65	1.0136	65	1.0136	67	1.0132
October 28, 5.15 p. m.	High ...	Cloudy .	SE.	70	65	1.0134	66	1.0136	66	1.0136	66	1.0136	66	1.0132	66	1.0132	67	1.0132
October 29, 12 m	Low	Rain....	SE.	65	65	1.0132	65	1.0132	65	1.0132	65	1.0134	65	1.0138	65	1.0138	65	1.0142
October 29, 6 p. m....	High ...	Rain ...	SE.	65	64	1.0136	64	1.0136	64	1.0136	64	1.0138	64	1.0142	64	1.0144	64	1.0146
October 30, 12.30 p. m.	Low	Clear ...	NE.	55	60	1.0140	61	1.0140	61	1.0140	61	1.0142	60	1.0140	60	1.0144	59	1.0146
October 30, 6.30 p. m.	High ...	Clear ...	NE.	50	57	1.0138	58	1.0140	58	1.0140	58	1.0142	57	1.0142	55	1.0142	54	1.0140
October 31, 7 a. m....	High ...	Clear ...	NW.	42	49	1.0144	51	1.0142	51	1.0142	51	1.0142	48	1.0144	48	1.0146	52	1.0148
October 31, 1 p. m....	Low	Clear ...	NW.	52	50	1.0148	51	1.0142	51	1.0142	50	1.0150	49	1.0150	49	1.0140	52	1.0150

Table of temperatures, weather, and density of water at Saint Jerome Station from November 1, 1885, to December 31, 1885, inclusive.

NOTE.—From November 1 to December 31, inclusive, the salinometer used was No. 5319.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water at oyster ponds.		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°	
November 1-3 *a*	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
November 4, 12 m	High	Clear	NW.	52	53	1.0150	54	1.0140	54	1.0140	54	1.0148	54	1.0142	56	1.0144
November 4, 6 p. m	Low	Clear	W.	54	52	1.0150	52	1.0142	52	1.0142	52	1.0150	52	1.0150	52	1.0150
November 5, 7 a. m	Low	Clear	SW.	60	58	1.0142	56	1.0144	56	1.0134	56	1.0142	57	1.0140	58	1.0142
November 5, 1 p. m	High	Clear	SW.	64	59	1.0140	59	1.0140	59	1.0140	60	1.0144	60	1.0144	60	1.0144
November 6, 8 a. m	Low	Cloudy	SW.	69	61	1.0140	61	1.0130	61	1.0134	64	1.0134	66	1.0136	66	1.0136
November 6, 2 p. m	High	Variable	SW.	72	64	1.0134	62	1.0134	62	1.0136	63	1.0134	63	1.0134	63	1.0134
November 7, 9 a. m	Low	Cloudy	SW.	66	64	1.0134	65	1.0132	64	1.0138	62	1.0136	62	1.0138	62	1.0138
November 7, 3 p. m	High	Cloudy	SW.	74	67	1.0138	65	1.0132	64	1.0138	67	1.0138	67	1.0132	68	1.0134
November 8, 9.30 a. m	Low	Cloudy	SW.	60	65	1.0132	65	1.0132	65	1.0134	65	1.0134	65	1.0134	65	1.0136
November 8, 3.30 p. m	High	Rain	SE.	60	65	1.0134	65	1.0132	65	1.0134	65	1.0134	65	1.0134	65	1.0134
November 9, 10.30 a. m	Low	Clear	NW.	58	58	1.0138	57	1.0134	57	1.0126	55	1.0138	55	1.0140	56	1.0140
November 9, 4.30 p. m	High	Clear	NW.	54	55	1.0140	55	1.0138	54	1.0136	53	1.0142	54	1.0142	56	1.0140
November 10, 11.30 a. m	Low	Clear	NW.	52	53	1.0130	53	1.0130	53	1.0130	51	1.0142	51	1.0142	53	1.0142
November 10, 5.30 p. m	High	Clear	NW.	54	53	1.0142	53	1.0142	53	1.0142	52	1.0144	52	1.0142	52	1.0142
November 11, 12 m	Low	Clear	SW.	60	55	1.0140	52	1.0138	52	1.0140	52	1.0140	56	1.0138	55	1.0140
November 11, 6.15 p. m	High	Clear	SW.	58	53	1.0140	53	1.0138	54	1.0140	54	1.0140	54	1.0140	53	1.0140
November 12, 7 a. m	High	Clear	SW.	64	56	1.0140	56	1.0138	56	1.0140	56	1.0140	56	1.0140	59	1.0138
November 12, 1 p. m	Low	Cloudy	SW.	65	56	1.0140	56	1.0138	56	1.0140	56	1.0140	57	1.0140	59	1.0140
November 13, 8 a. m	High	Cloudy	SW.	71	63	1.0136	60	1.0130	60	1.0120	60	1.0136	60	1.0136	61	1.0136
November 13, 2 p. m	Low	Rain	SW.	69	60	1.0136	61	1.0126	61	1.0112	61	1.0136	61	1.0136	63	1.0134
November 14, 8.30 a. m	High	Clear	NE.	52	52	1.0142	53	1.0138	53	1.0146	54	1.0140	53	1.0146	53	1.0146
November 14, 2.30 p. m	Low	Clear	NE.	57	52	1.0142	53	1.0138	54	1.0140	54	1.0144	54	1.0144	53	1.0144
November 15, 9 a. m	High	Clear	N.	48	49	1.0144	49	1.0140	48	1.0144	48	1.0144	48	1.0144	48	1.0144
November 15, 3 p. m	Low	Clear	N.	50	50	1.0144	51	1.0140	50	1.0146	49	1.0146	49	1.0146	51	1.0140
November 16, 9.30 a. m	High	Clear	NE.	52	47	1.0150	47	1.0142	48	1.0142	50	1.0146	50	1.0146	51	1.0144
November 16, 3.30 p. m	Low	Clear	NE.	56	50	1.0150	50	1.0142	50	1.0142	51	1.0144	51	1.0144	51	1.0144
November 17, 10 a. m	High	Clear	E.	49	46	1.0148	47	1.0146	47	1.0144	47	1.0148	47	1.0144	46	1.0146
November 17, 4 p. m	Low	Clear	E.	52	51	1.0144	50	1.0144	50	1.0142	51	1.0144	52	1.0144	54	1.0140
November 18, 10.30 a. m	High	Clear	SW.	62	55	1.0138	55	1.0136	54	1.0136	54	1.0134	54	1.0134	55	1.0134
November 18, 4.30 p. m	Low	Overcast	SE.	58	54	1.0138	53	1.0140	53	1.0140	53	1.0140	53	1.0140	55	1.0140
November 19, 11 a. m	High	Cloudy	SW.	60	55	1.0138	55	1.0138	55	1.0136	56	1.0136	56	1.0140	57	1.0138
November 19, 5 p. m	Low	Cloudy	NE.	60	56	1.0140	56	1.0138	56	1.0136	57	1.0140	56	1.0138	56	1.0140
November 20, 11.30 a. m	High	Clear	NE.	41	50	1.0142	50	1.0142	50	1.0142	50	1.0138	48	1.0138	50	1.0140
November 20, 5.30 p. m	Low	Clear	NE.	47	52	1.0138	51	1.0138	51	1.0138	50	1.0136	50	1.0138	51	1.0138

a No record kept.

Table of temperatures, weather, and density of water at Saint Jerome Station from November 1, 1885, to December 31, 1885, inclusive—Continued.

Date.	State of tide.	State of weather.	Direction of wind.	Temperature of air.	Water at wharf.		Water at oyster ponds.		Water at canal.		Water at lower pond.		Water at Deep Point.		Water in the bay.	
					Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.	Temperature.	Density.
1885.				°	°		°		°		°		°		°	
November 21, 12 m	High	Clear	W.	45	50	1.0134	49	1.0138	50	1.0134	49	1.0132	48	1.0132	49	1.0134
November 21, 6 p. m	Low	Clear	NW.	46	48	1.0134	47	1.0140	48	1.0134	49	1.0134	49	1.0134	49	1.0134
November 22, 7 a. m	Low	Rain	SW.	50	50	1.0132	50	1.0134	50	1.0132	51	1.0130	52	1.0130	51	1.0132
November 22, 1 p. m	High	Cloudy	W.	53	50	1.0132	51	1.0134	51	1.0130	51	1.0130	52	1.0132	52	1.0132
November 23, 8 a. m	Low	Cloudy	NW.	45	52	1.0134	50	1.0134	50	1.0134	50	1.0132	50	1.0130	50	1.0132
November 23, 2 p. m	High	Stormy	NW.	42	49	1.0134	48	1.0138	48	1.0134	47	1.0134	46	1.0136	49	1.0134
November 24, 8.30 a. m	Low	Stormy	NW.	37	45	1.0136	45	1.0136	45	1.0136	45	1.0136	45	1.0136	45	1.0136
November 24, 2.30 p. m	High	Stormy	NW.	42	47	1.0134	47	1.0134	47	1.0134	47	1.0134	47	1.0134	47	1.0134
November 25, 9.45 a. m	Low	Stormy	NW.	42	45	1.0136	45	1.0136	45	1.0136	45	1.0134	45	1.0136	45	1.0136
November 25, 4 p. m	High	Stormy	NW.	44	42	1.0134	47	1.0134	47	1.0134	45	1.0136	45	1.0136	45	1.0136
November 26, 11 a. m	Low	Stormy	NW.	42	42	1.0134	42	1.0138	42	1.0138	42	1.0138	42	1.0140	42	1.0140
November 26, 5 p. m	High	Clear	NW.	45	46	1.0134	44	1.0136	44	1.0134	43	1.0136	43	1.0136	44	1.0136
November 27, 12 m	Low	Cloudy	NW.	45	42	1.0136	42	1.0136	42	1.0136	42	1.0136	42	1.0136	42	1.0136
November 27, 6 p. m	High	Clear	NW.	42	43	1.0136	43	1.0136	43	1.0134	43	1.0136	43	1.0136	43	1.0136
November 28, 7 a. m	High	Cloudy	NW.	40	45	1.0132	43	1.0134	44	1.0130	43	1.0130	43	1.0132	46	1.0128
November 28, 1 p. m	Low	Clear	NW.	43	43	1.0130	45	1.0130	44	1.0130	41	1.0131	46	1.0131	46	1.0134
November 29 and 30 *a*	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
December 1 and 2 *a*	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
December 3, 10.30 a. m	High	Clear	NW.	45	43	1.0122	43	1.0122	43	1.0122	43	1.0122	42	1.0122	42	1.0122
December 3, 4.30 p. m	Low	Cloudy	NW.	44	42	1.0122	42	1.0122	42	1.0122	43	1.0122	43	1.0122	43	1.0122
December 4, 12 m	High	Clear	W.	50	44	1.0122	45	1.0122	45	1.0120	45	1.0120	45	1.0120	45	1.0120
December 4, 6.30 p. m	Low	Clear	SW.	45	44	1.0122	43	1.0120	43	1.0120	45	1.0120	45	1.0120	45	1.0120
December 5, 7.30 a. m	Low	Rain	W.	43	45	1.0124	44	1.0114	43	1.0116	45	1.0122	46	1.0122	46	1.0122
December 5, 1.30 p. m	High	Cloudy	NW.	40	41	1.0124	41	1.0120	41	1.0122	41	1.0121	41	1.0124	41	1.0124
December 6, 8.30 a. m	Low	Clear	NW.	31	34	1.0120	34	1.0120	35	1.0118	31	1.0124	35	1.0128	36	1.0128
December 6, 2.30 p. m	High	Clear	NW.	35	34	1.0120	34	1.0114	35	1.0118	35	1.0124	35	1.0124	36	1.0128
December 7, 9.30 a. m	Low	Clear	NW.	20	35	1.0126	32	1.0120	32	1.0120	32	1.0120	32	1.0122	32	1.0128
December 7, 3.30 p. m	High	Clear	NW.	20	32	1.0120	32	1.0120	33	1.0120	33	1.0120	33	1.0120	34	1.0140
December 8, 10 a. m	Low	Cloudy	SW.	26	34	1.0128	34	1.0120	32	1.0120	32	1.0128	32	1.0128	31	1.0140
December 8, 4 p. m	High	Clear	SW.	36	36	1.0128	35	1.0124	35	1.0122	37	1.0128	37	1.0128	36	1.0136
December 9, 10.30 a. m	Low	Cloudy	SW.	48	40	1.0128	44	1.0122	44	1.0122	43	1.0124	44	1.0124	45	1.0124
December 9, 4.30 p. m	High	Cloudy	SW.	50	44	1.0120	45	1.0112	44	1.0112	44	1.0110	44	1.0122	44	1.0124
December 10, 10.45 a. m	Low	Cloudy	NW.	48	45	1.0118	49	1.0114	47	1.0114	47	1.0114	47	1.0116	46	1.0124
December 10, 4.45 p. m	High	Clear	NW.	51	47	1.0118	47	1.0114	47	1.0120	47	1.0120	47	1.0120	46	1.0124
December 11, 11.15 a. m	Low	Clear	NW.	36	40	1.0122	40	1.0116	40	1.0122	39	1.0122	39	1.0122	38	1.0124
December 11, 5.15 p. m	High	Clear	NW.	44	42	1.0120	43	1.0114	43	1.0122	43	1.0124	44	1.0124	44	1.0124
December 12, 12 m	Low	Clear	NW.	36	40	1.0124	39	1.0112	39	1.0124	40	1.0120	41	1.0124	41	1.0124
December 12, 6 p. m	High	Clear	NW.	42	43	1.0124	40	1.0114	40	1.0124	40	1.0126	39	1.0128	39	1.0128

December 13, 12.30 p.m	Low	Rain	SW.	44	39	1.0126	40	1.0118	40	1.0120	40	1.0126	40	1.0128	40	1.0128
December 13, 6.30 p. m	High	Rain	SE.	40	40	1.0126	41	1.0118	41	1.0122	41	1.0128	40	1.0128	39	1.0128
December 14, 7.30 a. m	High	Rain	SW.	50	46	1.0110	47	1.0100	45	1.0102	45	1.0116	46	1.0124	46	1.0126
December 14, 1.30 p. m	Low	Cloudy	NW.	44	45	1.0114	43	1.0106	43	1.0104	44	1.0120	43	1.0122	43	1.0124
December 15, 8.30 a. m	High	Clear	NW.	28	34	1.0114	34	1.0116	34	1.0110	34	1.0116	34	1.0120	34	1.0124
December 15, 3 p. m	Low	Clear	NW.	33	35	1.0116	37	1.0116	37	1.0104	35	1.0116	37	1.0124	36	1.0124
December 16, 9.30 a. m	High	Clear	NW.	40	38	1.0128	38	1.0114	38	1.0112	36	1.0128	36	1.0128	38	1.0128
December 16, 4 p. m	Low	Clear	NW.	54	42	1.0118	42	1.0114	41	1.0118	41	1.0118	47	1.0124	42	1.0124
December 17, 10.30 a. m	High	Clear	NW.	38	38	1.0120	38	1.0118	38	1.0120	38	1.0120	37	1.0126	40	1.0126
December 17, 4.30 p. m	Low	Clear	NW.	45	38	1.0120	39	1.0118	39	1.0118	37	1.0120	40	1.0124	40	1.0126
December 18, 11.30 a. m	High	Clear	NW.	45	39	1.0124	40	1.0120	40	1.0124	40	1.0124	40	1.0124	40	1.0126
December 18, 5.30 p. m	Low	Clear	W.	50	45	1.0124	40	1.0120	44	1.0122	44	1.0122	44	1.0124	44	1.0126
December 19, 12.30 p. m	High	Clear	W.	40	43	1.0126	44	1.0122	44	1.0122	44	1.0126	44	1.0126	44	1.0126
December 19, 6.30 p. m	Low	Clear	NW.	38	40	1.0126	40	1.0124	40	1.0124	40	1.0126	39	1.0128	41	1.0126
December 20, 7.30 a. m	Low	Clear	NW.	38	44	1.0126	43	1.0122	43	1.0122	43	1.0126	44	1.0126	44	1.0126
December 20, 1.30 p. m	High	Clear	NW.	38	40	1.0126	40	1.0122	40	1.0122	40	1.0126	39	1.0126	39	1.0126
December 21, 8.30 a. m	Low	Clear	NW.	36	37	1.0126	35	1.0122	35	1.0118	37	1.0126	37	1.0126	36	1.0126
December 21, 2.30 p. m	High	Clear	NW.	35	37	1.0126	37	1.0122	36	1.0120	35	1.0124	35	1.0126	35	1.0126
December 22, 9.15 a. m	Low	Clear	NW.	45	45	1.0124	43	1.0124	43	1.0122	43	1.0122	45	1.0122	45	1.0122
December 22, 3.15 p. m	High	Clear	NE.	55	47	1.0124	47	1.0122	46	1.0120	46	1.0122	45	1.0120	47	1.0120
December 23, 10 a. m	Low	Clear	SW.	48	46	1.0120	46	1.0120	46	1.0120	46	1.0120	46	1.0120	47	1.0122
December 23, 4 p. m	High	Cloudy	W.	50	47	1.0122	47	1.0120	47	1.0120	46	1.0120	46	1.0120	47	1.0122
December 24, 10.30 a. m	Low	Clear	W.	60	50	1.0120	49	1.0120	49	1.0122	49	1.0118	48	1.0122	49	1.0120
December 24, 4.30 p. m	High	Clear	W.	52	50	1.0120	50	1.0120	50	1.0120	50	1.0122	50	1.0122	50	1.0122
December 25 *a*																
December 26, 12 m	Low	Cloudy	NNE.	32	32	1.0122	32	1.0122	32	1.0120	32	1.0122	32	1.0122	34	1.0122
December 26, 6 p. m	High	Clear	NNE.	30	32	1.0120	32	1.0120	32	1.0120	32	1.0120	33	1.0122	32	1.0124
December 27, 7 a. m	High	Clear	NW.	26	33	1.0126	33	1.0124	33	1.0122	33	1.0124	33	1.0122	35	1.0124
December 27, 1 p. m	Low	Clear	NW.	35	36	1.0120	37	1.0120	37	1.0120	37	1.0116	37	1.0116	38	1.0120
December 28, 8 a. m	High	Clear	NW.	35	38	1.0116	35	1.0120	36	1.0114	38	1.0116	39	1.0116	37	1.0116
December 28, 2 p. m	Low	Clear	W.	47	37	1.0116	36	1.0118	37	1.0114	38	1.0116	38	1.0116	40	1.0116
December 29, 9 a. m	High	Clear	W.	40	38	1.0118	38	1.0118	37	1.0118	38	1.0118	37	1.0118	38	1.0118
December 29, 3 p. m	Low	Clear	W.	52	40	1.0116	40	1.0114	40	1.0114	40	1.0114	40	1.0114	42	1.0114
December 30, 10 a. m	High	Clear	W.	40	41	1.0118	38	1.0116	37	1.0114	39	1.0114	40	1.0114	40	1.0118
December 30, 4 p. m	Low	Clear	SW.	45	42	1.0118	40	1.0118	40	1.0118	40	1.0116	40	1.0116	43	1.0112
December 31, 10 a. m	High	Rain	W.	44	43	1.0104	43	1.0108	43	1.0108	43	1.0112	43	1.0112	43	1.0112
December 31, 3 p. m	Low	Cloudy	NW.	46	49	1.0100	47	1.0100	47	1.0100	47	1.0108	47	1.0110	47	1.0112

a No record kept.

XIII.—REPORT ON THE THERMOMETERS OF THE U. S. COMMISSION OF FISH AND FISHERIES.

By J. H. Kidder, M. D.

CORRECTION.

In the earlier operations of the Commission its thermometers were used as they came from the makers, without previous comparison with standards. As the number of temperature observations increased, and their importance became more evident, instrumental errors were reported from time to time, which tended to discredit some of the observations, and to weaken the force of the inferences deduced from them. In the comparison of temperatures observed at considerable depths in the sea, where the differences recorded are small, instrumental errors become particularly important, and it was decided by the Commissioner that all the thermometers used by the Commission should be compared and their errors noted before their issue.

This duty was assigned to me early in the autumn of 1883, and the report which follows covers the period from December 12, 1883, when the first corrections were made, to May 1, 1885.

At the outset comparisons were made with two standard thermometers, manufactured by L. Casella, of London, one graduated according to the Fahrenheit and the other to the centigrade scale. These instruments had been procured through the London agent of the Smithsonian Institution, and had been verified at the Kew Observatory. The tubes were certified to by the maker as having been thoroughly "seasoned" before pointing, and the centigrade which survives (the Fahrenheit was broken December 20, 1883), shows no change in the zero point up to this writing.

Subsequently (February 28, 1884), two fine standards, both graduated according to the Fahrenheit scale, were received from J. Hicks, of London, which had also been verified at the Kew Observatory. One of these instruments has been used in all comparisons since the day of receipt. They are pointed to fifths of a degree, allowing a good reading to tenths of a degree, and cover the range from 10° to 120° F.

The corrections were got at first by immersing the instruments to be compared, together with the standard, in water contained in a large cylindrical glass vessel, provided with a ring stirrer and covered by a block of wood perforated so as to allow the instruments to pass through and to hold them in place. By agitating this stirrer, which was covered with muslin to guard against breakage of the thermometers, up and down, the water contained in the vessel was thoroughly mixed, and an uniform temperature obtained throughout.

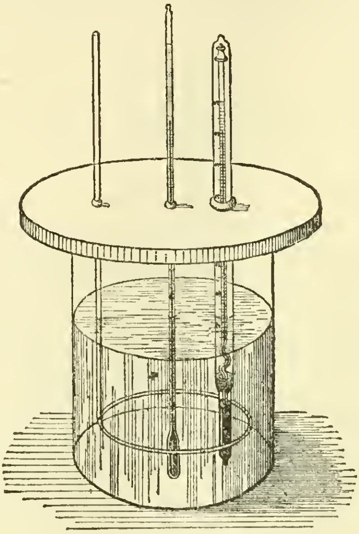

FIG. 1.—Small comparing jar.

This simple contrivance answers very well for ordinary thermometers, the bulbs of which are exposed directly to the water, but admits only two or three instruments at a time, owing to the comparatively small volume of water which it contains. A square aquarium tank, with plate-glass sides and slate bottom, was therefore procured from E. W. Taxis, of Philadelphia (received February 26, 1884). This tank is 18 inches square by 16 inches high, and contains about 22 gallons of water. Within the tank is a circular brass frame, to which a large number of thermometers may be attached at once, and which may be revolved about a central spindle by means of a winch-handle at the top. The water is stirred to an uniform temperature by turning the winch-handle, and is in sufficiently large volume to maintain a sensibly constant temperature for five minutes. The temperatures of the thermometers to be compared and of the standard can be read in this apparatus through the plate-glass sides, and a full series of readings, from 32° to 100°, can be taken without removing the thermometers from the frame.

For the "zero point," or 32° F., the thermometers to be tested are immersed in finely broken ice, contained in large glass percolators, 12 inches wide by 12 inches deep, with a small opening at the bottom for the escape of water as fast as the ice melts. These percolators are supported upon suitable iron tripods, and will hold eight thermometers each, without so crowding the instruments that one shall affect another.

For deep-sea thermometers, which are protected against water pressure by a double glass bulb, and which are therefore slow, and require exposure to a constant temperature for at least ten minutes, a contrivance is used, for the plan of which I am indebted to Mr. T. Russell, of the U. S. Signal Service, and which is illustrated by the sectional diagram, Fig. 2. A is a galvanized-iron can (in this case a 3½ gallon

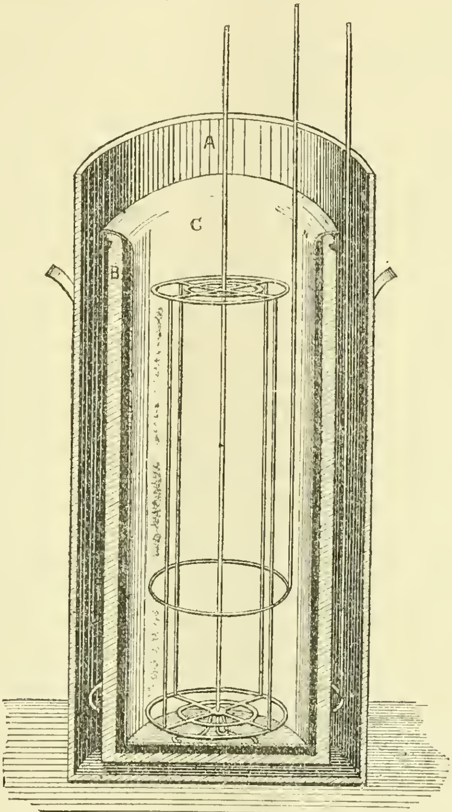

FIG. 2.—Comparing jar for deep-sea thermometers.

lard can), 13½ inches high by 11 inches wide; B is an earthenware jar, 11 inches high by 8 inches wide; C is a tinned copper pot, fitting pretty closely into B, and suspended by a flange at the top. Inside of C is a copper frame, movable about a central spindle, to which the thermometers are attached. A ring stirrer moves in the space between A and B, and another in the space between C and the thermometer frame. When the temperatures to be observed are below that of the air, the spaces between A and B and within C are filled with water, that in the outer space being from 5° to 10° colder than that in contact with the thermometers. It is advisable that these latter should be immersed for a time in water near the temperature sought, before transferring them to the comparing jar. By agitating both bodies of water briskly with the stirrers, and observing the standard thermometer (in the inner jar) from time to time, a sensibly constant temperature will at length be reached, at which the gain in temperature of the water in the inner jar by contact with the warmer air at its surface is very satisfactorily compensated by its loss through the air space between B and C and the badly conducting walls of B. For temperatures higher than that of the air, the water in the outer jar must be warmer than that in the inner. No positive rule for differences in the temperatures of the water in the inner and outer jar can be established. It may be said, however, in general terms, that the greater the difference between the temperature of the air and that desired for the comparison, the greater should be the difference between the temperatures of water in the outer and inner jars.

On the 13th March, 1884, seven Negretti-Zambra thermometers were compared at every 10° from 32° to 82°, and I find it noted that "the apparatus worked well, showing no change in forty-five minutes exceeding 0.1° at any temperature below 80°." On September 10, it is noted that "there was much difficulty, temperature of room being 86°, in keeping the water near a constant low temperature. The change was very regularly 0.2° every five minutes." On September 11, air being 82°, ice and water in outer jar, temperatures of water in the inner jar varied as follows: At 12 hours 40 minutes water in inner jar is 38°; at 12 hours 45 minutes water in inner jar is 38.2°; at 12 hours 50 minutes water in inner jar is 38.6°; at 12 hours 55 minutes water in inner jar is 38.6°; at 1 hour 0 minutes water in inner jar is 39°; at 1 hour 10 minutes water in inner jar is 39°, at which last figure the comparisons were made.

The above will serve as an example of numerous series of observations, with widely differing results. Sometimes more than an hour's patient watching is required; at others the constant temperature is reached in a few minutes, and may be maintained long enough for practical purposes by cautiously adding cold or warm water, as the case may be, to that in the outer jar.

To avoid parallax error in reading, the jars are levelled, and readings taken by aid of a hand-lens, with the eye and top of the mercury column at the level of the top of the outer jar, across the two sides of which the reading is "sighted," the thermometer being held in contact with one of the walls of the jar, and parallel with the central spindle of the frame, to insure its perpendicularity. Comparisons of readings taken in this simple way with readings taken by cathetometer, the thermometer being secured in a perpendicular position, show no perceptible error.

Since none of the thermometers in general use by the Commission are pointed to divisions less than 1° F., or need to be corrected for its purposes at temperatures above 100°, the contrivances above described have been found to afford as great accuracy as is practically required.*

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* For a good description, with illustrations, of the more exact methods followed at the Kew Observatory, see Mr. Francis Galton's paper in the Proceedings of the Royal Society of London for March 15, 1877 (vol. xxvi, p. 84), entitled "A description of the process for verifying thermometers at the Kew Observatory."

Corrections are furnished to the nearest (estimated) 0.1°, with a probable error in estimation not exceeding 0.2°.

I have tested a number of different observers, and find that the probable parallax error in reading, by those who use the thermometers in practice, is not far from 0.3°. It seems to be a difficult thing to hold a thermometer perpendicularly opposite the eye, some observers tipping it forward a little, and some backward, with a consequent change in the apparent relative positions of the top of the mercury column and of the scale behind it. This cause of error applies to all observations made previous to last June, when a reading lens was contrived which now insures uniformity. (See p. [28].)

There is a probable small inaccuracy in the comparisons of "Miller-Casella" thermometers, due to the difficulty of reproducing in laboratory comparisons the great pressures met with at considerable depths in the sea, which will be discussed more fully hereafter.

Up to May 1, 1885, 185 thermometers have been compared in one or other of the ways described. Of this number, 60 were Negretti-Zambra deep-sea thermometers; 15 were Miller-Casella deep-sea thermometers; 31 were Wilder protected water thermometers; 16 Wilder deck thermometers; 14 were salinometer thermometers; 7 were Green deck thermometers; 12 were hygrometer thermometers; 6 were standard thermometers; and 24 were various patterns no longer in use.

When issued each thermometer is accompanied by a printed blank, corresponding to a stub slip in the rating book, and filled out for each point at which a comparison is made. Following is a copy of one of these comparison blanks, with corresponding stub slips, the corrections being stated, for convenience, on the blank issued, at intervals of 10°, near the readings actually taken.

U. S. COMMISSION, FISH AND FISHERIES.

THERMOMETER RATING.

F. C. No._____

Maker's No._______________

By __________________________

____

____

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U. S. COMMISSION, FISH AND FISHERIES.

FAHRENHEIT. THERMOMETER RATING. CENTIGRADE.

Rated with attachments.

F. C. No.______________ MAKER'S NO.______________

By_______________________, ______________.

Corrections to be applied to the scale readings, determined by comparison with the standard instruments of the Fish Commission.

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NOTE I.—When the sign of the correction is +, the quantity is to be *added* to the observed reading, and when —, to be *subtracted* from it.

II.—This instrument should be returned within two years to be tested again.

WASHINGTON, D. C.,

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THE INSTRUMENT.

The following are the kinds of thermometers principally used by the Commission:

(1) *Deck thermometers* (Fig. 3).—These are in form like the "brewer's thermometers" of the trade; plain tubes with round bulbs, graduated upon a white metal scale to divisions of 2° F., and ranging from — 30° to + 120° F. They are inclosed in plain copper cases, open in front, with a cup at the bottom, perforated by a central hole. This cup can be closed by a cork and will then hold water. Made by Charles Wilder, of Peterborough, N. H., in two sizes, 10 inches and 14 inches long, used mostly for air temperatures and for temperatures of surface water.

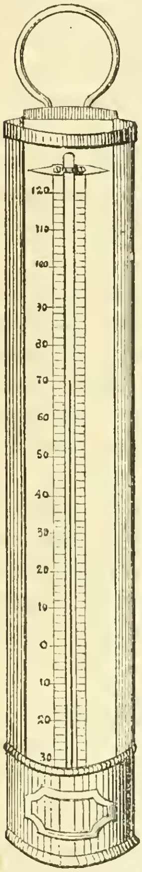

FIG. 3.—Deck thermometer.

These instruments, although cheap and not pointed to less than 2°, are now very trustworthy, the maker furnishing the Commission with "seasoned" tubes. The first seven received showed a maximum error of 1.1°, minimum 0°, and mean of 0.32°, between 32° and 92°. The last nine are much better, showing a maximum error of 0.5°, minimum of 0°, and mean of 0.1°. The spaces in graduation are wide, and might profitably be divided so as to indicate single degrees.

Six deck thermometers, of similar form to those above described, made by J. & H. J. Green, of New York, are graduated upon the stems to intervals of 1°, and rate with remarkable uniformity, with a maximum error of 0.3°, minimum of 0°, and mean of 0.1°.

(2) "*Protected" thermometers*, with round bulbs, graduated upon a white-metal scale to 1° intervals, and ranging from — 30° to 120° F. These thermometers are inclosed in cylindrical copper cases (devised by Professor Baird in 1873), with a hinged door in front. There is no perforation in the bottom of the cup, which is 3 inches long by $1\frac{3}{4}$ inches wide (Fig. 4); total length 12 inches; a stout ring at each end; made by Charles Wilder, of Peterborough, N. H.; used mostly for reading water temperatures at light-houses, and at shore stations of the Commission. For depths down to five fathoms these thermometers will indicate closely the temperature of the water below the surface, some of the water being caught and held by the cup at the bottom. The cylindrical copper cases protect the tubes from damage by striking against rocks, &c.

These thermometers also show a considerable improvement in accuracy since the maker has been furnishing seasoned tubes. The first four compared gave a maximum error of 1.3°, minimum of 0°, and mean of 0.58°. The next fifteen showed a maximum error of 1°, minimum 0°, mean 0.34°.

The last eleven showed a maximum error of 0.3°, minimum 0°, mean 0.07°. A single instrument gave the very large error of maximum 1.8°, minimum 1°, mean 1.5°, due to the sliding of the tube on the scale, the tip of the tube holding it at the top having been broken off. These instruments would be greatly improved by being pointed also upon their stems.

(3) *Thermometers attached to the Coast Survey "salinometer" cans.*—Simple tubes, with round bulbs, protected by a perforated brass cage, graduated to 1° intervals upon a white-metal scale. Since March, 1885, graduated also upon the stems; range from 30° to 100°. Fitted to slide into the front of the Coast Survey salinometer cups; made by Giuseppe Tagliabue and John Tagliabue, of New York. Used only in connection with salinometers.

Three of these thermometers (old) made by G. Tagliabue, show a maximum error of 1.2°, minimum of 0°, and mean of 0.5°. Five made by J. Tagliabue show a maximum of 1.1°, minimum of 0°, and mean of 0.67°. Six last received from J. Tagliabue, pointed on stems, and of improved quality, show maximum error of 0.6°, minimum of 0°, and mean of 0.26°.

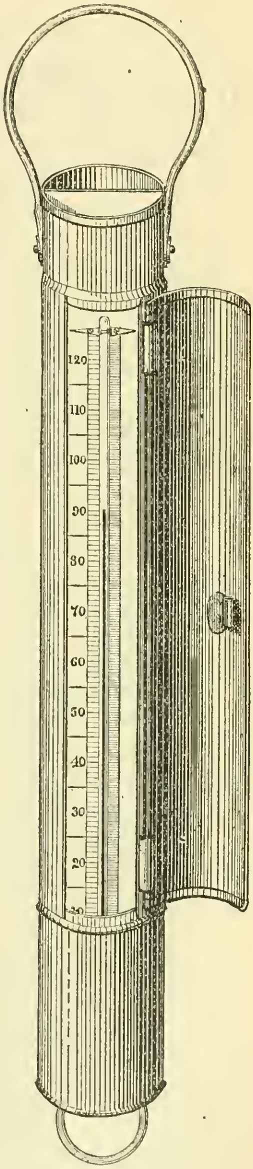

FIG. 4.—Professor Baird's protected thermometer.

(4) *"Miller-Casella" deep-sea thermometers.*—These instruments are a modification of Sixe's self-registering thermometer, consisting essentially in the protection of the larger bulb, which contains the expansible fluid acted upon by changes of temperature, by an inclosed sealed glass cylinder nearly filled with alcohol. By this device the effect of pressure at great depths below the surface of the sea is neutralized, the pressure being taken up by the fluid and vapor contained in the outer cylinder.

The following description, condensed from Lieutenant-Commander Sigsbee's Deep-Sea Sounding and Dredging (Washington, 1880, page 108), will explain the construction and operation of the instrument. (See Fig. 5.)

A thermometer tube, bent in the form of U, is fastened to a vulcanite frame and backed by a white glass slab, marked by graduated scales. The limbs terminate in bulbs, one much larger than the other, and the U is occupied by a column of mercury which serves as an index. The large bulb and part of limb not occupied by mercury are wholly filled with a mixture of creosote and water.* The smaller bulb and limb are partly filled with the same mixture and partly with compressed air. On each side, in the tube above the mercury, is a small steel index, having a human hair tied around its upper end to keep it in place. The fluid acted upon by temperature is that in the larger bulb. As the temperature rises the mercurial column is forced over into the other limb, driving the index before it. As the temperature falls the compressed air in the smaller bulb acts as a spring to send the mercury back again, driving the other index before it, and leaving the first index at the highest point it had reached. It is thus a self-registering maximum and minimum thermometer, and the scales are therefore graduated in opposite directions. The steel indices are set by means of a small magnet, grooved across its poles to permit close coaptation to the tubes. The larger bulb is made double, according to the recommendation of Dr. W. A. Miller, vice-president of the Royal Society (in April, 1869), being surrounded by another bulb, and the intervening space nearly, but not quite, filled by alcohol. Made by Mr. L. Casella, of London.

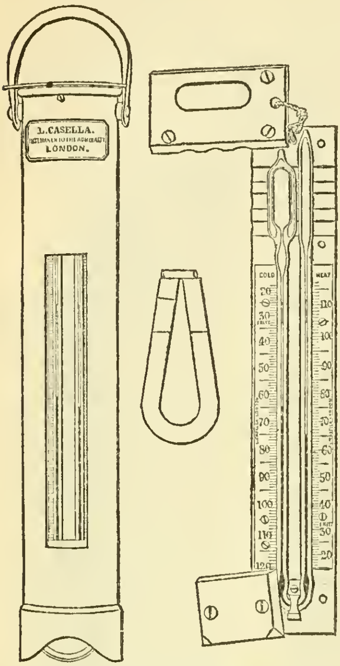

FIG. 5.—The Miller-Casella deep-sea thermometer, in and out of case.

In the original form of this instrument, invented by Negretti and Zambra (see page [13]), this space between the larger bulb and its protecting shield was partly filled with mercury, a better conductor of heat than alcohol. The instruments are advertised as having been subjected to hydraulic pressures equal to five tons to the square inch, before leaving the makers' hands.

The Miller-Casella thermometers now in stock and recently in use by the Fish Commission agree with the foregoing description and with Fig. 5, excepting in that the "aneurisms," † as Professor Tait has called them, or little swellings of the tube near the bends of the U have been omitted, perhaps because of Professor Tait's criticisms. The form figured is that which was first used in the cruises of the Porcupine in 1869 and 1870, of the Pomerania in 1872, by the Norwegian expedition in 1876–'78,

* In the Challenger Narrative, vol. i, p. 86, it is stated that the bulb contains creosote and *alcohol*.

† From *ἀνεύρυσμα*, a swelling (*ἀνὰ* and *εὐρύς*), not *ἀ—νευρος*, as more commonly derived. (*Scientific Results Voyage of Challenger, Narrative, vol. 2, Appendix A, p.* 1.)

in the cruises of the Valorous in 1875, of the Challenger in 1873–'76, of the Nares Arctic Expedition in 1876, and by the U. S. Coast Survey and Fish Commission up to a recent date.

Although justly regarded as a most important improvement upon the unprotected Sixe's thermometers used prior to the year 1869 (with exceptions to be hereafter noted), these instruments are not free from defects and individual peculiarities, which have doubtless often led to erroneous readings.

In the first place, the indices are likely to *slip*, especially since the use of steam winches and of wire for sounding, imparting a peculiar jarring motion to the whole line. "Even a slight jerk causes the index to move up or down," says Sir Wyville Thomson, * who found one or two thermometers to be wrong from this cause "in almost every serial temperature sounding."

Then, again, since these thermometers register only the maximum and mininimum temperatures which they encounter, in the possible case of a warmer stratum of water underlying a colder one of less specific gravity, or in the case that the air is colder than the water, the final registration may not be a correct indication of the temperatures met with, the instruments registering on their minimum sides either the temperature of the colder overlying stratum of water, or of the air, which may be inadvertently or ignorantly read as that of the greatest depth measured. When the air is colder than the water the thermometers may be artificially warmed before sending them down, but a colder overlying stratum of water offers much greater difficulties, which were fully recognized by the Challenger observers. Sir Wyville Thomson says, to this point:† "Very frequently, especially at considerable depths, where the differences were very slight, thermometers sent to greater depths gave indications higher than those above them. * * * I have no hesitation therefore in saying that a single indication with a thermometer on Sixe's principle is not trustworthy, and that a fact in temperature distribution can only be established by a series of corroborative determinations."

Another peculiarity, which fortunately tends to compensate that last described, is that these instruments are extremely *slow*. According to my laboratory observations quite twenty minutes are required for the change from the temperature of the air (60°–70°) to the freezing-point, the thermometers being immersed in melting ice.‡ It is possible that, inasmuch as a self-registering thermometer in actual use is recording

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*Voyage of the Challenger. The Atlantic, vol. 2. p. 259. See also Sigsbee's Deep-Sea Sounding and Dredging, p. 110.

†*Op. cit.*, vol. 2. p. 260; also Sigsbee, p. 112. "From what has been said it is seen that a maximum and minimum thermometer is not well adapted to ascertaining the temperature of intermediate warm or cold strata."

‡See also Commander Beardslee's observations, Rep. Com. Fish and Fisheries, 1877, App. C., and Coast Survey comparisons, quoted by Sigsbee, *op. cit.*, pp. 114-119.

during its descent through the water, the time figures deduced from laboratory observations may be too large; but it seems hardly safe to rely upon seven minutes' exposure, as directed by Sigsbee, in the operations of the Blake (*op. cit.*, p. 23), and still less upon five minutes' exposure, as was directed and followed in the Challenger work.*

Unless the thermometers are always kept bulb uppermost (for which reason the makers ship them in cases of a pyramidal form), the mercury is very likely to get above the indices. In such an event the index may be drawn by the magnet into the small enlargement just below the bulb, when the mercury will free itself and drop back into the tubes; but it will not always be easy to get the index back into the tube again, as it is likely to tip under the influence of the magnet, and to catch against the sides of the small enlargement. In the course of the tapping upon a table and swinging the thermometer about the head, which are to be tried in case of such an accident, it is very likely that the tube will be started a little from its right place upon the scale, since the fastening which is intended to secure the tube at the bend of the U is a soft copper band, fastened by *one end only*, probably to allow for expansion or contraction of the glass, under wide variations of temperature or pressure.

As to breaks in the mercurial column, an accident common to all mercurial thermometers, and other small mischances which may be remedied by the observer himself, I cannot do better than refer to Sigsbee's monograph, already often quoted (p. 110), for clear and practical directions as to all that may be safely done without sending the instruments back to the maker for repair.

Pressure errors.—In the Challenger observations a subtractive correction of about $\frac{1}{2}$° F., applied to the maximum side, was assigned by Dr. Wyville Thomson for every mile of depth below the surface of the sea. This correction was the result of a series of careful observations made, with the aid of a powerful hydraulic press, by Capt. J. E. Davis, R. N.,† assisted by Prof. W. Allen Miller and others. Since the return of the Challenger, and during the three years preceding July, 1881, the pressure-error of these thermometers has been made the subject of especial examination by Prof. P. G. Tait, whose conclusions are published as Appendix A of the second volume of the narrative part of the "General Report on the scientific results of the voyage of H. M. S. Challenger," already cited. In the experiments of both Captain Davis and Professor Tait, the thermometers were subjected to heavy pressures in a hydraulic press, and the phenomena presented were similar in both series. Professor Tait concludes, however, that Captain Davis's corrections (and consequently those of the Challenger report) are too large, for the following reasons: In the first place the water in the press is heated by com-

* Challenger Narrative, vol. 1, p. 120.

† See his paper on "Deep-sea thermometers" in Proceedings of Meteorological Society, April, 1871.

pression, but the *amount* of heat developed is dependent in a very curious manner upon its original temperature. If compressed at the temperature of its maximum density, the water is neither heated nor cooled, but is heated when compressed at a temperature above, and cooled when compressed at a temperature below its maximum density; and the wider the divergence of its original temperature from that of its maximum density, the greater is the effect produced. Captain Davis combined one set of observations taken near, but below, the temperature of maximum density, with a number taken near 55° F., striking out (unfortunately), as probably erroneous, all observations which differed much from the majority of the others. By an interesting graphic diagram Tait shows that the true figures for temperature correction, according to Davis's experiments, lie in a line coinciding much more nearly with that indicated by his rejected observations than by those which he adopted.

Professor Tait found by experiment that a Phillips self-registering mercurial thermometer,* wholly inclosed in a sealed glass tube, nearly filled with alcohol, as suggested by Sir William Thomson,† was "absolutely perfect, so far as regards immunity from pressure" (p. 7). So that the pressure error of the Miller-Casella thermometer, the bulb of which is protected in precisely the same way, is due almost, if not quite, entirely to pressure upon the stem. For tubes of uniform caliber throughout, it was found by experiment that the effect of pressure upon a tube similar to those of these thermometers would be an elongation of about $\frac{1}{1000}$ of the length of the column of mercury for each ton weight applied to the outside of the tube (or about 800 fathoms of depth). As the elongation will occur in both legs of the U, and as increase in pressure is in practice (at sea), associated with decrease in temperature, this correction for pressure should have been applied also to the minimum scale, instead of, as was the fact, to the maximum only.

As the instruments used by the Challenger were actually constructed, each leg of the U contained an "aneurism," or small enlargement,‡ near the bend, intended to facilitate recovery of the steel index when it had been lost in the mercury. These swellings appear to be larger than they really are in the ratio of 1.6 (the refractive index of glass) to unity, but were actually found by Tait, in several instances, to contain five times as much mercury as a similar length of thermometer tube, and, consequently, to produce five times as great an error.

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* A mercurial thermometer, self-registering by an index produced by a break in the column. Invented by Prof. John Phillips, of Oxford. First used at Kew in 1851. The principle is now universal in clinical thermometers.

† "The effect of pressure in lowering the freezing point of water." Proc. R. S. E. February, 1850.

‡ The "aneurisms" were first added to Sixe's thermometers by Aimé, in 1844, to prevent the mercury from passing by the indices. *Ann. de Chimie et de Physique, Ser.* 3, *t.* xv, p. 5 (1845).

I have gone somewhat fully into this matter of pressure error because, if Professor Tait's results are to be accepted as correct (a conclusion strongly favored by internal evidence), the pressure corrections applied to observations made with the Miller-Casella thermometer hitherto may safely be disregarded, and the laboratory corrections under ordinary atmospheric pressures, which I was at first disposed to regard as of little value, because of the difficulty in reproducing the conditions prevailing at great depths under the sea, may be accepted as practically exact. For the outcome of Professor Tait's inquiry (the details of which would be too voluminous for this report) is that Captain Davis's corrections, although corresponding closely with those obtained in similar experiments by Tait, are misleading, because of certain facts brought out for the first time by the later inquiry. Not only is there some error in the allowance by Davis for the heating of water by compression in the press, but there are errors due to the heating of the vulcanite mounting and of the glass protecting bulb, by pressure,* discovered for the first time by Tait, which could not have been known by the former experimenter. Professor Tait concludes that for thermometers without aneurisms the correction will not exceed 0.05° for every ton of pressure (nearly a mile in depth of water) applied to the minimum scale, and that in no case need the correction to the minimum scale exceed 0.14° per mile in depth; a correction which, considering the probable parallax error in reading on the unsteady deck of a ship, may be safely disregarded as less than the probable error of observation for the depths usually explored.

At present, and since the year 1877, the Miller-Casella form of deep-sea thermometer has been very seldom used by the Fish Commission, its place being filled by the Negretti-Zambra thermometer, constructed on a quite different principle. Only fifteen in all have passed through my hands, and of these the first six were called for immediately, as a reserve supply for the winter cruise of the Albatross in 1883–'84. They were compared only at 32° F., at which point none of them showed any error. The other nine, still on hand, are a lot of old instruments which had been more or less damaged by careless handling, and have been repaired by the makers. Some of these show rather unusually large errors, apparently because of displacements of the stems upon the scale-plates. One is unserviceable from the jamming of its index in the small enlargement at the top of the minimum tube. One marks 31° in melting ice on the maximum side (31.5° on the minimum side). Of the eight still serviceable the maximum error is 1°, minimum 0°, and mean 0.18°.

When used with a due regard to the causes of error already noted,

* All of these heating effects are of course peculiar to the laboratory experiments, and do not affect observations at sea, where the heat is at once conducted away by the surrounding water.

these instruments answer well the purpose of their construction, and have, in fact, been the means by which most of the best modern temperature observations beneath the sea have been made. Now that the small aneurisms near the bends of the U have been given up by the makers, it appears that the pressure error may be safely disregarded in practice (excepting at very great depths, when Professor Tait's tables will be found useful), and that the laboratory corrections, under ordinary atmospheric pressures, will answer every practical purpose.

This form of deep-sea thermometer, under its present name, is a curious example of *re-invention* within a shorter time than usual after the original publication of its conception. As now advertised and used, it is commonly supposed to be the invention of the late Dr. W. A. Miller, vice-president of the Royal Society in 1869, and to have been first used in the cruise of the Porcupine in that year. The invention consisted, as has been already said, in the protection of the larger bulb of a Sixe's thermometer by another cylindrical glass tube, hermetically sealed about it and partly filled with alcohol. There is no reason to doubt that Dr. Miller promulgated his invention in good faith, but there is also no reason to doubt that an exactly similar, and perhaps more effective, instrument of the same sort had been made so early as 1857.

In that year the late Admiral Fitzroy, acting under a suggestion by Mr. Glaisher, requested Messrs. Negretti and Zambra to endeavor to protect the bulb of Sixe's thermometer against sea pressures, which was successfully accomplished by inclosing the bulb in an air-tight glass shield, nearly filled with mercury to promote conduction of heat.* Some fifty of these instruments were made for and purchased by the hydrographic office of the admiralty. It appears to be certain that these instruments were used by Captain Pullen, in the voyage of the Cyclops, which began in 1857. Forty-one important observations were taken in the North and South Atlantic, the Indian Ocean, and the Red Sea, at depths from 2,400 to 16,000 feet, with "Negretti and Zambra's protected Sixe's thermometers."† Pullen noted that the *maximum index* often shifted, indicating that he used the instrument provided with both maximum and minimum scales.

From an account published by the makers in 1864,‡ I infer that the original form was precisely like Sixe's thermometer§ with a double curve,

* Meteorological Papers, No. 1, July 5, 1857.

† J. Prestwich, on Submarine Temperatures, &c. Phil. Trans. Roy. Soc. Vol. clxv (1875), p. 608.

‡ A Treatise on Meteorological Instruments, Negretti and Zambra. London, 1864.

§ Invented by James Six (or Sixe) of Canterbury (or Colchester), in 1782. In the original account (Trans. R. S., vol. lxxii, p. 72, 1782) Mr. Six states that "our thermometer resembles in some respects those of M. Bernoulli and Lord Charles Cavendish," the invention claimed consisting in the mode of registration. A thread of glass was at first used, instead of a hair, to hold the index in place.

excepting in that the larger bulb was protected as described above. (Fig. 6.) A smaller and more compact instrument, with the tube bent but once, in U-shape, was constructed for the registration of minimum temperatures only. The copper case inclosing this last-named instrument was made, by a poppet valve at the top and bottom, opening upward, to serve also as a water-bottle. (Fig. 7.)

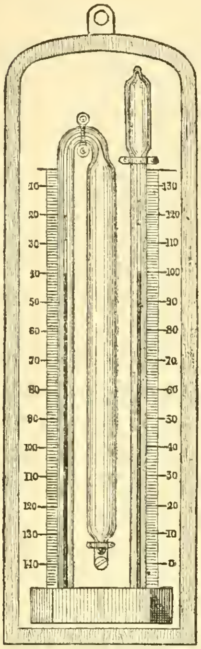

FIG. 6.—Sixe's self-registering maximum and minimum thermometer.

After the appearance of the form now in common use, under the name of the "Miller-Casella" or "Casella-Miller" deep-sea thermometer, the question of its authorship was made the subject of a somewhat acrimonious correspondence in *Nature* (October and November, 1873), between Mr. Casella and the Messrs. Negretti and Zambra, which resulted in satisfying the editor of that periodical that "the whole credit of the double bulb belongs to Negretti and Zambra." This statement, although conclusive as regards the controversy between the two firms, is somewhat too positive to be accepted as establishing absolute priority of invention, since the use of a double cylinder to meet pressure error was made sufficiently familiar by Sir William Thomson's paper on the "Effect of pressure in lowering the freezing point of water," published in 1850,* in which his "thermometer was entirely inclosed and hermetically sealed in a glass tube," and had been known to marine investigators at least as early as 1822, when Sir Edward Sabine used a strong iron cylinder for this purpose; † if not, as has been supposed by Sir Wyville Thomson and the authors of the Challenger Narrative, to Sir John Ross, in 1818.

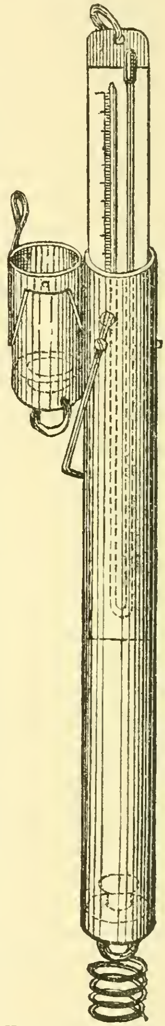

FIG. 7.—Negretti-Zambra self-registering minimum deep-sea thermometer.

The Negretti-Zambra deep-sea thermometer, as at present used, is represented by Fig. 8. Mercury is the thermometric fluid, and the bulb is about 2 inches long by one-half inch in diameter. Just beyond the bulb the tube is curved like the Greek ς laid upon its side, the convexity of the curve being widened into a small reservoir, beyond which the tube is constricted in a particular manner. At the upper end of the tube is a small pyriform enlargment. The

* Proc. R. Soc. Ed., January 2, 1849, and January 1, 1850.

† Phil. Trans. R. Soc., vol. cxiii (April 17, 1823), 1823.

instrument is graduated upon its stem *towards* the bulb in intervals of 1° F., and a white enamel backing facilitates readings. The whole tube, including the bulb, is surrounded by a glass protecting cylinder. sealed at both ends, to take up the pressure of the sea water, and is 9½ inches in length. That portion of the protecting cylinder which covers the bulb is nearly filled with mercury, confined by a partition cemented about the neck of the bulb, to promote conduction of heat between the bulb and the surrounding water. Made by Messrs. Negretti and Zambra, of London.

When in use, the thermometer is attached to a sounding line, and lowered into the water bulb downward. At the desired depth, after a sufficient delay to insure its having taken on the temperature of the surrounding water, it is overset; the portion of mercury contained in the tube above the constriction breaks off at that point and stands opposite the scale-reading corresponding to the temperature. It may be read at any time, provided that it be kept in a reversed position, the enlargement at the end of the tube farthest from the bulb being too small to be seriously affected by ordinary temperature changes.

The first form of this valuable invention, as presented to the Royal Society of London, by Henry Negretti and Joseph Warren Zambra, March 12, 1874,* was a siphon tube, with parallel legs and a considerable enlargement at the bend. (Fig. 9.) Instead of the double curve, small reservoir, and constriction in the tube of the later forms, there was a single funnel-shaped curve above the bulb, containing a small glass plug, similar to that used in Negretti and Zambra's patent maximum thermometer. The office of this plug was to close the tube on reversal and cause the column of mercury to break off at that point. The instrument was

Fig. 8.—The Negretti-Zambra self-registering deep-sea thermometer, modern form.

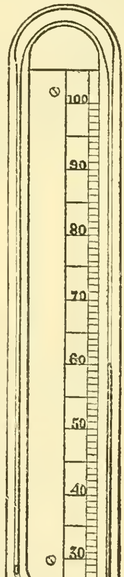

Fig. 9.—Negretti and Zambra's self-registering deep-sea thermometer, earliest form.

* Proc. Royal Society, 1874. Vol. 22.

pivoted near its center, upon a frame, and a small rudder or fan was geared to the pivot. This rudder pointed upward during the descent of the instrument, and downward during its ascent, making a half revolution at the moment of reversing the direction of motion, which produced a complete revolution of the thermometer. The broken part of the mercurial column in the tube dropped first into the enlargement at the bend, and then passed over into the other leg, where its height, and the temperature at the time of reversal, could be read on the scale. The bulb was protected as in the Miller-Casella instrument.

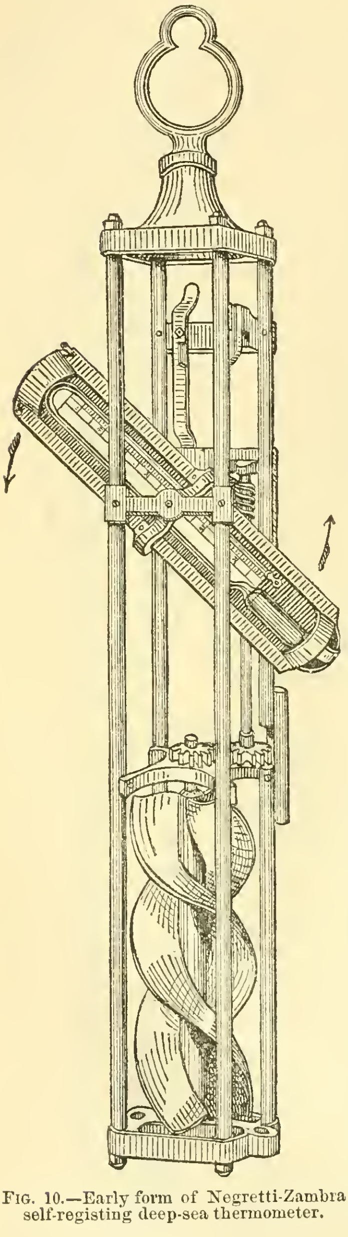

FIG. 10.—Early form of Negretti-Zambra self-registing deep-sea thermometer.

Subsequently a frame was constructed carrying a screw-propeller (Fig. 10), which revolved freely during the descent of the instrument but engaged a train of ratchet-work as soon as the direction was changed to ascent, and caused the thermometer to revolve once upon an axis near its center, first to bulb uppermost, catching the separated column of mercury in the bend of the siphon, and then to bulb downward again, allowing the mercury to flow into the other limb of the tube, where the temperature was read. A specimen of this form was purchased by the Coast Survey and tried by the Blake in 1875, "but it was so cumbersome, expensive (the advertised price was 10 guineas), and left so much open to doubt in its indications, that it was reported on adversely to the Superintendent."* Several were also sent out to the Challenger and tried during the cruise. At first, Staff Commander Tizard reports that† "it was found in practice that the propeller being arrested over the thermometer, after it had overturned, brought such a strain on the cog-wheel as to twist it off its spindle and cause its loss." This difficulty was remedied by the chief engineer of the Challenger, Mr. Ferguson, but the record of the instruments was not found to be satisfactory. Four that were tried

* Sigsbee, *op. cit.*, p. 114. † Narrative, vol. 1, p. 89.

in the Sulu Sea (p. 91), disagreed materially with the Miller-Casella instruments sent down at the same time.

In the stock of old thermometers belonging to the Commission I find one of the form represented by Fig. 11, which appears to be intermediate between that just described and the form now in use, although, as the bulb is not protected, it seems to have been intended for use in shallow water only. The tube is bent twice upon itself, making an S-shaped curve just above its bulb, and leaving the bulb inclined to the stem at an angle of 10 degree. Here I first find a small reservoir in the curve of the bend, and a constriction above, instead of a glass plug, for breaking the column on reversal. The single specimen on hand is inclosed in a wooden case, which will be described further on.

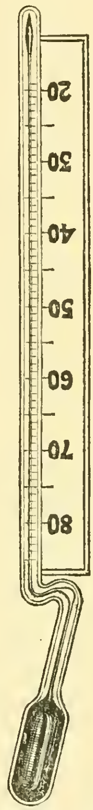

FIG. 11.—Negretti-Zambra self-registering thermometer, intermediate form.

The Negretti-Zambra deep-sea thermometers were first used in this country by the U. S. Fish Commission early in 1877, and were then of the form described on page [15], Fig. 8. The construction is necessarily handwork, and requires very expert glass-blowing, in which a decided improvement has been noticed. Thus, in 1879, I reported that the instruments then under observation "have sometimes a trick of breaking the column in the wrong place, and so giving a false indication. In one instance I noticed that the break was diagonal, instead of being directly horizontal, as it should have been. Professor Hind, of Halifax, informs me that he has noticed the same defect, and has brought it to the attention of the makers, who have assured him that it has been corrected in their more recent form of instrument." *

On the 18th of April, 1884, I note that of twelve Negretti-Zambra thermometers compared to date at 32°, six show no error, four show +0.1°, one shows +0.2°, one shows +0.63°. Maximum error (for the twelve), +0.60°; minimum, 0°; mean +0.2° (nearly).

Twelve compared on the 16th of September, 1884, at 32°, show a mean error of 0.57°, of which two show +1°, three show +0.7°, three show +0.5°, two show +0.3°, one shows +0.1°. The mean errors of all thermometers of this pattern examined are given in full in the appendix.

The errors recorded are, as I think, larger than they should be, and make it very dangerous to rely upon unseasoned instruments which have not been recently compared. Some of the error is doubtless due to rise in the zero point, the natural result of "seasoning"; another part

* On the Temperature of Fishes. J. H. Kidder, M. D., surgeon, U. S. Navy, Proc. Nat. Museum, March 25, 1880, p. 310.

(perhaps) to the difference in *pull* between a long and a short column of mercury, upon the main body at the breaking point. The possible operation of this cause, tending to break the column a little nearer or a little farther away from the narrowest constriction, is not made very obvious by the comparisons, although it may explain some individual peculiarities which have been noted.

As to such individual peculiarities the following notes may be of interest as illustrating the frequency with which these instruments have been found to break column in the wrong place:

Fish Commission number.	Maker's number	Notes.
5149	50302	Error 0.2° to 1°, column breaks unequally.
5151	50306	Error 0° to 0.4°, column breaks unequally at 42°.
5276	54812	Column broke in wrong place once at 49.8°; broke correctly in five repetitions of observation.
5280	54821	Very slow in breaking.
5285	54822	Very slow in breaking.
5325	52729	Column broke wrong *once* at 60° and once failed to break at 92°; correct on repetitions.
5284	54823	Very slow in breaking.

Three of the instruments were noted as very slow in breaking; two broke column frequently in the wrong place; one did not break at all, on one trial, at 92°, but broke correctly on repetitions of the experiment; two broke colum *once* in the wrong place (one at 49.8°, one at 60°), but not again during frequent repetitions of the experiment. One was found (at 32°) to hold back the separated part of the column after being inverted, read, and returned to the bulb-downward position.

Several series of experiments were made to determine the *slowness* of the instruments. Thus, Fish Commission No. 5206 (maker's No. 51452), immersed in melting ice, fell:

	°
In 1 minute from 64° to 43.1°	20.9
In 2 minutes from 64° to 42°	22.0
In 3 minutes from 67.5° to 33.8°	33.7
In 4 minutes from 68° to 33.8°	34.2
In 5 minutes from 68.2° to 35°	33.2
In 5 minutes from 66° to 35.8°	30.2
In 6 minutes from 66° to 33.8°	32.2
In 7 minutes from 67° to 32.4°	34.6
In 8 minutes from 65.5° to 32.4°	33.1
In 9 minutes from 66.6° to 32.4°	34.2

The true reading (32.4°) was in this case reached in 7 minutes. Fish Commission No. 5184 (maker's No. 47995), inclosed in a metallic case, as in use at sea, and immersed in melting ice, fell:

	°
In 1 minute from 71° to 64.2°	6.8
In 2 minutes from 62° to 41°	21.0
In 3 minutes from 62° to 40°	22.0
In 4 minutes from 76° to 39°	37.0

	°
In 5 minutes from 62° to 35.5°	26.5
In 6 minutes from 58° to 43°	15.0
In 7 minutes from 68° to 38.8°	29.2
In 8 minutes from 58° to 37°	21.0
In 9 minutes from 50° to 36°	14.0
In 10 minutes from 60° to 37°	23.0
In 10 minutes from 72° to 32.6°	39.4
In 11 minutes from 58.5° to 32.4°	26.1
In 15.5 minutes from 60° to 32.4°	27.6

The change is rather irregular, depending somewhat upon the temperature marked by the thermometer at the beginning of each experiment, and partly upon the more or less close coäptation of the melting ice to the outer case of the thermometer. The rapidity with which the instrument is overset may also sometimes influence the position of the breaking point, as in the following instance: Fish Commission No. 5157 (maker's No. 52752), immersed in water at 45.3°, overturned by a quick movement read 45.6°, by slow movement 46.5°. In water at 46°, overturned by quick movement it read 46.1°, by slow movement 46.3°. Even when compared without the investing metallic case now used at sea, it seems that the reading cannot be safely depended upon with less than ten minutes exposure, in laboratory comparisons. In practice, at sea, since the thermometers are changing on their way down, and the water in contact with them is continually renewed, it is probable that a less time may serve. The use of self-oversetting cases insures uniformity in the quickness of the turn. The present rule in the work of the Commission is to leave the thermometers down for ten minutes.

An annoying defect in construction, which might easily be remedied, is the wide variation in graduation on the scales. In twelve thermometers of this pattern, compared September 12, 1884, for example, the range of graduation varied between 63° (+32° to +95°), and 112° (—25° to +87°). The degree spaces in the first-named instrument are nearly twice as wide as those in the last, and, since there is no pointing to fractions of a degree, estimations of fractional parts are made much more difficult by these inequalities in spacing, the eye gaining nothing by practice with one thermometer when another is substituted for it.

The Negretti-Zambra thermometer, as at present constructed, leaves little to be wished for as a deep-sea temperature recorder, beyond some improvement in the details of construction. The mode of protection absolutely does away with pressure error, and the use of mercury in the bulb-case has raised its sensitiveness to a point considerably above that of the Miller-Casella. With a little greater certainty in the formation of the column-breaking contrivance, and a good deal more uniformity in the graduation of the stem, there need be no fear of erroneous indications from any depth that the glass protecting tube will stand. With due care in noting untrustworthy instruments by laboratory comparisons, there should never be any possibility of recording an error exceeding one-half a degree. By increasing the length of the stem and restricting the graduation to the range between 32° and 90°, it would be possible to point the stem to fifths of a degree, for special observations at great depths, where the variations of temperature are small.

With the exception of the single specimen tried and reported adversely upon by the Coast Survey in 1875 (see p. [16]), the earlier forms of reversing gear for these thermometers have never, to my knowledge, been used in this country. As first used by the Fish Commission in 1877, the thermometers were inclosed in wooden cases, about 13 inches long, secured to the sounding line by a lanyard about 6 feet long attached to the bulb end. The case was hollowed out inside, and contained a quantity of small shot, movable from end to end, sufficient to nearly, but not quite, overcome its buoyancy in sea water. On sending the case down the shot fell to its bulb end and tended to keep it upright in the water. On reversing the motion and hauling in the line, the case was overset, the shot ran to its other end, and tended to keep its bulb uppermost. (Fig. 12.)

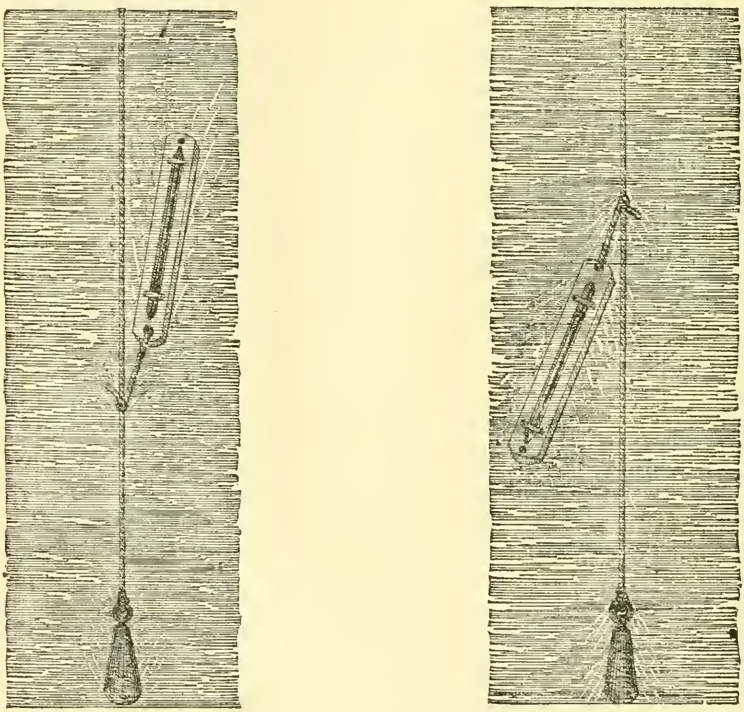

FIG. 12.—Negretti-Zambra thermometers in wooden cases, as first used by the Fish Commission.

For the moderate depths at first explored this contrivance answered very well, due care being taken that the acts of lowering and hauling in were continuous. At 800 fathoms, however, Commander J. R. Bartlett, U. S. Navy, found the wooden cases shriveled and compressed* (the pressure at 800 fathoms is about a ton to the square inch), so that their buoyancy was quite lost. Professor Hilgard, of the Coast Survey, suggested the use of a metal case, filled with paraffine, but I do not know that the suggestion was ever carried out.

Lieut.-Commander (then lieutenant) Z. L. Tanner, U. S. Navy, commanding the Fish Commission steamer Fish Hawk, noted in 1880 that, "The bottom and intermediate temperatures were unreliable, owing to the use of the Negretti-Zambra deep-sea thermometer in a sea-way, the motion of the vessel being liable to capsize it at any time. It was the results of this day's work [September 4, 1880] that led us to devise some plan by which this admirable thermometer could be used under all conditions of wind and weather. * * *

"Several devices were tried, and finally a simple gas-pipe, seven-eighths of an inch inside diameter, was adopted. Several holes were drilled in the end inclosing the bulb, a slit cut in the side to expose the scale, and a pair of slip-hooks held in position by a small spring placed in the opposite end. The thermometer was then inserted, the rubber guards used to protect the shield in the wooden frame serving not only to hold it securely in place but to protect it from sudden jars, and a lanyard of cod-line, spliced into the end carrying the bulb, completed the arrangement.

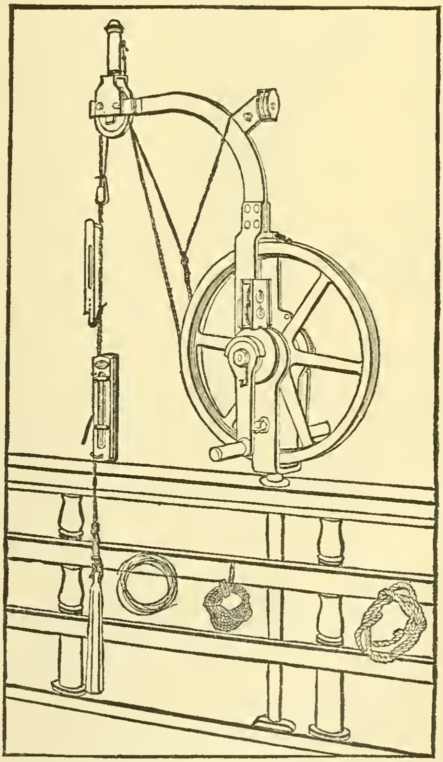

Fig. 13.—Sounding machine, with Negretti-Zambra deep-sea thermometers descending. Shows the wooden case and the Tanner metallic case.

"The messenger used for capsizing the thermometer is of cast brass, cylindrical in form, with rounded ends. It is about 2 inches in length, 1 in diameter, and has a three-eighths inch hole through its center, well rounded at the ends to prevent catching on splices. Its weight is from 3 to 4 ounces.

"Fig. 13 shows both forms of the Negretti-Zambra thermometer arranged for descent. In the modified form it is held firmly in position by the slip-hooks through which the stray-line passes.

"Having attained the proper depth, and sufficient time elapsed for the thermometer to indicate the temperature, the messenger, which has

* Sigsbee, *op. cit.*, p. 116.

been resting in its cradle under the guide-pulley, is sent down the wire and capsizes the thermometer by striking the slip-hooks and forcing them pen, when, having lost its support, the instrument promptly reverses, as shown in Fig. 14, where both forms are represented as on the ascent.

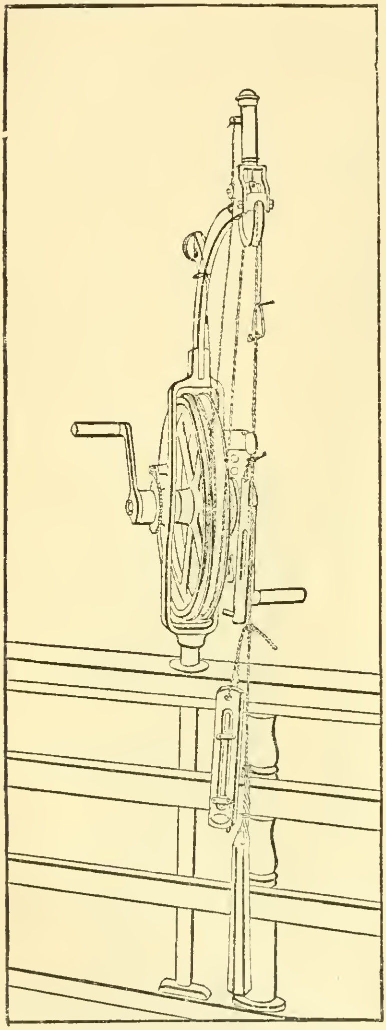

Fig. 14.—Sounding machine, with Negetti-Zambra deep-sea thermometers ascending.

"All buoyancy being destroyed by substituting a metal case, the thermometer is independent of the motions of the vessel, either from rolling, pitching, or drifting. The line may be stopped on the ascent or lowered again without affecting the instrument in any way. We have taken hundreds of temperatures with the apparatus described, under varying conditions of wind and weather, with the most satisfactory results."*

This device of Mr. Tanner's is the first instance of the use of a metallic case as a protective and reversing apparatus that I find record of. Although invented on the spur of the moment, and to meet an unforeseen emergency, it was found to answer its purpose as effectually, if with less elegance of design, as any that has been since contrived.

The next improvement was the invention of Passed Assistant Engineer William L. Bailie, U. S. Navy, attached to the Fish Hawk, and appears to have been about contemporaneous with the invention of the Magnaghi case, adopted and sold by Negretti and Zambra in the year 1882. It consists essentially of a propeller and slip-hook, inclosed in a metal case, which screws to the upper end of the Tanner case, its slip-hook having been removed for the purpose. By this device, which is illustrated by Fig. 15, the thermometer is reversed by the action of the propeller, "bringing the screw in the upper part of the spindle into action, gradually raising the propeller until the small part of the spindle at the lower end allows the hook to open, releasing the wire, when the thermometer

* Report on the construction and work in 1880 of the Fish Commission steamer Fish Hawk, by Lieut. Z. L. Tanner, U. S. N., commanding. (In Report of the Commissioner, 1881, pp. 32, 26.)

capsizes and registers the temperature by breaking the column of mercury."*

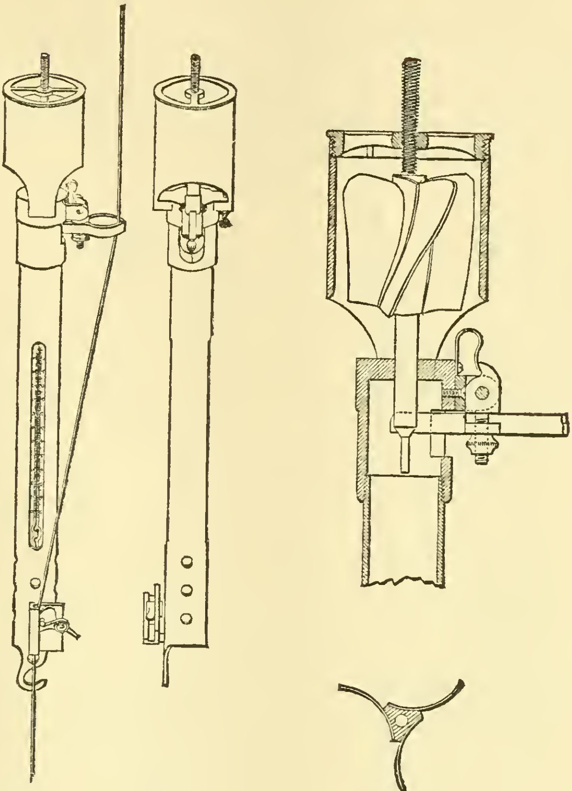

FIG. 15.—The Bailie-Tanner deep-sea thermometer case.

The time consumed by the descent of a messenger in deep water is saved by this device, and the distance through which the apparatus must pass before the propeller releases the wire can be regulated at pleasure, by a set screw, between the limits of 3 and 10 fathoms.

The Magnaghi case, invented by Commandante Magnaghi, of the Italian navy, and sold as "Negretti and Zambra's patent improved frame standard deep-sea thermometer," was found to be not well adapted for use on a sounding wire, and was therefore not often used in the work of the Commission. It is described by the makers as follows:

"The apparatus will be best understood, short of inspection, by reference to Fig. 16. A is a metallic frame, in which the case B, containing the thermometer, is pivoted upon an axis, H, but not balanced upon it. C is a screw-fan attached to a spindle, one end of which works in

* Report on the work of the U. S. Fish Commission steamer Fish Hawk for the year ending December 31, 1882, and on the construction of the steamer Albatross, by Lieut. Z. L. Tanner, U. S. N., commanding. (In Report of the Commissioner, 1882, p. 11.)

a socket, D, and on the other end is formed the thread of a screw, E, about half an inch long, and just above it is a small pin or stop, F, on the spindle. G is a sliding stop-piece, against which the pin F impinges when the thermometer is adjusted for use. The screw E works into the end of the case B the length of play to which it is adjusted. The number of turns of the screw into the case is regulated by means of the pin and stop-piece. The thermometer in its case is held in position by the screw E, and descends into the sea in this position, the fan C not

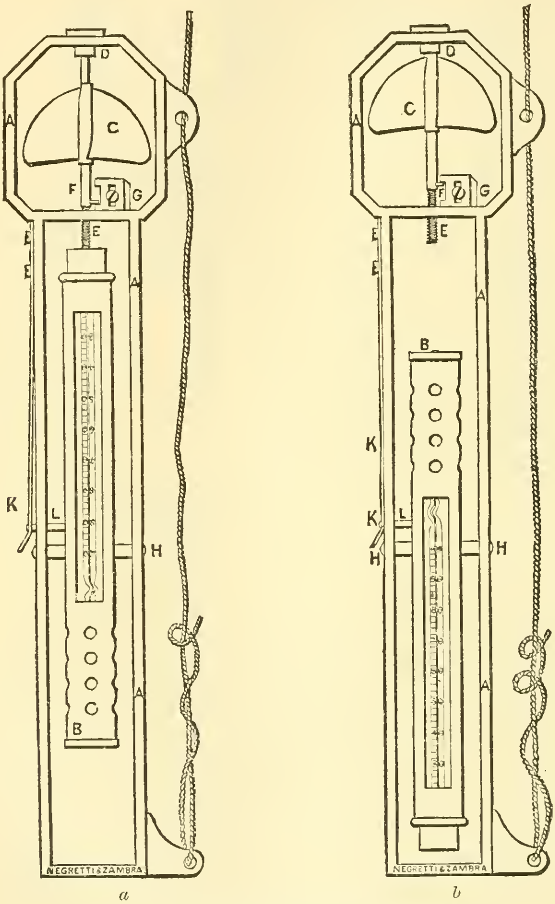

FIG. 16.—The Magnaghi deep-sea thermometer.

acting during the descent because it is checked by the stop F. When ascent commences the fan revolves, raises the screw E, and releases the thermometer, which then turns over and registers the temperature of that spot, owing to the axis H being below the center of gravity of the case B, as adjusted for the descent. Each revolution of the fan represents about 10 feet of movement through the water upward, so that the whole play of the screw requires 70 or 80 feet ascent; therefore the space through which the thermometer should pass before turning over must be regulated at starting. If the instrument ascends a few feet by reason of a stoppage of the line while attaching other thermometers, or through the heave of the sea, or any cause whatever, the subsequent descent will cause the fan to carry back the stop to its initial position, and such stoppages may occur any number of times provided the line is not made to ascend through the space necessary to cause the fan to release the thermometer. When the hauling-in has caused the turn over of the thermometer, the lateral spring K forces the spring L into a slot in the case B and clamps it until it is received on board, so that no change of position can occur in the rest of the ascent from any cause. The case B is cut open to expose the scale of the thermometer, and is also perforated to allow the free entry of the water.

"The construction of the thermometer will be understood by reference to the figure. The bulb is cylindrical, and mercury is the thermometrical fluid. The neck of the bulb is contracted at A, and upon the shape and fineness of this contraction the success of the instrument depends. Beyond A the tube is bent, and a small reservoir is formed at B. At the end of the tube a small receptacle, C, is provided. When the bulb is downward it contains sufficient mercury to fill the tube, and a part of the reservoir C, if the temperature is high, leaving sufficient space for the expansion of the mercury. In this position no scale would be possible, as the apparent movement of the mercury would be confined to the space C. When the thermometer is held bulb upward, the mercury breaks off at A, and by its own weight flows down the tube, filling C, and a portion of the tube above. The scale accordingly is made to read upward from C. To set the thermometer for observation it is only necessary to place it bulb downward, then the mercury takes the temperature just as an ordinary thermometer. Whenever the existing temperature is required, all that has to be done is to turn the thermometer bulb upward and keep it in this position until read off. The reading may be taken any time after."

To insure the prompt reversal of this instrument, which was found sometimes to stick, an india-rubber band was applied during the cruise of the Triton, in the summer of 1882.*

In the voyage of the Talisman a frame was used "*construit d'après les indications* de M. Alphonse Milne-Edwards,"† which closely resembled the Magnaghi frame, without the revolving propeller. The detaching apparatus consisted in a lever attached to the sounding weight by a light hempen string, and holding the thermometer in place. When the weight was released the lever was pulled down by the string, setting the thermometer free to the action of a spring, which caused it to over-

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* Challenger Narrative, vol. 1, part first, page 95.

† Explorations Sous-Marines. Voyage du Talisman. H. Filhol, in *La Nature*, No. 556, January, 1884, page 135.

turn. The hempen string was so slight as to be easily broken when the lever had reached the limit of its excursion. (Fig. 17.)

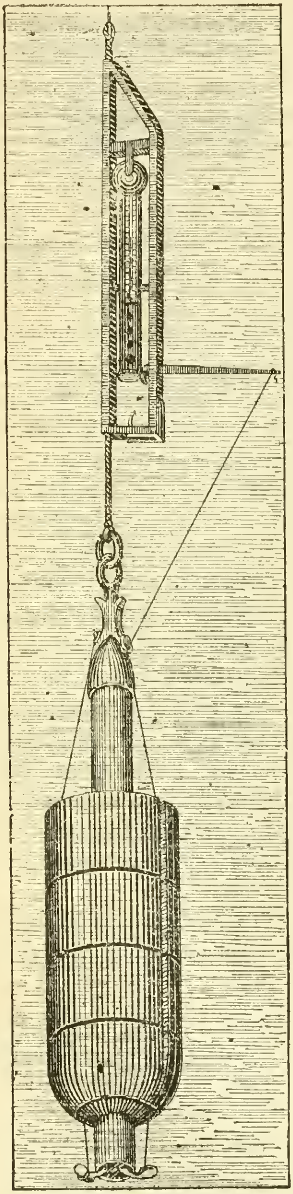

FIG. 17.—The Talisman thermometer frame and sounding-lead.

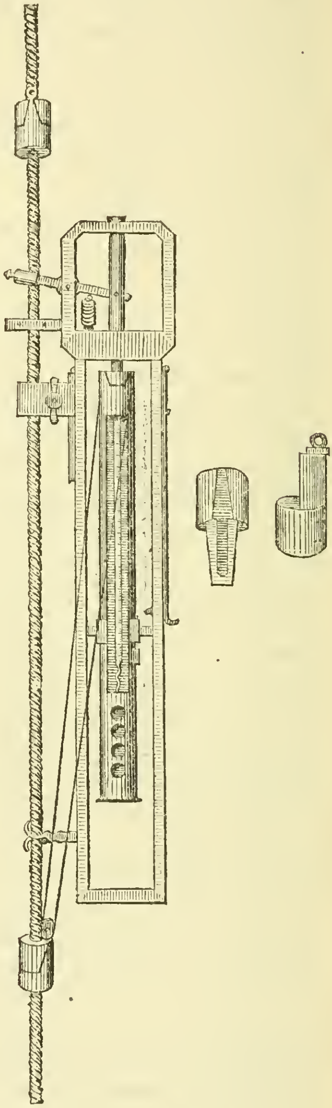

FIG. 18.—The Scottish thermometer frame.

In the work at the Scottish marine station, at Granton, Edinburgh, the Magnaghi case is modified in still another way by the substitution, for the propeller, of a detaching lever at the top, as shown by Fig. 18.

"The thermometer T is supported on pivots, *p p*, in the frame F, and kept in its upright position by the pin P, which dips into a groove in the top of the instrument, and moves freely through two holes, *h h*, in the frame. A lever, L, turning on a pivot in the frame, works in a slot in the pin P, and when its outer end is depressed the pin is raised out of the groove G. A spiral spring, S, keeps the pin in position when not counteracted by the lever. The forked end of the lever embraces the sounding line, to which the whole apparatus is attached when in use. * * * When the pin P is raised, the thermometer turns on its pivots by its own weight, and is retained in the inverted position by the tooth *t*, attached to the spring *s*, and fitting into a hole in the projection *f*.

"The lever is depressed by the fall of a weight, B, called a messenger, along the line. The messenger is the invention of Captain Rung, of the Meteorological Institute, Copenhagen. It is made in two parts, so that it can be fitted on the line at any point without the trouble of reeving.

"When the temperature is to be ascertained at two or more depths simultaneously, a messenger is hung by a cord to the top of each thermometer, except the lowest, as shown in the figure. Thus, when the first thermometer is inverted, a messenger is released, which inverts the next, and so on."*

This contrivance is called by its inventors "the Scottish thermometer frame," and was described by Mr. Hugh R. Mill in the Proceedings of the Royal Society of Edinburgh, vol. xii, p. 929, July, 1884.

The new pattern "Tanner case," which is now used by the Fish Commission and Coast Survey, was invented by Lieut.-Commander Tanner in 1884. (Fig. 19.)

Fig. 19.—The Tanner thermometer case, new form.

It is a modified combination of the Bailie-Tanner and Magnaghi cases, retaining the propeller gear and clutches for the sounding wire of the former and one of the upright side bars of the latter. The thermometer is pivoted at the bottom, and when reversed comes up hanging clear of the

* The Scottish Marine Station for Scientific Research, Granton, Edinburgh; its work and prospects. Edinburgh, 1885, p. 35.

frame altogether. There is a longitudinal slit in the case, uncovering the thermometer scale, and a corresponding slit on the opposite side, so that the temperature can be read by holding the instrument up against the light. To guard against the "jiggling" motion communicated from the reeling engine along the wire rope or sounding wire now universally used by the Fish Commission, which was found during the Albatross cruise of 1883–'84 to have in some cases jarred the mercury from the bulb into the tube after reversal, spiral springs have been introduced into the metal case above and below the thermometer. The whole instrument is heavily nickel-plated to prevent rust, and works well in practice.

To guard against parallax errors in reading (see p. [5]) I have had constructed by Mr. Joseph Zentmayer, of Philadelphia, a reading lens of about 3 inches focal length, fitted at right angles to the center of a brass saddle adapted to the convex surface of the thermometer case, and provided with a short draw-tube for focussing. The eye-piece opening is made smaller than the pupil of the eye, and there is therefore no variation in the reading, whatever be the inclination to the perpendicular at which the scale is viewed. (See Fig. 20.) The slight magnifying power of the lens makes it much easier than formerly to read the temperature to fractions of a degree.

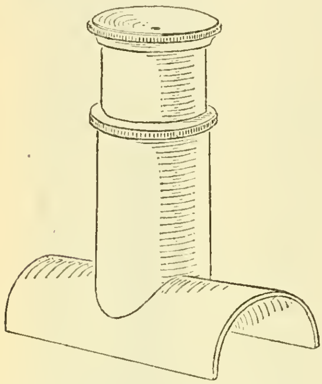

FIG. 20.—Reading lens for the Tanner thermometer case.

The abandonment of the propeller reversing-gear by French and Scottish observers seems to have been due partly to a fear that the propeller-fans might be turned by a strong lateral current, as for example in the Straits of Gibraltar (see Challenger Narrative, vol. 1, p. 95), and partly, as stated in M. Filhol's report on the work of the Talisman, by the observation that the fans have sometimes failed to revolve at all. In the Bailie-Tanner case the protecting shield around the propeller would meet the former objection (so long as the instrument remained in a perpendicular position) if currents strong enough to affect the fans should ever be met with in the open sea. No instance of the latter defect in construction has yet been noted in the instruments of the Fish Commission. Up to the present time the propellers of the new Tanner case, although not so well protected as the earlier forms against lateral currents, have not yet failed to answer the purpose for which they were designed. In deep-sea work the saving in time by dispensing with messengers becomes an important consideration.

Many of the features which are combined in the modern apparatus for observing deep-sea temperatures are revivals or re-inventions of old devices which had been once used and forgotten. Thus the outer protective shield to the bulb of the Miller-Casella thermometer, its only important distinction from Sixe's form of a century ago, was certainly tried by Sir Edward Sabine as early as 1822 (see p. [14]), and thought of by Péron* about 1804. Aimé suggested and appears to have used an outer glass case, sealed by the blowpipe, some time before 1845,† and the same device for meeting and avoiding the pressure error at great depths was made public property by Sir William Thomson's well-known paper upon the effect of pressure upon the freezing-point of liquids in 1850. Aimé also used messengers for detaching weights and for oversetting self-registering thermometers prior to 1845 (*op. cit.*, p. 5), and devised several different patterns of thermometers for registering deep-sea temperatures by being overset at the depth to be investigated, which, when protected by his closed glass or metal tubes, gave excellent results. The propeller was used by Messrs. Negretti and Zambra in 1874 to reverse their earlier form of thermometer, and the same firm, as has been explained, preceded Dr. Miller by about twelve years in the application of a protecting shield to Sixe's self-registering thermometer.

The first practical self-registering thermometers appear to have been the inventions of Lord Charles Cavendish in 1757, registering by the measurement of a portion of fluid which had been caused to overflow at the maximum or minimum temperature encountered by the instrument. Mr. Sixe, who expressly acknowledges his obligations to these inventions, improved them in form and by the addition of a movable steel index. The idea of protection against pressure by an outer shield first appears about the beginning of this century and was practically perfected about 1845, as early as which date messengers were in use for detaching weights, for closing water bottles, and for oversetting thermometers. Revolving propellers have been used, abandoned, and taken up again in very recent times, and the latest novelty appears in the modern Negretti-Zambra thermometer, in the use of the same fluid for the measurement and the registration of temperature, and in breaking the column, when overset, by means of a peculiar narrowing of the tube at a particular place. From the time of Lord Cavendish to the present the progress of improvements in the form of deep-sea thermometers has been by a very natural and regular process of evolution and of survival (or sometimes revival) of the variations best suited to their purpose.

CENTRAL STATION, WOOD'S HOLL, MASS., *July* 31, 1885.

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* Voyage de Découvertes aux Terres Australes. Vol. II, Paris, 1816, p. 330, *note.*
† Ann. de Chimie et de Physique, Ser. 3, t. xv, p. 10, 1845.

APPENDIX.

Maximum, minimum, and mean errors of fifty-one Negretti-Zambra deep-sea thermometers, by comparison with Fish Commission standards.

Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
°	°	°	°	°	°	°	°	°
0.5	0.0	0.14	0.38	0.0	0.19	0.7	0.1	0.4
0.7	0.0	0.2	0.5	0.0	0.15	0.5	0.0	0.3
0.8	0.0	0.2	0.5	0.0	0.23	0.5	0.1	0.25
1.0	0.2	0.5	0.34	0.1	0.21	0.5	0.0	0.2
0.7	0.2	0.3	0.3	0.1	0.2	1.0	0.0	0.4
0.4	0.0	0.13	0.3	0.1	0.2	0.2	0.0	0.1
0.6	0.1	0.27	0,5	0.2	0.27	1.0	0.0	0.4
0.6	0.0	0.34	0.4	0.0	0.2	0.4	0.0	0.2
0.6	0.0	0.3	0.4	0.0	0.2	0.5	0.2	0.3
0.3	0.0	0.16	0.6	0.1	0.25	0.5	0.0	0.2
0.7	0.0	0.2	0.4	0.1	0.3	1.0	0.0	0.27
0.3	0.0	0.17	0.5	0.4	0.45	0.4	0.1	0.2
0.4	0.0	0.1	0.7	0.1	0.4	0.2	0.1	0.15
0.5	0.05	0.19	0.3	0.0	0.2	0.5	0.2	0.4
0.8	0.12	0.33	0.5	0.2	0.3	0.7	0.1	0.3
0.3	0.0	0.12	0.5	0.0	0.2	0,2	0.0	0.1
0.3	0.0	0.15	0.8	0.1	0.4	0.8	0.1	0.5

APPENDIX B.

THE FISHERIES.

XIV.—REPORT ON THE DISCOVERY AND INVESTIGATION OF FISHING GROUNDS, MADE BY THE FISH COMMISSION STEAMER ALBATROSS DURING A CRUISE ALONG THE ATLANTIC COAST AND IN THE GULF OF MEXICO; WITH NOTES ON THE GULF FISHERIES.*

By Capt. J. W. Collins.

ANALYSIS.

* This report covers investigations carried on during a cruise of the steamer Albatross, which began January 3, and ended April 6, 1885.

In this connection it seems desirable to include such facts as I have been able to gather relative to the sea fisheries, fishing vessels, &c., of some of the ports that have been visited during the cruise.—J. W. C.

I.—NARRATIVE OF THE VOYAGE.

1. FROM NORFOLK TO HAVANA.

Leaving Norfolk at 2.25 p.m., on Saturday, January 3, 1885, we steamed past Fortress Monroe, and thence to sea, the ship heading southerly, down the coast, after leaving the Chesapeake.

The wind, which was northeasterly when we sailed, veered gradually to the eastward and southeastward, and on Sunday morning, when we were off Cape Hatteras, there was a fresh and increasing southeast breeze, with considerable easterly swell. The sea and wind continued to increase and change during the day, precluding the possibility of fishing.

Monday morning, January 5, the weather being fine with a light southeast wind and smooth sea, the dinghy was lowered at about 9.15 a.m., and I went in her, with two seamen, and set a tub of haddock trawl-line (about 400 hooks), baited, on every alternate hook, with salt mackerel cut into small sections. The line was set in 79 fathoms, coarse sand with black specks being the distinguishing feature of the bottom, while the position was practically that designated as "station

2311" on the ship's log, this locality being off the Carolina coast, in lat. 32° 54′ N. and long. 77° 53′ W., approximately.

After setting the trawl-line I lay by its lee end in the boat until 10.20 a. m., when we began hauling. There was a strong current running, and soon after the first anchor was aweigh the weather end of the ground line, near the other anchor, parted, and before we got all the line in, the boat had drifted out of sight of the other buoy-flag. Knowing, however, the direction in which it lay, we pulled for it, and sighted it after awhile, but the current ran so strong and the wind also began to breeze up somewhat, making a small choppy sea, that we gained very slowly, despite our utmost endeavors. There was little prospect of reaching the buoy, at least within a reasonable time, unless we had assistance from the ship, which, in the mean time had been engaged in dredging with the beam-trawl at some distance from the boat. We were finally taken in tow by the ship and pulled up to the buoy, when we succeeded in getting the remainder of the apparatus, which, it may be remarked, had become so much deteriorated by previous use that it was decided to condemn the line, the hooks only being of any value.

The results of this "set" were unimportant, the "take" consisting only of three small fish, two of which were hake, *Phycis regius*, and the other an eel, that was identified by Dr. Bean as probably belonging to the genus *Ophichthys*.

The hauls made with the beam-trawl also seemed to demonstrate the fact that the locality was evidently not one that would support an abundance of such fish life as would tend to make it of any importance, so far as the commercial fisheries are concerned.

The prevalence of rough weather during the next two days practically made it impossible to fish, even had it been desirable.

An attempt was made to catch fish by drailing on Thursday, January 8, while steaming across from the Bahama Reefs to the coast of Florida, but nothing was caught.

On the following day, however, while sailing along the Florida coast, south of Alligator Light, we caught five kingfish on drail-lines. These fish appeared to be most abundant near Sombrero Key, where many were hooked and a still greater number struck the drails. But as the ship was steaming about 10 knots, the speed was so great that it was difficult to hook a fish, and the chances of getting one that had been hooked were reduced to a minimum. But allusion is made to this matter more, as an episode of the cruise than as being of any special importance, for, as will be detailed in a succeeding paragraph, the locality mentioned is a well-known and much frequented fishing ground for the boats which go after kingfish, and some of these craft we saw at work as we passed along the coast, not far from Sombrero Light.

Nothing in the way of fishing was done at Key West, with the exception of making several "shots" with the capelan seine for the purpose of securing collections of fishes for scientific purposes. The report on these operations, the different species captured, &c., belongs more properly to Dr. Tarleton H. Bean, who was always present on the several occasions, and who, having the collections in his charge, is the only person capable or entitled to submit a report concerning what was done. This being the case, I deem it only necessary for me to allude incidentally to these operations, both at this time and later during the cruise, and this might not even be required were it not seemingly desirable to remark upon the feasibility of using such apparatus for fishing on the shores which we visited.

We found that while a certain amount of success might be attained at Key West by using a drag-seine for the purpose of collecting, such apparatus could not be profitably employed in fishing for market, at least not where we went. The bottom is composed largely, if not wholly, of coral formation, and even with the greatest care we tore large holes in our seine, while the catch of fish that would be marketable was insignificant.

I wished to make a trip in one of the open boats that were going for kingfish off Sombrero Key. An arrangement was accordingly made with the skipper of one of the boats on Saturday, January 10, to take me on board next morning when he started out. He said he would return on Monday afternoon to sell his fish to the smack that was expected to sail for Havana on Tuesday, and he promised to come alongside the Albatross on his way out of the harbor and take me on board. This he did not do, and consequently I failed to make the trip. I learned later that the date of the smack's sailing was changed to the evening of the day on which we thought to leave Key West, and the boatman did not expect to return to the harbor until our ship had left it.

My time at Key West, during the six days of our stay, was occupied to some extent in obtaining data of the fisheries of the port, and Mr. N. B. Miller volunteered to take some photographs of vessels, boats, &c., that may serve as material for illustration. The fishing industries of Key West are important and support a large percentage of the population of the island, while a numerous fleet of vessels and boats find employment in gathering the ocean products which may be taken about the keys, banks, and along the shores within the radius of 150 miles.

It seems to me desirable that the information which has been gathered relative to the fisheries of Key West and other places visited, particularly in the United States, should be appended to this report. Aside from the interest which may attach to the fisheries themselves, which is considerable, it is only by making a full record of the methods, vessels, boats, &c., now in use that we can form an intelligible idea of the business, and be able to determine whether or not it is desirable to offer any suggestions for improving the same.

On the afternoon of January 15, the ship left Key West Harbor and proceeded to sea. Several hours were spent, in the latter part of the day, in dredging, and in the early evening the ship was headed for Havana, Cuba, where we arrived the following day, passing in by Moro Castle about 8 a. m.

During the four days that we remained in Havana and its vicinity, little transpired that was especially worthy of note in this report, and reference is made to the reports of others for the details of the operations carried on by the ship. A temporary illness during most of the time, as well as my unfamiliarity with the patois spoken by the fishermen, prevented me from gaining as much information as it seemed to me desirable to obtain concerning the fisheries of Havana, and particularly in relation to the demand and supply of the Cuban markets as bearing on the subject of the importation of American-caught fish.

From casual observations from the ship I was able to gain a general idea of the boat-fisheries of the port, and a short row about the harbor in the dinghy on Sunday, January 18, enabled me to obtain some definite information concerning the two leading types of fishing boats that are used, as well as to make rough sketches of them.

Each morning during our stay, when the weather was suitable, a fleet of small sail boats left the harbor about sunrise, and after passing Moro Castle scattered along the coast, chiefly in an easterly direction. These boats fish with hand-lines at a short distance from the shore, where they lay anchored. The bottom about this part of the Cuban coast descends rapidly to a depth of several hundred fathoms at a comparatively short distance from the land, and it is therefore obvious that fishing must be done close inshore. As we passed along the coast the fishing boats were often seen at anchor with their sails down.

Between 3 and 5 o'clock in the afternoon the little fleet return to harbor to market their catch.

The boats used in this hand-line fishery are mostly of one type, which is a poor imitation of the American dory, from which it has doubtless been derived, as has a somewhat similar form of fishing craft in use at Porto Rico. It is a flat-bottomed, carvel-built (the sides made of a single wide board), keel boat, with little flare to the sides, rather straight on top and bottom, sharp, wedge-shaped bow, and stern like that of a dory, excepting that it has, comparatively, very little rake. The stem is heavy, made of hard wood, and rabbited so that the planks fit in flush with its forward part. One of these boats which I examined and measured, and which was evidently essentially the same as others of her class, had six sets of stout timbers, heavy gunwales, two thwarts, was decked, forward and aft, for a length of 2 or 3 feet, had a stern-post outside the V-shaped stern, and gudgeons for hanging a rudder. The following are the principal dimensions: Length, over all, 15 feet; beam, extreme, 3 feet 9 inches; depth, amidships (top of gunwale to floor), 17 inches; depth of keel, 5 to 6 inches.

Both oars and sails are used as a means of propulsion. The rowlocks are heavy wooden cleats fastened to the gunwale and in each of these is stuck a single stout wooden thole-pin, the oar being held to this by a rope becket. A sprit sail and a small jib tacking down to the stem head is, perhaps, the most common rig, but many of the boats carry only a single sail.

Another and larger class of boats, which are purely European in type, are used at Havana, chiefly for the net and seine fisheries, we were told. Many of these were built at the Balearic Isles and brought from Europe to Cuba by merchant vessels trading between the island and Spain. One of these which I had the opportunity of examining had all the characteristic features that distinguish the fishing boats of the region from whence she originated. She was a carvel-built, keel boat, with broad beam, medium depth, ends moderately sharp, rounding at the gunwales, and concave at the water line; a full, round, easy bilge, and curved stem and stern post, the latter rising about 15 inches above the gunwale. The boat had a moderate sheer, and three heavy rowlocks on a side, in each of which was a single thole-pin. An outrigger projected 4 or 5 feet beyond the stern on the port side. The boat was decked, with the exception of an open space amidships, that was 3 feet wide and about two-thirds of her length. The deck was built with a very decided curve upwards (or "crowning" as it is called), so much so that while the center of the beams were but little below the level of the gunwales, the bulwark, amidships, was 15 to 18 inches deep. She carried two lateen sails, the mainsail, as is common on Spanish boats, being much larger than the foresail. The two men who constituted the crew were busy making a gill-net at the time I went on board the boat, and they stated that they fished only with nets.

The following are the principal dimensions of the boat's hull: Length, over all, 24 feet 6 inches; beam, 8 feet; depth, top of gunwale or rail to garboard strake, 3 feet.

There is a fleet of smacks, both sloops and schooners, sailing from Havana, and several of these lay in port. They differ a good deal in size, but in respect to model and rig resemble the smacks of Key West or New England. Indeed, as has been mentioned elsewhere, many of these vessels were built in the United States and have been sold to Cuban parties.

2. FROM HAVANA TO COZUMEL.

Leaving Havana January 20, the ship steered westerly for the island of Cozumel, off the east coast of Yucatan, where we arrived on the evening of January 22, and anchored off the northern end of the island.. In the mean time, dredging operations had been carried on off the north side of the western end of Cuba, near the Colorado Reefs, on the day after we sailed from Havana, and the tangle and trawl were also used on or near Arrowsmith Bank during the early part of the day on which we reached Cozumel.

The bottom off the north end of this island has a very gradual slope from the shore for a distance of 5 or 6 miles. The ship's anchorage was about 3 miles from the land, in 5 or 6 fathoms of water. Here the water was so clear that objects on the bottom could be seen, and, indeed, this was practically the case quite out to the verge of the bank.

After anchoring, some small hand-lines were put out and three or four yellow tails (probably *Sciæna punctatus* Linn) and one grunt (*Diabasis formosus* J. & G.) were caught; also a small shark. It was nearly dark when the lines were first put out, and we had not fished long before the sharks gathered around in sufficient numbers to take away the hooks and sinkers from several lines. Just how many there were it was, of course, impossible to tell, as a single fish of this species might play havoc with as many small lines as he took a fancy to bite at. However, we were satisfied that more than one did the mischief, since two lines were stripped of their hooks at the same time. A shark line was put out, but beyond the specimen mentioned no sharks were taken.

At daylight on the morning of January 23, the ship got under way and steamed around to the little village of San Miguel, on the northwest side of the island, where we came to anchor in about 5 fathoms within easy distance of the shore. The beach at the village makes a slight bend, curving in to the eastward, and with easterly winds, which generally prevail, this cove offers an excellent shelter and good landing. But with a norther or even with a westerly wind, which are very liable to come on suddenly in winter, a vessel would be on a lee shore, or at best be exposed to a wind and sea driving along the coast. This being the case, it was, therefore, somewhat risky, to say the least, to attempt any night fishing with gill-nets, since it might at any time be necessary for the ship to get under way and leave the place, and the danger of getting afoul of gear in the night and entangling it in the screws, was one not to be despised, providing the apparatus was set near the ship; to put it far from her would expose it to the sweep of the swift current that ran along the coast. No night fishing was attempted.

Although fish of many varieties appear to be abundant about Cozumel, there is no fishing, strictly speaking, carried on by the inhabitants. A few fish are sometimes captured by means of cast nets thrown from the hand, but these are seldom used so far as we could learn, and of course the results obtained are so meager that such operations can scarcely come into the category of fishing, as understood from a commercial standpoint.

It would appear that little can be done with hook and line. Nearly every day while we were at the island, the ingenuity of the ship's officers and naturalists was exercised to capture the fish which could be seen swimming about, several fathoms down, in the clear, translucent water. A few specimens of barracuda, also some parrot and file fishes were taken, it is true, but the mouths of the two last mentioned species are so small, and the dentition of such a character, that a hook might be stripped of its bait by them time after time, until one's patience was quite exhausted, and it was only by a "lucky hit" that a capture could be effected. The parrot fishes are not, so far as I am aware, very highly valued as food, and as a matter of fact, it is probable that a majority of the species in the waters of this region are of little economical importance. No fishing, other than that mentioned above, was attempted, otherwise than for making collections for scientific purposes. To obtain such collections the capelan seine was set several times. The catch, while often very important so far as the capture of different varieties was concerned, was nevertheless always insignificant from a fisherman's stand point. The reason for this may be found in the fact that the general characteristics of the shore are unfavorable for seining. In a few places smooth, white, sandy beaches occur, where it is easy enough to haul a seine, but, unfortunately, these localities are invariably barren of fish-life, with the exception of a limited amount of the smallest varieties that are of no commercial importance. There are long stretches of beach, not only near San Miguel, but more particularly toward the southern part of the island, on its western side, which, seen from a distance, have the appearance of being very favorable localities for landing a seine. But, with few exceptions, appearances are misleading, and we found on close examination that numerous outcropping coral rocks, with jagged edges and sharp points, lay just outside the surf, if they did not show above the water line, and it goes without saying that where these occurred in considerable numbers seining was impracticable. But it was around these particular beaches, that bristled with craggy rocks, and where there was a greater or less abundance of algæ, madrepores, &c., that fish were plentiful. It was not unusual in these places to see some of the larger species, like barracuda, lady-fish, &c., chasing the schools of smaller fish, darting about and leaping out of water, a short distance outside of the surf. Such displays were a great temptation to try the seine, but the result—the destruction of the net—was too self-evident to warrant us in making an attempt to use it. The difficulties encountered may be judged from the fact that on several occasions, notwithstanding much care was exercised in selecting what appeared to be a favorable spot for hauling the seine, it took the whole party of six seamen and two or three others more than an hour to make a landing. The foot-line had to be constantly watched and pulled from beneath the coral rocks by a man in the boat, though, where the water was shallow enough for the purpose, one or two of the seamen waded out up to their arm-pits and shoulders and tended the net, frequently diving under water to detach the foot of the seine from the bottom. Even with all this labor and care, often rendered doubly fatiguing by the blazing heat of a tropical noonday sun, we rarely succeeded in making a haul without tearing more or less large holes in the net; and as the constant lifting of the foot-line from the bottom made the escape of fish possible, the natural result was that the catch was always small, though, of course, larger than on the smooth beaches.

Many of the less predaceous species of fish that frequent the inshore waters about Cozumel evidently are as much in need of means of concealment from their enemies as they are of food to enable them to avert destruction. Fortunately, the shores of the island are mostly formed of coral, in which the ceaseless action of the waves have worn innumerable fissures and submarine caves, where it is easy for a fish to hide so as to escape the observation of his enemies; and as such localities also furnish a large amount of food suitable to the species found there, it is not at all surprising that they should be more abundant there than elsewhere. It was often interesting and instructive to note the extreme timidity of these hiders, and their remarkable dexterity in concealing themselves. If one stepped suddenly out on a projecting point of the craggy coral shore, particularly if he made much noise, the chances were that he saw not a single fish; or possibly he might catch a glimpse of blue or yellow, or several colors combined, disappearing like a flash—so suddenly, perhaps, as to leave him in doubt as to whether or not his eyes had deceived him. But let one sit quietly down and keep perfectly still, near the edge of the rocks, where they go straight down 10 or 15 feet to the bottom, or are hollowed out into cavernous openings beneath, and he will not wait long before here and there he may see, moving cautiously out from the rocky fissures in the clear depths below, curious little heads from which bright eyes are peering forth to seek the cause of alarm or ascertain if the coast is clear. Reassured at last, they move slowly out from their hiding places, and off a little way among the madrepores, sponges, &c., that one can see on the bottom at a short distance from the surf. Radiant in their many-tinted iridescent hues—blue, yellow, black, silver, and red, varying, of course, with different species, these fishes may be easily observed so long as one chooses to sit perfectly still; but the instant one makes a motion, or a dip-net is thrust into the water, the alarm is taken, and all scurry away for their hiding places, where they are lost to sight in a moment.

Some 5 or 6 miles southward from San Miguel was a little estuary with deep water, a narrow entrance, and several branches or arms. This we visited one day in the steam launch, and as many kinds of fish could be seen, I conceived the idea that perhaps they might be caught by setting a gill-net across the mouth of one of the branches, and then, by splashing and making a noise, so frighten the fish that they would run into the net. This we tried on a subsequent occasion, but our success was limited to the capture of two individuals. There was no doubt but that we frightened the fish badly enough, but their habits of hiding under rocks proved too much for us, and despite our utmost endeavors to drive them out of the branch, and thus into the net, they invariably succeeded in escaping to their favorite retreats with the two exceptions above alluded to. The most careful attempt to catch them in a dip-net was only time wasted. We managed, however, to take a few parrot-fish and box-fish on hooks.

Should the capture of the fish of this region ever be a matter of commercial importance, it is probable that they might be taken in considerable quantities in gill nets set at night, but the presence of many large predaceous species, among which sharks are not uncommon, would compel the fisherman to watch his gear with a never-failing vigilance to prevent its destruction.

It may be mentioned that porpoises appear to be numerous about the shores of Cozumel, and we frequently saw large schools of them close in to the land, passing up or down the coast, and apparently feeding.

For reasons already named, I kept no record of the different kinds of fish captured at Cozumel, and reference is made to other reports to supply this omission, as well as the details as to date, &c., of the seine hauls; the latter I have, but it is obvious that they would be of no importance here, and properly belong elsewhere.*

3. FROM COZUMEL TO PENSACOLA.

Our stay at Cozumel ended on the evening of Thursday, January 29. On the morning of the same day we left San Miguel and steamed down the west coast of the island, some 14 or 15 miles to the southward, and while a party of us were ashore with the seine making hauls on the beach and otherwise engaged in collecting, the ship made some dredgings in the deep water outside the plateau that slopes away very gradually, for a distance of a mile or so from shore, when the bottom drops suddenly down, like a mural cliff, to a depth of 100 or 200 fathoms.

Our seining operations on this occasion were conducted under considerable difficulties. Aside from the trouble that arose from the seine being almost constantly afoul of the bottom, thus, on one occasion, at least, requiring hours of incessant toil to make a single landing, the afternoon was excessively hot; the sun shone in unclouded brilliancy most of the time, sending down a burning blazing heat, that was greatly intensified by being reflected from the white sand beach, and which the light air of wind then blowing scarcely modified at all. It was almost unendurable, and sometimes we were nearly blinded with the glare from the beach, as well as with the perspiration that streamed down our brows and filled our eyes. However, the work went on until it was time to return to the ship, and no one suffered seriously from the exposure.

On the day after leaving Cozumel, January 30, we made several attempts to catch fish with hand-lines on Campeche Bank, that lays to the

*As it is the privilege as well as the duty of others to report upon the ichthyology, as well as other matters relating to Cozumel, it seems necessary for me to give only such facts as pertain particularly to fishing; though in writing of a place so little known and so interesting on many accounts as is this island, there is, of course, more or less temptation for one to stray somewhat from the subject one may be dealing with. This I have tried to avoid.

northward of Cape Catoche. The first trial was made about 8 a. m., when two lines were put out, soundings having been previously taken (at 7.42 a. m.) in 26 fathoms, on white coral bottom (station 2360). No fish were taken on this occasion. Several dredgings were then made with tangles and beam-trawl at stations 2361 and 2362. From the latter position the ship steamed 8 knots on a southwest by west course, and at 10.37 a. m. sounded in 21 fathoms, on red and white coral bottom (station 2363, lat. 22° 7′ 30″ N., long. 87° 6′ W.). A number of lines were put out, but, with the exception of one small fish that was of no commercial value, nothing was caught. A haul was made with the beam trawl at this station, bringing up, among other things, a large amount of dead shells and coral, also a few small fishes, none, however, of any economic importance.

After the trawl was up, the ship steamed northward about a mile, and at 11.25 a. m. sounded in 22 fathoms (station 2364, lat. 22° 08′ N., long. 87° 06′ W.). Eight or ten lines were put out—baited, as before, with salt mackerel and the meat of live conch shells—and we engaged in fishing until a little after 1 p. m., the fish biting the best, perhaps, about noon. Fifteen large red groupers were caught, and probably twice that number lost after being hooked. Some got away after being brought alongside, and in several instances they parted the snoods and went off with the hooks. The fish weighed from about 9 to upwards of 15 pounds apiece.

After the fish ceased biting, the beam-trawl was put out and a dredging made. In this instance, as before, the trawl brought up considerable quantities of dead shells and dead coral, among other material, the general character of the haul indicating what fishermen usually designate as "dead bottom."* As a rule, this kind of ground is more or less destitute of animal life that may serve as food for the larger and more valuable kinds of ground-feeding food-fishes, and it is seldom that they are found in great abundance in such localities.

Later in the day, the ship steamed northwardly, and dredgings were made at station 2365 (lat. 22° 18′ N., long. 87° 04′ W.), in 24 fathoms; station 2366 (lat. 22° 28′ N., long. 87° 02′ W.), in 27 fathoms; and at station 2367 (lat. 22° 38′ N., long. 87° 00′ W.), in 124 fathoms. At the two first-mentioned positions a line was put out for a few minutes, but nothing was caught. The last haul with the beam-trawl was made after dark.

From Campeche Bank the ship proceeded directly to Pensacola, and on the afternoon of February 2 we reached the navy-yard at that port and made fast to the pier.

4. FIRST RED-SNAPPER TRIP FROM PENSACOLA.

On the following morning, in compliance with the request of Captain Tanner, I went to the city of Pensacola, some 5 miles above the navy-

* For details of the material taken in these dredgings reference is made to the reports on the collections obtained during the cruise.

yard, in the steam launch, to meet Mr. Silas Stearns and invite him to go on board the ship to have an interview with the captain relative to the red-snapper fishery and our proposed cruise on the grounds where the snapper is taken. Mr. Stearns, as I learned, had left Pensacola the previous evening, with a party of friends, for a boating and hunting trip to the eastward, his intention being to stay two or three weeks, and, perhaps, extend his cruise upward of 100 miles. It was deemed desirable to have some one to go out with us who was familiar with the snapper fishery, and failing to get Mr. Stearns, upon whom Captain Tanner had depended, I was requested to engage some one to go in his stead. Accordingly, on Wednesday, February 4, I again went to the city and had an interview with Mr. A. F. Warren, senior member of the fishing firm of Warren & Co., of which Mr. Stearns is the junior partner. Mr. Warren kindly offered to permit his foreman, Mr. Asa Ward, to make a trip with us, and as Mr. Ward cheerfully assented to this arrangement, and besides had the reputation of being one of the best experts in the port—having commanded a smack in the snapper fishery for several seasons—the offer was very gratefully accepted.

On this occasion I also purchased some lines and sinkers, so that a set of gear might be rigged suitable for catching red snappers, since the hand-lines on the ship had become more or less deteriorated and out of repair after two years' service.

As the navy-yard steam-launch, upon which I had gone to the city, would return after a short stay at Pensacola, I decided to remain at the town until the next day, in order that I might make some investigations concerning the fisheries of the port and other points on the adjacent coast. I am under obligations to Mr. Warren, not only for the valuable information furnished by him, but also for the important assistance he rendered in procuring me interviews with persons who were best able to supply the facts I wanted. The result of these interviews is given in the appended notes on the fisheries of Pensacola and other points on the west coast of Florida.

I returned to the ship on the afternoon of February 5, and busied myself during the latter part of the day and evening in rigging the fishing gear, which, however, was not completed until the next day. On the morning of the 6th I went in the steam launch to Pensacola and got Mr. Ward, it having been decided that we should leave port in the evening, so that we might reach the fishing ground off Cape San Blas the next morning.

We got under way late in the afternoon, and, after pulling off the lumber-loaded three-masted schooner Fannie Whitmore, of Rockland, Me., which we came across on our way out, grounded on the western side of the channel, near the ruins of Fort McRae, we steamed out to sea and headed to the eastward. There was a light southwest breeze and smooth sea in the evening, with a promise of a good day on the morrow. This promise was verified. The morning of the 7th was fine, with a light southeast breeze, and the weather continued favorable throughout the day, the wind increasing slightly, and veering a little, perhaps, but not enough to be considered a material change.

At 5.45 a. m. a sounding was taken in 16 fathoms; fine white sand, lat. 29° 31′ N., long. 85° 36′ 20″ W. Our object was to get on the "Old Cape Ground," a well-known and favorite fishing bank for red snappers off Cape San Blas, and which lay a little farther offshore, where the water was deeper, the depths most generally resorted to in this region at this season being from 26 to 31 fathoms, though during the spring and summer snappers are frequently taken inshore in much shallower water.

After making the sounding alluded to above the ship headed to the southward, and two successive soundings were made, one at 6.25 and the other at 6.55 a. m., without deepening the water, that last mentioned giving only 15 fathoms. Finally, at 8.11 a. m., we sounded in 27 fathoms (lat. 29° 16′ 20″ N., long. 85° 34′ W.), on a bottom of gray and black sand and shells. The bottom as well as the depth was favorable, and lines were immediately put out, baited with salt mackerel. No sooner had they reached bottom than first one and then another of those fishing had a vigorous bite, and a few minutes later several red snappers were landed on deck, and also some porgies and a red grouper. A dozen lines were now out, and fishing began in good earnest, but success was at first often interfered with by the hooks being stripped of bait before a fish could be caught. If a fish failed to swallow the hook sufficiently for its point to fasten in his mouth he invariably took the bait, as long as mackerel were used, the result being more or less "water hauls" that were certainly not satisfactory to those engaged in fishing. But this difficulty was soon averted by using bait cut from the sides of the porgies, and very excellent and tough bait this was; but this is about all that the species is good for, as it has a strong, disagreeable odor that makes it repulsive for food.*

The snappers caught on this occasion were small, the largest not exceeding 10 pounds in weight, while the average would probably not be above 5 pounds. Porgies were almost as numerous as the snappers, and even more so after a little while. They served a good purpose in supplying us with bait, but their skill in "skinning" the hooks proved a source of annoyance. After the fishing had continued for twenty minutes or a half hour, the ship drifted away from the snappers, and nothing could be caught except porgies. The ship then got under way the fish were counted, and it was found that 30 red snappers, 3 red groupers, and 25 porgies had been caught. It may be remarked incidentally that Mr. Benedict, the resident naturalist, made an examination of all the fish taken on this and subsequent occasions during the day, for the purpose of securing parasites and making other observations.

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* Porgies are used for food at Key West, where, curiously enough, it is said that they do not have the strong ordor that is their chief characteristic about Pensacola.

After steaming to windward a short distance, possibly a little farther than we had drifted, the ship hove to again and the lines were put out. This time we were fortunate enough to stop directly on the center of the school, and the fish not only bit with the utmost eagerness, but they were much larger and finer than those previously taken, and besides there were very few of other kinds. No sooner would the hooks reach bottom than they would be taken; pairs of large snappers were frequently caught, and so eager did they become that they chased the gear up in the water. It frequently happened that if one started his line from bottom with only a single fish on it another would bite the free hook before it got far up. In one instance my line was fouled and stopped running for a moment, when about half way to bottom. When it was free I found it "loaded," and pulled in two fine snappers that averaged 15 pounds each, at the least. As is well known, the red snapper is one of the gamiest of sea fishes, consequently it requires some muscle and grip to continue pulling in such big and active fish, particularly when two at a time come as often as one. Every one began fishing barehanded, and, as a consequence, it was not long before all had their hands more or less blistered by the lines, and gloves, mittens, &c., were in requisition. For nearly an hour or more the fishing continued in good earnest, but at the expiration of that time the ship drifted off the school, as before, and not a single fish could be caught. While we were steaming to windward again opportunity was afforded to sum up the results, which were as follows: 80 red snappers, the largest weighing 21 pounds, 2 groupers, and 6 porgies. A large number of the snappers would tip the scales at 12 to 15 pounds, while not a few were heavier.

The ship hove to after going a short distance, but on this occasion we were less fortunate than before. Only seven snappers were caught, but these were of extraordinary size, the largest weighing 27½ pounds, which would seem to be about the maximum for the species, since we are told that one is seldom seen to exceed or even equal this in size. Besides the snappers, we caught two or three gags and a single porgie. It was not long, however, before we could not catch anything, and the ship then shifted her position again. The remainder of the day was spent in dredging with the beam-trawl, but no more fish were taken, notwithstanding lines were put out at nearly every station. The material dredged up from the bottom consisted for the most part of dead shells, dead corals, black sand, gravel, &c., with which were many small crustacea, small octopods, and worms, also a few little fish, and some other material. In one locality "live bottom" was found, many live corals, shells, sponges, &c., being brought up in the trawl. The fishermen claim that patches of bottom of this character are the favorite haunts of the red snapper. In another place (station 2375, in 30 fathoms, lat. 29° 10′ N., long. 85° 31′ W.), where we made the last dredging of the day, large numbers of flat sea urchins, called "sand dollars" by fishermen, came up in the beam-trawl. Where these occur, either in northern or southern seas, the bottom is usually barren of such fish life as would be of any economic importance.

On the evening of the 7th, the ship steered for Pensacola, where she arrived and made fast to the navy-yard wharf on the following morning. Monday, Dr. Bean and I went on a seining expedition along the west shore of Pensacola Bay. Six seamen were detailed to go with us in the dinghy to assist in handling the apparatus. We carried both the capelan seine and the Baird collecting seine, but, notwithstanding the men worked with much willingness, volunteering to wade into the water whenever there was any probability of securing fish, the results obtained were rather unimportant. Our lack of success was chiefly due to the fact that a cold westerly wind was blowing, and this lowered the temperature of the shallow inshore waters to such an extent (according to the local fishermen) that the fish would not "play in."

5. FROM PENSACOLA TO NEW ORLEANS AND RETURN.

On the afternoon of February 10 the ship left Pensacola and stood out to sea.

While at Pensacola, Mr. Warren had shown me a chart on which a bank of considerable size, with an average depth of about 40 fathoms, was laid down between Pensacola and the passes of the Mississippi, in a position where the twenty-ninth parallel of north latitude cut its southern edge, and the eighty-eighth meridian, west longitude, crossed nearly at its center. On some of the more recently published charts no soundings are laid down in this particular locality, which is some distance outside of the 50-fathom line of shore soundings, while on others it is marked as "uncertain." The fishermen, therefore, have been in some doubt as to whether such a bank really existed or not, and as they fully believed that, if it did exist, red snappers and other species of food-fishes would be found in abundance on it, they have naturally felt much interest in having this fact fully determined. On one occasion a smack attempted to find the bank and failed, but as she was provided with no nautical instruments for determining her position, it has always been a mooted question whether or not she sounded in the right locality. So important was the settlement of this question considered that Mr. Stearns, in a letter addressed to the Commissioner of Fish and Fisheries, mentioned this as a matter deserving of special investigation by the Albatross whenever she should visit this part of the Gulf of Mexico.

Having made this seemingly necessary explanation, it only remains to be added that a series of soundings were made on the 11th, with the purpose of determining whether or not such a bank exists in the locality alluded to.

The following data, extracted from the official records of the ship, show where the soundings were made and the depths obtained:

[Date, March 11.]

Depth.	Lat., N.	Long., W.	Character of bottom.
Faths.	° ′ ″	° ′ ″	
43	29 22 00	87 46 30	
99	29 17 30	87 49 00	
206	29 13 00	87 51 30	
362	29 08 30	87 54 00	
599	29 04 00	87 56 30	
740	28 58 15	88 00 00	
698	28 54 00	88 02 30	
747	28 56 30	87 58 30	
611	28 59 00	87 55 30	
739	29 02 45	87 53 00	
573	28 59 30	88 06 00	
486	28 58 20	88 14 00	
324	29 03 15	88 16 00	
210	29 07 30	88 08 00	
68	29 14 30	88 09 30	
46	29 19 30	88 11 30	Gray mud.
35	29 21 45	88 14 00	Gray sand.
32	29 22 30	88 17 00	Gray sand and mud.*
30	29 22 15	88 21 00	
36	29 17 30	88 21 00	

* The character of the bottom, like the few instances given, was unsuitable for red snappers and similar food-fish to live on.

Several hauls were made with the beam-trawl on the afternoon of the 11th, in about 500 fathoms, and excellent results were obtained.

On the 12th we entered the South Pass of the Mississippi, and the following day reached New Orleans, where the ship remained until March 1, she having been opened to the public, at the wharf near the Exposition grounds, from the morning of February 20 until our departure. It is, perhaps, proper to remark in this place that the Albatross proved a great attraction, and during her stay at the Exposition she was thronged by a crowd of sight-seers, many of whom were gentlemen and ladies who were interested in scientific work and who found in the ship and her apparatus and collections material so instructive and attractive that some of them came on board repeatedly and frequently made it a point to bring their friends and relatives.

The two days after we left the Mississippi, March 2 and 3, were spent in dredging in deep water in the northern part of the Gulf. On the 4th the entire day was spent in dredging and trying for fish along a stretch of ground off Mobile. The first attempt to catch fish was made at 6.30 a. m., in 54 fathoms (lat. 29° 17′ 15″ N., long. 88° 05′ 30″ W.), but nothing was caught. Eleven other trials were made in course of the day, in from 22 to 40 fathoms, at intervals of about 2 to 4 miles, but no success was met with, not even a bite having been felt on the lines, several of which were put out whenever the ship stopped. The series of soundings and trials for fish were not run in a straight line, but in a sort of zig-zag form along the ground, the ship first heading in at an angle on the bank toward shallow water and then off. This method offered the greatest probability of success. The last attempt to catch fish was made late in the afternoon, in 22 fathoms, on fine white sand, the ship's position being 29° 40′ 30″ N. lat., and 87° 32′ 30″ W. long. The soundings for the day, in the order of their occurrence, between the first and last trial for fish, were as follows: Thirty-two fathoms, sand, gravel, broken shells; 25 fathoms, gray sand; 35 fathoms, yellow sand, black specks; 27 fathoms, gray sand, broken shells; 36 fathoms, fine gray sand, black specks; 30 fathoms, coarse sand, black specks, stones; 25 fathoms, gray sand, black specks; 25 fathoms, coarse sand, black specks, broken shells; 22 fathoms, fine white sand. As will be seen the depth and character of the bottom are precisely the same on the two last soundings taken, although they were made more than 4 miles apart. It would appear somewhat strange that not a single food-fish was taken over all this extended area. But the dredgings made with the beam-trawl brought up very little that might serve as food for fish so active and voracious as either the red snapper or grouper. According to Mr. Stearns, red snappers are often found abundant over this ground, and, indeed, still farther inshore, a few weeks later, in April and May, when they are near their spawning season. He thinks that they go in at such times on the sandy bottom to spawn, where their eggs may be less liable to attacks from crustacea and numerous species of predaceous fish that are plentiful a little farther out, in deeper water. He is also of the opinion that it is possible some schools of snappers might have been found in 35 to 47 fathoms, a little outside of the northernmost soundings obtained by us. Although the snappers that are caught to the eastward, in the vicinity of Cape San Blas, are taken in from 27 to 31 fathoms (and on one spot in a less depth) in winter, the fishermen say that they must go in deeper water on the grounds off Mobile.

Early on the morning of March 5 the ship arrived in Pensacola and made fast to the coal wharf at the navy-yard.

6. SECOND RED-SNAPPER TRIP FROM PENSACOLA.

During the forenoon after our arrival at Pensacola I went to the town in the steam launch, at Captain Tanner's request, to see Mr. Stearns and ask him to come on board the ship, which he did. He wished to make a trip with us to the snapper banks, and on his return to town made arrangements to do so. He accordingly came on board again the next day (March 6), and at 5.15 p. m. the ship left the navy-yard and steamed to sea. After getting outside the bar the course was laid for the "Old Cape Ground," off Cape San Blas. At a little before 6 o'clock on the morning of the 7th we began fishing, in 30 fathoms; bottom of gray sand, black specks, and broken shells; the ship's position being lat. 29° 16′ 19″ N., long. 85° 49′ 30″ W. Several hand-lines were put out, these being baited with mackerel, but only one grouper was caught; one of the men reported hauling a small red snapper alongside, but he lost it. At 6.30 the ship started ahead and steamed nearly 2 miles southeast by east, where soundings were taken in 29 fathoms; bottom same as before; position, lat. 29° 16′ 00″ N., long. 85° 47′ 30″ W. The fishing lines were put out as soon as the ship stopped, and almost immediately a grouper and snapper were caught. We fished almost an hour in this berth, the total catch being as follows: One amber fish (*Seriola*); 1 scamp (*Trisotropis falcatus* Poey); 1 large black grouper or gag (*Trisotropis brunneus* Poey); 2 spotted hinds (*Epinephelus drummond-hayi* Goode & Bean); 6 red groupers (*E. morio*); 2 porgies (*Sparus*); 9 red snappers (*Lutjanus blackfordii* Goode & Bean).

It may be remarked that as soon as it was practicable fresh bait—grouper and porgie—was used instead of the salt mackerel. It appears, however, that the red snapper is not fond of grouper bait, and unless he is very hungry will not take it readily. The fishermen usually "point" their hooks with some sort of bait which is attractive to the snapper, putting the coarser kinds on the shank.

At 7.40 the ship started ahead on an east by north course, and ran 20 minutes, when soundings were taken in 31 fathoms, bottom as before (lat. 29° 17′ 20″ N., long. 85° 45′ 30″ W.). The lines were hove out as soon as the ship stopped, and fishing continued for 55 minutes. The catch in this berth was 7 snappers, 6 groupers, 2 spotted hinds, and 2 scamp. After this, twenty-eight more trials were made for fish during the day, with the result given in the following table, which also contains the positions, depth of water, &c., where soundings were taken and lines put out. As a rule, the ship stopped from 5 to 10 minutes in each position, except when fish were caught, when the stay was longer. The last sounding was taken at 5.56 p. m., when it was nearly dark and too late to carry the investigation farther, though there appeared to be some fish in this berth.

[Date, March 7.]

Depth.	Lat., N.	Long., W.	Character of bottom as shown by the lead.	Remarks.
Faths.	° ′ ″	° ′ ″		
30	29 18 40	85 43 30	Gray sand, black specks, broken shells.	No fish.
27	29 20 00	85 41 30	......do	Do.
29	29 19 00	85 41 45	......do	Do.
25	29 18 15	85 41 00	......do	1 porgie.
29	29 17 30	85 40 15	......do	2 groupers, 1 porgie.
28	29 16 45	85 39 30	......do	6 red groupers, 5 red snappers, 1 porgie.
31	29 16 00	85 38 45	......do	5 red groupers, 2 snappers, 1 porgie
33	29 15 11	85 38 00	Gray sand, black specks .	No fish.
32½	29 15 10	85 37 00	Fine gray sand, black specks.	Do.
31	29 15 10	85 36 00	......do	Do.
29	29 15 40	85 35 15	Fine gray sand..........	Do.
25	29 16 15	85 34 30	Coarse, black sand, fine shells.	Do.
27	29 15 00	85 34 30	White sand, black specks, fine shells.	Do.
27	29 14 00	85 33 30	Fine sand, black specks.....	Do.
26	29 13 00	85 32 30	Fine white sand, black specks.	Do.
26	29 12 30	85 32 00	Coarse sand, black specks, fine shells.	Do.
29	29 15 10	85 34 30	Fine white sand, black specks.	Do.
29	29 16 30	85 36 00	do......................	Do.
27	29 17 10	85 36 30	Fine white sand, black specks.	Do.
27	29 17 50	85 37 00	Fine sand, black specks, broken shells.	Do.
28	29 18 30	85 37 30	Gray and black sand, broken shells.	Do.
26	29 19 15	85 38 00	......do	Do.
26	29 19 40	85 39 20	......do	Do.
26	29 20 05	85 40 40	......do	Do.
26	29 20 30	85 42 00	.... do	Do.
28	29 19 45	85 42 50	......do	Do.
28	29 19 20	85 43 15	.... do	Do.
28	29 19 00	85 43 15	......do	10 snappers, 8 red groupers, 2 black groupers.

The scarcity of red snappers on this ground may be considered somewhat remarkable, considering that only a few years ago they were abundant. However, from their peculiar habit of going in schools that cover only a limited area, it is often difficult for the fishermen to find them, and sometimes a whole day will be spent in sounding and trying to catch snappers without meeting with any material success.

At this season, we are told, it is more difficult to find good snapper fishing than in winter. The fishermen say that the schools appear to be somewhat broken up, the fish are moving about, and it is believed they are up in the water chasing smaller fish that come on the coast in the early spring.

After the last sounding was made, and some fish taken, the order was given to set the large gill-nets to ascertain if any red snappers could be taken in them. There was considerable difficulty in getting the two nets ready; they got fouled up and had to be cleared, and besides, sinkers had to be prepared for them. Consequently, considerable time was occupied in preparing them for setting. In the mean time the ship had, of course, drifted off the spot where the fish were caught, but she steamed back to the place, or as near to it as could be judged.

At 8.30 p. m. the dinghy was lowered, and Mr. Stearns and two seamen went into the boat with me to set and haul the nets. As soon as the boat was well clear of the ship we began setting the gear. It was a slow job, for the twine fouled a good deal here and there on the dinghy, and in the darkness was more or less difficult to clear, while the boat jumped about considerably, notwithstanding there was only a moderate breeze and a small choppy sea. We got the nets set at 9 p. m. and began hauling at 10.40. There was somewhat more wind and sea by the time we began to haul; the current ran quite strongly to leeward, and as we had to pull the net in over the boat's side, thus keeping her broadside to the sea and tide, it was a heavy drag to get the apparatus up. We returned to the ship a little after midnight. No fish were taken. The nets set on this occasion were each 50 fathoms long, and 3 fathoms deep, when hung. They had a 9-inch mesh, and were made of strong linen twine, such as is used in the manufacture of cod gill-nets.

After the dinghy was hoisted, the ship steamed to the westward 7 or 8 miles, and hove to for the night. During the forenoon of the 8th trials were made for fish on nearly the same ground that we fished over the previous morning. Satisfactory results were not obtained, however, and about 10 a. m. the ship started to the southeast for the "New Cape Ground," the locality aimed at being about 40 miles from the starting point.

The following tabulated statement will show where the trials were made, the catch, &c.:

[Date, March 8.]

Depth.	Lat., N.	Long., W.	Character of bottom as indicated by the lead.	Remarks.
Faths.	° ′ ″	° ′ ″		
30	29 16 15	85 42 30	Gray and black sand, and broken shells.	No fish.
29	29 16 45	85 41 00	......do	4 groupers; 1 red snapper; 1 spotted hind
29	29 15 30	85 40 15	......do	4 groupers; 1 red snapper.
31	29 17 45	85 42 00	......do	No fish.
27	29 20 30	85 44 00	......do	Do.
29	29 19 30	85 45 00	......do	Do.
29	29 20 15	85 45 40	......do	6 red groupers; 2 red snappers.
28	29 21 00	85 46 20	Gravel and broken shells	No fish.
31	28 51 20	85 10 00	Gray sand and broken shells.	Do.
30	28 52 10	85 09 20	Coarse gray sand and broken shells.	Do.
29	28 53 00	85 08 40	Gray sand and broken shells.	Do.
28	28 54 00	85 08 00	Gray sand, black specks, and broken shells.	20 red snappers; 2 black groupers.

The snappers taken in the last berth were much larger and finer than any that had been caught before on this or the previous day. As soon as the fish were struck the order was given to set the trawl-line, which was already baited and placed in the dinghy, with the other necessary apparatus, in readiness for use. The boat was lowered at once, and I went in her, with two seamen, to set the gear. As soon as the dinghy was well clear of the ship's stern we began to put out the line, and set it to leeward, which was nearly in the direction that the current was running. Unfortunately, the trawl-line was too far to leeward to cross the spot where the snappers were found, and, as a consequence, no food-fishes were taken on it, the catch being three eels, each about 15 inches long, and two other small fish of no economic value.

The day was well advanced when the trawl was set, and it was a little past 5 p. m. when we returned to the ship. In the mean time, while the boat had been out, a dozen or fifteen fine snappers were caught on board the ship about one or two cable's length to windward of the weather trawl-buoy. As soon as the dinghy was hoisted, the ship started ahead on her course for Pensacola, where she arrived, and made fast to the navy-yard wharf, about 3:30 p. m. on the 9th.

Before concluding the account of the trip above described it should be stated that during the two days the ship was on the fishing ground the weather was fine, and the wind moderate, consequently there was a good opportunity for obtaining observations to determine the positions accurately, and nothing to prevent a boat from going out whenever it seemed necessary.

We laid at the navy-yard three days. On the afternoon of March 11 Mr. Benedict and I started off in the dinghy for a cruise about the bay, hoping to capture some porpoises, which appear to be abundant there. Although we saw numbers of them, and they seemed especially plenty about Santa Rosa Island, they were too wary for us to get near enough to kill them. Despite numerous attempts, we could not approach close enough even to shoot at them with any hope of success, and as for striking them with an iron, it was entirely out of the question. On one occasion we both discharged our guns simultaneously at a school, and doubtless hit some individuals, but it is probable that the shot struck them only in their backs, where they would have no very marked effect. The porpoises were "playing" about in the shallow water near the island, apparently feeding on small fish, and one would naturally suppose they could be approached without difficulty. But they invariably noticed the presence of the boat when within 40 to 60 yards of it, and would disappear to come up at a greater distance.

7. FROM PENSACOLA TO TAMPA.

About 5 o'clock on the afternoon of the 12th the ship cast off from the navy-yard wharf and stood out to sea. The two succeeding days (March 13 and 14) were spent in dredging to the southward of the snapper grounds, between 87° 27′ 00″ and 85° 33′ 30″ west longitude, in depths varying from 111 to 724 fathoms.

On the morning of the 15th the ship headed toward the fishing grounds off Cape San Blas, and a continuous series of dredgings and trials for fish were carried on throughout the day. The first two soundings, 88 and 60 fathoms, respectively, were made outside the snapper bank. To ascertain, however, if there were any food-fish in deeper water than they are usually caught in, a snood, with a baited hook attached, was bent to the sounding wire before the first sounding was taken. Nothing was caught on this hook, though it was tried several times, even after we got into shoaler water. But this failure is not so much to be wondered at, for on the same occasions we did not catch any fish on the hand-lines, a number of which were put out to try for snappers whenever a sounding was made (after we got on the bank), and also after the beam-trawl had been hove up. Indeed, every effort was made to catch fish whenever a chance offered, and where we failed it is fair to assume that there were none.

The following tabulated statement of the day's work shows the positions where these trials were made, and contains other data bearing on the investigation:

[Date, March 15.]

Depth.	Lat. W.	Long. N.	Character of bottom as indicated by the lead.	Remarks.
Faths.	° ′ ″	° ′ ″		
88	28 42 30	85 29 00	Gray mud	Here (station 2403), the beam-trawl was put out. Many small fish, crustacea, and a few living shells were taken. No large food-fish were caught; no fishing lines put out.
60	28 44 00	85 16 00	Gray sand	No food-fish taken. The beam-trawl was used. It brought up a number of fish, none of them of any commercial value and most of them very small varieties. There were also some crabs, dead shells, &c. The general character of the material taken indicated "dead bottom," and the presence of large flat sea urchins ("sand dollars"), such as we took here, is considered a "sign" of barren ground by fishermen.

[Date, March 15—Continued.]

Depth.	Lat. W.	Long. N.	Character of bottom as indicated by the lead.	Remarks.
Faths.	° ′ ″	° ′ ″		
30	28 45 00	85 02 00	Coarse sand, broken coral.	No food-fish taken. A dredging was made with the beam-trawl. Quantities of dead shells, with a few small fish, and several forms of invertebrate life were taken; nothing however to indicate the presence of food-fish.
26	28 46 00	84 49 30	......do	Tried for fish when sounding was taken, but without success. The beam-trawl was put out and brought up about the same kind of material as before, though this time there were a few live shells. After the trawl was hove up the fishing lines were put out and 1 red grouper was caught.
24	28 47 30	84 37 00	Coral and broken shells	No fish.
24	28 48 00	84 36 00	Sand, coral, broken shells.	Do.
24	28 47 00	84 35 50	..... do	Do.
23	28 46 00	84 35 40	......do	Caught 4 red groupers. Steamed ahead about three times the ship's length to try for snappers, but caught nothing in new position.
24	28 45 00	84 35 30	......do	Caught 1 red snapper soon after the ship stopped, but not getting any more, ship changed her position about one-quarter of a mile. Put out lines again but caught nothing.
24	28 44 00	84 35 20	Sand and coral........	No fish were caught, but the men reported feeling fish nibbling at their hooks Those were probably porgies.
24	28 43 00	84 35 30	Sand, coral, broken shells.	No fish.
26	28 42 00	84 35 40	Sand with black specks and broken shells.	Do.
26	28 41 30	84 35 50	Coarse black and gray sand, coral.	Do.
27	28 41 00	84 36 00	Gray sand, black specks, coral.	Do.
26	28 40 45	84 35 30	White sand, black specks, broken shells.	Do.
26	28 40 00	84 32 40	White sand, broken shells.	Do.
24	28 42 00	84 29 50	Yellow sand, black specks, broken shells	Do.
22	28 43 20	84 28 00	Coral	Do.
23	28 44 00	84 27 00	Fine white sand, broken shells.	Caught 2 red groupers.
21	28 44 40	84 26 00	Coarse gray sand	No fish.

One cannot help being impressed with the idea that the distribution of red snappers in this region is not what might be expected, and, though fares of these fish may be taken on this ground, it is evident that they occupy only a very limited area on it. It is certainly remarkable, to say the least, that we should have made nineteen trials and caught only eight groupers and a single snapper.

The last sounding and trial for fish was made after 6 p. m., at twilight, after which the ship lay drifting until the next morning.

As soon as daylight (5.30 a. m.), on the morning of the 16th, the work of "trying the ground" was again commenced and continued unremittingly throughout the day. These investigations were made to the southeastward of where we worked on the previous day, and a considerable number of the soundings were taken and fishing lines put out on a piece of ground which of late has become quite celebrated for the number of good fares that have been taken from it. Nevertheless, we failed to find good fishing, or anything approaching thereto, and considering that two of the largest fares of the winter were caught here only a few days before, the conviction is forced upon one that either the fish had, in the mean time, left the ground, or else to find them it is necessary to sound every few fathoms, in fact, to literally "try every inch of the bottom." The result of the day's work is given in the following table:

[Date, March 16.]

Depth.	Lat., N.	Long., W.	Character of bottom as indicated by lead.	Remarks.
Faths.	° ′ ″	° ′ ″		
21	28 50 00	84 32 30	Broken shells	No fish.
21	28 45 00	84 33 15	Fine white sand, black specks, broken shells.	Do.
27	28 40 00	84 34 00	Fine white sand, black specks.	Do.
24	28 38 45	84 28 30	Fine white sand, broken shells.	Do.
24	28 32 45	84 27 00	Coarse gray sand, broken shells.	Do.
21	28 28 00	84 25 00	Coral	10 red snappers and 1 grouper were taken here in a half hour's fishing. The snappers seemed to be not very abundant. The small beam-trawl was put out; it brought up some sponges, several species of little fish, sea urchins, hydroids, &c.
24	28 25 00	84 21 00	Coarse sand, black specks; shells.	No fish.
23	28 21 00	84 18 00	do	Do.
22	28 20 00	84 12 00	Gray sand	Do.
21	28 19 45	84 06 00	White sand, black specks, broken shells.	Do.
21	28 15 45	84 02 35	do	2 red snappers and 10 groupers caught at this position; fished about 20 minutes.
22	28 11 45	83 59 10	do	No fish.
22	28 07 45	83 55 40	White sand, black specks.	1 grouper.
22	28 03 45	83 52 15	Fine gray sand, black specks.	No fish.
22	27 59 40	83 48 50	Coarse sand, broken shells.	Do.
22	27 55 30	83 45 25	Gray and black sand	No fish. This sounding (and trial for fish) was made at 5.42 p. m., and closed the operations for the day, so far as fishing is concerned. Later, the ship headed in for Tampa Bay, and a series of soundings were taken in the evening, but these were for other purposes, and need not be detailed here.

A little after midnight the ship anchored off Egmont Key, and early on the morning of the 17th got under way and ran into Tampa, going as far up the bay as her draught would permit. She anchored off Gadsden Point at 9.30 a. m. While going up the bay arrangements were made to go on a seining expedition to the mouth of Manatee River, some 5 miles below the ship's anchorage, on the southeastern side of the bay.*

We noticed, while passing, that there were some beaches about the entrance to the river that had the appearance of being good seine hauls, but elsewhere in the vicinity of where we anchored the indications were not favorable. The capelan seine having been put in the dinghy with other necessary articles, before the ship dropped anchor, the boat was soon after lowered and a party of us started for the Manatee. Lieutenant Baker, Ensign Swift, Mr. Lee, three seamen, and myself made up the party.

* The charts of this section do not agree as to the location of Manatee River. On some of them its mouth is placed near the lower part of Tampa Bay. The large-scale Coast-Survey chart of the bay is my authority for the location given above, which is doubtless the correct one.

With a strong head tide and light wind, our progress was necessarily somewhat slow, but with the assistance of the oars we reached the first beach on the point northeast of the entrance to the river about 11 o'clock. As we ran in across the broad shallow plateau that extends outwards from this point we frequently saw large fish going along over the bottom, but they were too far off to definitely determine what they were, though we thought the most of them were sharks. Nearer the land fish were seemingly abundant. They could be seen jumping out of water here and there, and occasionally a small school of mullet were noticed running along not far from the beach. Landing some of the party with the guns, baskets, buckets, &c., that had been brought along, we shoved off and immediately threw over the seine. Unfortunately for our complete success, so far as the capture of a large number of fish was concerned, the seine was too deep and too heavily leaded for the shallow water. The bottom was covered with algæ, and the bunt of the seine became so filled and clogged with it that considerable difficulty was experienced in making a landing; and notwithstanding our best efforts, this could not be done quickly enough to prevent a large number of mullet from jumping over the cork rope, while more of them were seen to escape by running around the ends of the net. But, even with these hindrances, we made a very fair haul, landing about a barrel or more of fish, among which were mullet, crevallé, catfish, sea trout, sheep's-head, and bill-fish, besides several kinds of smaller ones. Subsequently we made two other shots with the seine, and, in addition to the varieties mentioned above, we took drum, big-eyed herring [?], two shovel-nosed sharks, and some other kinds of fish that none of our party were familiar with.

Our second haul was made around the point from where we first landed, and at the mouth of the river. Fish of various kinds were very abundant here, jumping out of water in all directions over a large area. The water was shallow, from 2 to 6 feet deep, and from shore to shore, a distance of half or three-quarters of a mile, we could see fish springing into the air. But the loose algæ was even more plentiful here than where we had first set the seine, and as a result we had great difficulty in making a landing, and the mortification of seeing the fish we had inclosed jump the cork rope or dart by the wings of the net. However, we got several varieties that had not previously been taken, and, considering that we were not anxious to catch large quantities, the result was fairly satisfactory. But with a larger-meshed seine, 70 or 80 fathoms long, and about 6 feet deep, we could doubtless have filled our boat in a short time.

Sharks are seemingly abundant here. Besides the two small ones taken in the seine, we saw a large one come in near the shore in the shallow water. As he swam about, near the point, his dorsal fin was plainly seen above the water's surface. Of the other species, mullet were apparently most plentiful, but big-eyed herring, crevallé, sheepshead, and catfish were also abundant. Fish-hawks were numerous, and evidently had no difficulty in supplying their wants, since in such shallow water they could easily capture all the fish they required, as we had a chance to observe.

We returned to the ship about 5 p. m. The steam launch met us, after we had sailed about a mile from the point, and took the dinghy in tow.

Were it not for the presence of so many sharks, pounds could probably be used here with great success. But the destruction of any netting left in the water for a considerable length of time would be inevitable. It is possible, however, that a brush weir might be successfully used, but it is probable that the toredo would injure it to such an extent that it would have to be rebuilt at comparatively short intervals. Therefore, while the demand for fish can be supplied by using seines that are inexpensive and seemingly well adapted for work in the shallow waters of the coast, there is little inducement to make any very radical changes in the apparatus employed.

8. FROM TAMPA TO KEY WEST.

Early on the morning of the 18th the ship got under way and ran out of Tampa. After getting outside the channel, or fair-way, buoy, she steamed offshore on a southwest three-quarter south course. The day was fine, with a light westerly breeze, and after we were well off from the land a series of soundings and trials for fish were begun and continued until night, and also on the next day. The general direction of these researches, after we reached a depth of 28 fathoms, was southerly and southeasterly, or nearly parallel with the coast line. The following is a tabulated statement of the work done on the 18th and 19th:

[Date, March 18.]

Depth.	Lat., N.	Long., W.	Character of bottom as indicated by the lead.	Remarks.
Fath.	° ′ ″	° ′ ″		
18	27 16 00	83 10 00	Gray and black sand..	Stopped to pick up small sharpie that was adrift; put out lines; no fish.
25	27 08 30	83 19 30	Coarse gray and black sand.	No fish.
26	27 04 00	83 21 15	Coarse gray sand and broken shells.	Here, 1 red snapper, 2 groupers, and 1 porgie were taken. As soon as we began to catch fish the beam-trawl was lowered and dragged along the bottom as the ship drifted. The trawl was on the ground about fifteen minutes. It brought up a large mass of material (about $1\frac{1}{4}$ barrels), most of which was sponges of various species, 3 of them being very large cup sponges. There were also a few live corals, bryozoa, hydroids, shells, and some small fish. A scarcity of dead shells, dead corals, &c., was noticeable, and contrasted strongly in this respect with the grounds we have previously dredged, particularly in those localities where no fish were caught.
26	26 58 00	83 22 30	......do................	In this position, where we stopped less than fifteen minutes, 2 large red snappers (one weighing 20 pounds), 1 black grouper (25 pounds), and 4 red groupers were caught. As previously explained, our object was not to catch quantities of fish, but only to ascertain if there were any in the positions where we stopped; therefore ten or fifteen minutes was generally long enough to determine this, after which the ship stood on for a new berth unless the trawl was put over.

[Date, March 18—Continued.]

Depth.	Lat., N.	Long., W.	Character of bottom as indicated by the lead.	Remarks.
Fath.	° ′ ″	° ′ ″		
27	26 53 00	83 24 00	White sand, black specks, broken shells.	No fish.
28	26 47 30	83 25 15	Fine white sand, black specks, broken shells.	No fish. Rake-dredge put out.
29	26 42 30	83 22 45	Coarse sand, black specks, broken shells.	No fish.
28	26 38 00	83 20 00	Coarse sand, black specks.	1 red snapper.
27	26 33 30	83 15 30	Fine white sand, black specks.	1 red snapper (weight 20 pounds). Made a dredging with the beam-trawl and brought up a number of sponges that were filled with small crustaceans, worms, &c. In handling these our hands were filled with minute spicules that caused a troublesome irritation for several days. Some large holothurians also came up. A second haul was made, going faster, in hopes to catch some fish in the trawl, but none were taken. This was the last attempt made to catch fish for the day, since it was 6.24 p. m. when we stopped to sound, and therefore about dark. The ship lay drifting till next day.

[Date, March 19.]

Depth.	Lat., N.	Long., W.	Character of bottom as indicated by the lead.	Remarks.
26	26 28 15	83 11 00	Fine white sand, black specks.	No fish. This trial was made at daylight (5.22 a. m.).
28	26 23 15	83 11 15	Coarse gray sand, black specks, broken shells.	No fish.
27½	26 18 30	83 08 45	Fine gray sand, black specks, broken shells.	In this position we caught 12 fine red snappers and 1 grouper in ten minutes. The fish were exceedingly abundant, and were caught in pairs as fast as the lines were put out. They followed the gear up and were seen in the water alongside of the ship. Almost as soon as we struck fish, the beam-trawl was put over and a dredging made. It was left on the bottom only a few minutes. A considerable quantity of material was brought up in the trawl, among which were eight or ten different species of sponges, and also many live corals, bryozoa, hydroids, small crustacea, and several varieties of small fish. Of the latter a small species with yellow tail and pectorals was most numerous, there being 14 of this kind. Some ascidians were also taken, while the sponges were found to be filled with animal life, worms being most numerous.
27	26 12 30	83 06 30	Coarse gray sand, black specks, broken shells.	1 grouper.
25	26 08 30	83 03 45	Fine white sand, black specks, broken shells.	Here 3 groupers, 1 scamp, and 1 porgie were caught. Fished ten minutes.
24	26 04 30	83 01 00	Fine sand, black specks, broken shells.	No fish.
24	26 00 00	82 57 30	......do................	No fish. A dredging was made with beam-trawl, which came up heavily loaded, the bulk of the material being large cup sponges.
25	25 54 00	82 59 30	Fine white sand.......	No fish.
25	25 49 00	83 01 00	......do................	Do.
27	25 44 30	83 02 30	Sand and coral........	1 red snapper caught; 2 others hauled up and lost.
27	25 39 30	83 01 00	Gray sand and broken shells.	The catch was 3 red snappers and 1 grouper. Several other fish were reported hooked, but broke away. Fished ten to fifteen minutes.
27	25 34 30	83 01 00	Gray sand, black specks.	No fish.
28	25 29 30	83 01 00	Coarse gray sand, broken shells.	Do.
27	25 24 30	83 00 00	Gray sand, black specks.	Do.
27	25 19 30	82 59 30	Gray mud, broken shells.	Do.
27	25 14 30	82 59 00	Gray mud, fine sand, broken shells.	Do.
27	25 09 30	82 59 00	Broken shells.........	Do.
26	25 04 30	82 59 15	Fine white sand, broken shells.	Do.

The last sounding, on the 19th, was made after 6 p. m., when it was nearly dark. The beam-trawl was put out here. After it was up the ship headed on her course for Key West, where she arrived the following morning.

The investigations that were made after leaving Tampa may fairly be considered as probably the most important work done on the cruise in the direction of making researches on the fishing grounds. The region lying between Tampa and the Tortugas, outside of a depth of 20 fathoms, has never been resorted to by fishing smacks, and it is certainly questionable if any one knew that red snappers could be taken on the ground we went over. That they are more generally distributed here, in depths of 26 to 27 fathoms, and far more abundant than on the grounds visited by the snapper fishermen of Pensacola, seems clearly established by the result of the researches made.

In view of the growing demand for the red snapper, and the fact that the fish on the old grounds are believed to be more or less depleted and becoming scarcer every year, the importance of this discovery, if it may so be termed, can scarcely be overestimated, since it opens up an additional field of broad proportions that there is good reason to suppose will be profitably worked in the future. Its nearness to Tampa, which has the advantages of an excellent harbor and railroad communication, are features that should not be overlooked, for if the distance from Pensacola is too great to run fish there they can be shipped from the nearer port.

In the latter part of the day on which we arrived at Key West I engaged a boat fisherman to catch some kingfish, and late on Monday afternoon, March 23, he got back, having taken all I wanted, besides a considerable quantity more. The fish having first been split, they were taken on board the ship and salted. These were purchased with the intention of experimenting with them, to ascertain if they can be smoked so as to make them a desirable article of food.

9. FROM KEY WEST TO WASHINGTON.

Early on the morning of March 30 the ship got under way and proceeded to sea, on her way north. A moderate to light head wind prevailed, but the next day the wind blew strong. The weather moderated during the night, and shortly after daylight, April 1, a dredging was made with the beam-trawl in 440 fathoms, a large mass of live corals, hydroids, sponges, bryozoa, &c., being obtained. The ship then steered north-northeast, and another haul was made with the trawl in the afternoon, sponges of various kinds being the chief part of the material taken. At 6 p. m. the ship stopped, and soundings were obtained in 86 fathoms, lat. 31° 54′ 45″ N., long. 79° 17′ 00″ W. Several fishing lines were put over, baited with salt mackerel, but nothing was caught, though we kept the gear out a half hour.

About 1 p. m., April 2, another attempt was made to catch fish in 95 fathoms, at station 2417 (lat. 33° 18′ 30″ N., long. 77° 07′ 00″ W.), but none were taken.

A haul with the beam-trawl was made near this place; sea urchins, of the "sand-dollar" type, and a few small fish (of which little skates and flounders formed the chief part) being the principal material taken. This is probably at all times "barren bottom." Another dredging and trial for fish with hand-lines were made about 6 p. m., in 107 fathoms (lat. 33°, 34′ N., long. 76°, 40′, 30″ W.), but we caught no fish, and a limited quantity of spiny sea urchins was nearly all that the trawl brought up.

From this time until 10.01 p. m., April 3, the ship was under way, steaming up the Gulf Stream. At the hour above mentioned the officers began taking a set of serial temperatures at intervals of 20 miles, beginning in the Gulf Stream, in 2,340 fathoms (lat. 36° 30′ N., long. 73° 14′ W.), and running in a west-northwesterly direction. This work was continued uninterruptedly until 6.20 p. m. on the 4th, when the ship was in lat. 37° 9′ 23″ N., long. 74° 30′ 30″ W. Not far from this position, in a depth of 65 to 100 fathoms, it was deemed desirable to try for fish, since here, on previous dredgings last year, various forms of life had been found abundant that were known to exist in great numbers on the grounds where the tilefish (*Lopholatilus chamæleonticeps*) was found previous to the remarkable mortality that occurred to that species in the spring of 1882, since which time not a single individual has been seen. Among these different animals a peculiar kind of crustacea, known as *Munida*, was found on the tilefish bank in great abundance, but, strange as it may seem, this also practically disappeared at the same time that the *Lopholatilus* was destroyed in such numbers. As these would be excellent food for large, voracious, bottom-feeding species, like the tilefish, it has been inferred that where the *Munida* is found plentiful there also it is probable (or possible) that the *Lopholatilus* may be caught. Therefore, the fact having been determined by previous investigation that this particular species (as well as some others that were contemporary with the tilefish) were plentiful just inside the Gulf Stream, in the locality named, the importance of ascertaining what kinds of fish could be taken on the same ground will be apparent.

But at the time we reached the proper locality, on the 4th, the wind blew up so strong from the westward that it kicked up a choppy sea and made it impracticable to do any fishing. The ship, therefore, lay by, steaming to windward only enough to hold her own, or a little more, until the next morning. About 6 a. m., on the 5th, a depth of 104 fathoms was obtained, and a haul was made with the beam-trawl (station 2420; lat. 37° 03′ 20″ N., long. 74° 31′ 40″ W.).

The trawl was on the bottom only a short time, but nevertheless brought up large quantities of *Munida*, eighteen specimens of small hake (*P. regius* [?]), several small tiger sharks, some small skate (*Raia*), hermit, and other kinds of crabs, small octopods, &c. Many stones, wave-worn and of various kinds, came up, these having the appearance of beach rocks, or such as one sometimes sees pulled up from the bottom on the northern fishing banks. There were also many specimens of a hard, clayey substance, more or less perforated with holes of considerable size, but just what this is, or rather what causes such a formation, I believe has not yet been determined. Taken as a whole, this bottom must be excellently well adapted to the support of many kinds of fish life, particularly such as might be of commercial importance.

As soon as the trawl was up, several fishing lines were put out in 67 fathoms (lat. 37° 3′ N., long. 74° 33′ W.), and we continued fishing for about three-quarters of an hour. Eight dogfish (*Squalus acanthias*) were caught. These were so plenty that several pairs were taken on a single line. Nothing else was caught on the lines, however, and little else could be expected where these pests of the fishing grounds are abundant. For such is their pugnacity and greediness that they generally prevent all other species from taking the hooks, and not uncommonly, when they swarm in a locality, they drive other fish from it. This being the case, it will readily be understood that it is yet difficult to say precisely what kinds and what quantities of fish can be taken here, when the region is not infested by dogfish, which is probably a large part of the summer and fall.

Another matter that should be considered is this: we had only salt bait to use, and as tilefish have always, when taken, been caught on fresh bait, we are left in doubt as to whether they would bite at any other. The presence of such large quantities of live food that is suitable for them would lead one to suppose that they will not bite at salt material. However, this is not so important in the present case as it might be under other conditions, since, as has been explained, the presence of so many dogfish on the ground would doubtless render abortive all attempts to catch other fish, whatever bait was used.

A second trial was made in 98 fathoms, about 2 miles northeasterly from the position given above, but nothing was taken on the lines.

The ship then headed for the Chesapeake, and the work of taking serial temperatures was resumed. The importance of making these observations on temperatures at this season will be apparent to any one at all familiar with the habits of many species of our migratory fishes. About this time, or a little earlier, the mackerel, shad, and river herring or alewive, make their appearance on the coast in the latitude of the Chesapeake and a little north of it, while the menhaden, bluefish, and other species come a short time after. It is now a well recognized fact that the varying conditions of ocean temperature influence the movements of fish in a remarkable degree. This being the case, it need scarcely be added that the observations made must materially aid in the scientific study of the species referred to.

It may be remarked that we saw no schools of fish of any kind while running in. It is probable that the strong westerly wind and rather cool weather might prevent mackerel from schooling, since it is well known that they do not "show up" much when such conditions prevail.

Porpoises were playing about the ship on the morning of the 5th, and I tried to harpoon one. He was too far under water, however, for the iron to fasten, and no other opportunity was presented for making a capture, since the school left the ship's bow immediately after.

We entered Chesapeake Bay late on the afternoon of the 5th, and arrived at Washington at 1.30 p. m. on the following day.

II.—NOTES ON THE FISHERIES OF KEY WEST.

A.—THE SPONGE FISHERY.

The most important fishery of Key West is that which has the sponge for its object, and this may be reckoned among the leading industries of the port. Originating about 1852, when it was first understood that the sponges of this region were of commercial value, the business increased rapidly until it reached nearly its present limit several years ago, since which time the advance has been comparatively slow.

Although it is not my purpose, in these notes, to give much statistical data, it may nevertheless be said that citizens of Key West who are competent to judge estimate that at the present time a fleet of about 60 to 80 vessels, ranging in size from 5 to 50 tons, and fully 200 sail boats, 18 to 20 feet in length, are employed in this industry, while the aggregate number of fishermen who man this fleet is not far from 1,000. The above is doubtless an underestimate, for Hall, in his "Report on the ship-building industries of the United States" (Vol. VIII, Tenth Census), says:

"At Key West there are owned about 100 vessels, ranging from 5 to 25 tons, costing from $500 to $4,000 each, employed in the sponge business, * * * and about 300 boats, of less than 5 tons register, for sponging and other fishing, costing from $100 to $500 each."

A local authority states that for the year ending January 1, 1884, the large amount of "3,663 bales, or 206,945 pounds, of sponges were bought and shipped from Key West, the total amount paid for same reaching $244,309.50."*

The commercial forms of American sponges are specifically identical with those of the Mediterranean, according to Prof. Alpheus Hyatt, who is one of the best recognized authorities on this subject, but he finds that there are some subspecific differences.

There are five kinds of sponges taken by the Key West fishermen, though these may possibly be subdivided into grades according to their size or other qualifications. They are (1) the sheepswool sponge (*Spongia equina* Sch., subsp. *gossypina*), (2) yellow sponge (*S. agaricina*,

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* "The Key of the Gulf" (Key West), December 20, 1884.

subsp. *corlosia*, *dura*, *punctata*), (3) velvet or "boat" sponge (*S. equina*, subsp. *meandriniformis*), (4) grass sponge (*S. equina*, subsp. *cerebriformis*), (5) glove sponge (*S. officinalis* Linn., subsp. *tubulifera* and *S. graminea* Hyatt). The most valuable of these is the sheepswool sponge, and, according to Rathbun, "The Florida sheepswool sponges now command a higher price than those from the Bahamas."

1. FISHING GROUNDS.

The most important sponge grounds resorted to by the Key West fishermen are about Rock Island, Anclote Keys, Saint Mark's, in Apalachee Bay, and Cedar Keys. "The Florida sponge grounds," according to Rathbun, "form three separate elongate stretches along the southern and western coasts of the State. The first includes nearly all of the Florida Keys; the second extends from Anclote Keys to Cedar Keys, and the third from just north of Cedar Keys to Saint Mark's, in Apalachee Bay. The linear extent of these grounds is about 120 miles, and their breadth varies from a few miles to 15 or 20 miles. The total area of the sponge grounds worked in 1880 was reckoned at about 3,000 square geographical miles, but this does not by any means cover the possibilities of the coast, as many additional sponging areas have been discovered since then."

Within the past few years some of the larger vessels have made trips to the coast of Yucatan, but the sponges taken there were inferior to those of the Florida coast, and consequently the fishery in that region has been abandoned, for the present, at least.

Formerly sponges were found in abundance in shallow water on any of the grounds now resorted to, those nearest Key West being, of course, the ones that were chiefly visited in the early days of the industry. At that time and, indeed, until a comparatively recent date, the fishery was carried on near the land in depths not exceeding 18 feet, and often good results were obtained in 5 or 6 feet of water. But the eager pursuit of the sponge by many hundreds of men has eventually caused its depletion in the shallow waters, where it could most easily be procured, and, as a consequence, it must now be sought farther out, in greater depths, even as deep as 40 feet or upwards, where, sometimes, the distance from the coast is so great that the low land cannot be seen.

Sponges are abundant in many of the deeper localities, but fishing there is attended with many difficulties and cannot be carried on except when the water is clear and the weather fine. Consequently, when the conditions are unfavorable for working in the greater depths, the fishermen resort to the reefs where the water is shallow, and though their captures may be comparatively small, they thus manage to utilize time that otherwise would be of no value to them. It is obvious that the increased area of fishing ground, which is obtained by this venturing into waters so much deeper than those formerly worked, is of vital consequence to the industry in question, since the operations of the fishermen are extended over a much wider region, and while one locality is being depleted of its sponges another may have an opportunity to renew its crop. It is the opinion of sponge dealers and fishermen with whom I conversed at Key West that if the sponges should be left unmolested for a year they would be quite as abundant as they ever were, even on many of the old grounds where the water is shallow. The fishermen say that on some of the reefs, where the depth does not exceed from 6 to 15 feet, sponges are numerous, but of small size, owing, of course, to the fact that before they have time to grow large they are captured.

In this connection it may be well to mention that this constant harrowing of the grounds, while it certainly has some undesirable features, is nevertheless believed by competent judges to be advantageous in improving the quality of the products obtained. It is asserted that a bar which may be stripped of large sponges will have a succeeding crop much finer in quality than those first taken. No special reason is assigned for this, but it is altogether probable that it may easily be explained by those familiar with the localities and the life habits of sponges.

On some occasions, and particularly in 1878 and 1880, it is claimed that the yield of the sponge grounds has been seriously affected by the "poisoned water" which appeared off the Florida coast, and proved so fatally destructive to all forms of marine life, sponges included. This destruction of sponges was referred to by Mr. Ernest Ingersoll in a letter to Professor Baird, in 1881, "On the fish mortality in the Gulf of Mexico." He writes: "In regard to some of the manifestations of this deadly influence in the sea during 1878, Mr. John Brady, jr., an intelligent captain, told me that the time of year was January, and that the 'poisoned water,' to which universal belief credits the death of fishes, could easily be distinguished from the clear blue of the pure surrounding element. This discolored water appeared in long patches or 'streaks,' sometimes 100 yards wide, drifting lengthwise with the flow of the tide. The earliest indication of it was the floating up of vast quantities of dead sponges, chiefly 'loggerheads.' All those seen by Mr. Brady were less than 40 miles north of Key West, in what is known as 'The Bay,' nor has anything of the sort been seen at any time outside (*i. e.*, southward or eastward) of the Florida Reefs; but it was soon discovered that all of the hitherto profitable sponging grounds lying off the coast as far north nearly as Cedar Keys, and particularly off Anclotes had been ruined. These grounds are only now beginning to show signs of reproductiveness in sponges. * * * In the case of the sponges, only a few of other species than the loggerhead would be seen floating; but when they were hooked into, all were found dead, though still clinging to the bottom. When a sponge dies naturally it gradually becomes white at its base, through the loss of its sarcodal matter, but all these were observed to have turned black. The abandonment of these sponging grounds from the reefs to Cedar Keys, during the three or four years following this attack, entails a loss which it is hard to estimate, because partially compensated in the increased price of the article in the market due to its consequent scarcity, and because at all times the product there is an uncertain quantity; but I hazard the opinion that $100,000 would not repair the damage to this business interest alone. Had it not been for the fortunate discovery just at that time of the sponge-tracts off Rock Island, northward of the Suwanee River, almost a famine in this article would have ensued."*

Mr. Silas Stearns, who has had exceptional opportunities for becoming familiar with the subject which Mr. Ingersoll refers to, is authority for stating that the sponge fishery about Anclote Keys was not to any appreciable extent injuriously affected by the poisonous water. He was there in 1878, 1879, and 1880; part of the time employed as an expert by the United States Government to investigate the fisheries of Western Florida and collect statistics of them for the Tenth Census. On one occasion he took a boat-load of sponges himself near Anclote, in 2 fathoms of water, a feat that pretty effectually settled the question as to whether the sponges were all destroyed in this region.

In regard to the discovery of the sponge grounds off Rock Island, which Mr. Ingersoll says occurred "just at that time," Mr. Stearns tells me that this region had been known long before the date alluded to. He also states that there is little or no probability of any new discoveries being made of this kind, since almost every foot of ground that might by any possibility bear sponges has been carefully worked over. He says that he has himself dragged a boat-dredge nearly the whole length of the coast south of Pensacola, and no results were obtained except on grounds well known.

Sponge culture has of late attracted the attention of those engaged in the Key West fisheries, since the almost exhausted state of many of the old grounds from over fishing and natural causes renders it desirable to aid nature, if possible, in increasing the supply of sponges. The success which has attended attempts at raising sponges from clippings in the Mediterranean gave reason to hope for equally good results here; and the experiments already made seem to indicate that the culture of sponges may be made remunerative in the waters of Florida. The process of sponge culture, as detailed to us by parties at Key West, is comparatively simple. A sponge is hooked up from the bottom and brought to the surface of the water, but is never lifted into the air. It is then clipped into small pieces and fastened on a wire or stick, which is afterwards fixed to the bottom as firmly as practicable. For the first four months the "clippings" do not show any increase in size (it taking them this length of time to recover from the injury done by cutting), but later they develop with considerable rapidity.

While it is believed that unquestionable advantages may be gained by introducing sponge culture in Florida, it is nevertheless a subject

* Proceedings of United States National Museum, Vol. 4, 1881, page 75.

that seemingly requires the most careful consideration on the part of the State government to enact such laws and regulations as may tend to its success without interfering with the general prosperity and freedom of those who are more directly engaged in obtaining this product of the seas. At the present time the fishermen are bitterly opposed to the introduction of any methods for cultivating sponges in the manner above alluded to. This opposition arises from the fact that they, being chiefly poor men, naturally anticipate that in the event of sponge culture being adopted on a large scale, the entire control of the industry will pass into the hands of capitalists, who, should they succeed in securing legal control of large areas of ground, would have it in their power to prevent the fishermen from visiting localities which they now consider as their own—an inherited and natural right, of which no one should be empowered to dispossess them. They also fear that, with extraordinary privileges given to capital, they would have to encounter a competition that would eventually drive them all out of the business or compel them to submit to any terms that their wealthy competitors may dictate. The feeling is so strongly antagonistic to this that some of the fishermen do not hesitate to express their determination of proceeding to extreme measures for preventing its accomplishment. At the same time they would advocate the policy of sponge culture, and believe it might prove a blessing to them, providing laws are framed to limit the area of ground which any single individual could hold, and also to make it impossible to dispose of such a tract to any other person, the property reverting to the State whenever the original owner or planter ceased to use it. This, it is believed, would effectually prevent a consolidation of the areas cultivated under one head, or place them in the hands of a few individuals who might control the trade. Whether or not these crude suggestions can be formulated into such shape as to make them of practical use is one of the problems that should engage the attention of those who are charged with the responsible duty of legislating on this subject, should it ever be deemed wise to make sponge culture the object of special enactment.

2. VESSELS AND BOATS.

The largest vessels of the sponge fleet, those upwards of 35 tons register, have, in most cases, been originally designed for other trades, but it has often been possible to purchase them much cheaper than it would cost to build a vessel, and therefore schooners not intended for the business have been put to work in it. The smaller craft, however, particularly those less than 30 tons, have, with few exceptions, been built for the particular industry in which they are employed, and which requires special features in a vessel, both in the form and minor arrangements. With comparatively few exceptions, the vessels upwards of 8 to 10 tons are schooner rigged. They carry a single topmast, and no jib-boom, unless in some instances an adjustable jib-boom is rigged out and the sail set "flying" without a stay. They are beamy, shallow, center-board craft, with a very light draught, a quality that is essentially necessary in a vessel which must knock about the shoal water on the reefs, where sponges occur, or frequent shallow, barred harbors like those of the Florida coast in the region that they visit. They are sharp forward, have a projecting cut-water or "long head," as it is called; a moderately raking, curved stem; considerable rise to the floor; rather quick turn to the bilge; a long, lean run; slightly overhanging counter and broad square stern, the latter being much thinner at the sides than in the center, although this feature is scarcely prominent enough to characterize it as being of the pattern commonly called a V-shaped stern. They are flush decked, and have no bulwark or waist, but instead a so-called "log gunwale," varying from 10 to 18 inches in height, which runs along the sides from the knight heads to taffrail. Chain cables are used, and, as a rule, short-shanked anchors, while the vessels are generally provided with some form of patent windlass. The larger craft usually carry a galley on deck, a small box-like affair about 5 or 6 feet square, in which the cooking is done. The larger schooners have a forecastle under deck and a trunk cabin, the latter generally of tolerably large dimensions. I noticed, however, that the cabins of the vessels I was on board of were peculiar in having no berth boards, as may be seen on northern-built craft. This feature appears to be somewhat general, too, on the vessels of this region, for the same arrangement was found on some of the smacks built at Key West, though other smacks had cabins similar to the same class of schooners built in New England. Instead of berths there are extraordinarily wide lockers, extending out from the vessel's side some 5 to 7 feet, according to the size of the cabin. A wide bed can be made up on these, on which several persons may lie, an arrangement which utilizes the space to the best possible advantage. But while this method of sleeping may be found practicable on a sponger in a smooth sea, it would scarcely meet with favor on a vessel employed in any of the offshore fisheries, for the simple reason that in rough water the occupants of one side of the cabin might at any time find themselves suddenly wakened, if nothing worse happened, by being pitched to the other side, whenever the vessel took a lurch. Iron ballast is generally used, and as a cargo of sponges has little weight enough ballast is carried to bring the vessels down to their load line. The quantity, of course, varies with the size of the craft, but, being so wide and shallow, they require much less ballast than vessels of a heavier draught. They are seldom coppered, but, to protect them from attacks of the toredo or boring worm, their bottoms are kept well coated with metallic paint.

The vessels built at Key West are said to be much more durable than those obtained from other sources. Their frame is "maderia," a sort of red wood indigenous to Florida, and which is reputed to be exceedingly durable; the planking is yellow pine; while the fastening is chiefly copper, at least under water, and galvanized iron, the latter being used for the upper works. The spars are made of hard pine, spruce, or white pine, most commonly of the former.

The following details of the clipper schooner Lillie, of Key West, one reputed to be a very swift sailer, will give a fair idea of the characteristic features of the best class of sponge vessels. She is a wide, center-board, two-masted schooner, with medium sheer, flush deck, "log gunwale," long cut-water; sharp bow, slightly concave water lines forward; moderate rise to the floor; long, finely-shaped run; wide, square stern; and moderate rake to stem and stern post. Her spars are made of hard pine, and she is ballasted with iron.

The following are her principal dimensions: Tonnage, 43 tons; length, over all, 69 feet; on keel, 60 feet; beam, 19 feet; depth of hold, 6 feet; depth of keel, 1 foot; height of log gunwale, 18 inches; draught, with center-board up, 5 feet; the center-board is 16 feet long and 7 feet deep. Spars: Mainmast, 61 feet, foremast, 60 feet; bowsprit, outside, 19 feet; main topmast, 24 feet; main boom, 45 feet; distance, center to center of masts, 22 feet. A vessel of this size and class costs, if built at Key West, about $9,000 to $9,500. We were told by builders that the usual price for constructing the hull and spars is $120 per register ton. The owner of a small schooner, of about 10 tons register, said that he paid at the rate of $125 per register ton for building his boat, and he also furnished all the wood for the frame. She cost him $1,900.

The smaller class of sponge vessels are generally wider in proportion than those like the Lillie. For instance, the schooner General Hancock, with a length of 44 feet, over all, and 40 feet keel, is 15 feet wide—so I was told by the builder—and her masts are, respectively, 42 and 43 feet in length.

The following are the details of the sloop-boat Terror, of Key West, which is employed in the sponge fishery, and is a fair representative of the smaller class of craft engaged in this industry.* In general appearance the Terror resembles the small sloop yachts which are so common along the Atlantic coast of the United States, particularly at New York and northwards.† She is a wide, shallow, center-board, carvel-built boat, with a moderate sheer; a long sharp bow, the greatest beam being about 2 feet aft of amidships; a rising floor; long run (with a skag); and raking, square stern, which rises considerably at the sides and is somewhat narrower than the midship section. She is decked, with the exception of a steersman's cockpit aft of the large trunk cabin. The latter is oval in shape, and occupies the greater part of the deck

*Mr. Lawrence Higgs, of Key West, the builder of the Terror, has presented the working (or half) model of the boat to the National Museum. I am also indebted to him for details of construction, &c.

†In this connection it may be remarked that, in point of lines, rig, or speed, many of these sponge boats would bear favorable comparison with the finest yachts of their size on the coast.

amidships, being 11 feet long by 7 feet wide; it is used for the double purpose of sleeping and stowing sponges and apparatus. The mast stands well forward, being only a little over 4 feet aft of the stem, and the boat may be easily handled under her mainsail alone. A large boom-and-gaff mainsail and a jib are carried, but no light sails. The wood used in the construction of the Terror is the same as that of which the larger vessels are built. Copper is used for fastening the outside plank, and galvanized and black iron for the frame and deck.

The following are the principal dimensions of the Terror: Tonnage, 6 tons; length, over all, 24 feet; keel, 21 feet; beam, 10 feet; width of stern, 6 feet 8 inches; depth (molded, gunwale to garboard), 3 feet; depth of keel, 4 inches. Spars: Mast, 30 feet; topmast, 12 feet; bowsprit, outside, 8 feet; boom, 26 feet; gaff, 9 feet.

A boat of this description carries from 2 to 5 men, while the larger vessels, like the Lillie, have 13 men on board.

Mr. Rathbun says that "the crews number from 5 to 15 men each," but I was assured by several parties that at present the number of men on a vessel rarely, if ever, exceeds 13, and it is also stated that many of the boats are manned by only 2 or 3 persons.

For gathering the sponges small open boats of the Whitehall type are used, these being locally called dinghies. Many of these boats are built by the fishermen themselves, and are light, strong, and durable. We were told, however, that a considerable number of the boats used in the business are second-hand craft, brought from northern ports. They can be bought cheap, and, with such repairs as the fishermen can make, they serve a very good purpose for a comparatively limited time.

The typical dinghy is a carvel-built, keel boat, with a sharp bow —the greatest beam being about amidships—straight stem above water, curved below; a round easy bilge; good run (with skag); and heart-shaped, vertical, square stern. It varies from 12 to 15 feet in length, and is generally about one-third as wide as long, while the depth ranges from 16 to 18 inches. It has considerable sheer, and comparatively low free board, the object being to have a boat sit rather low in the water amidships in order that the "hooker"—the man who watches for and hooks the sponges from the bottom—may the more easily use his water-glass without bending too much over the boat's side. Each boat is provided with a stern and bow seat, and three thwarts, the middle one, on which the sponge fisher always sits, being adjustable. Two men go in a boat, as a rule, and while one watches for and hooks the sponges from the bottom the other slowly sculls the dinghy over the ground. A few of the boats have scull-holes cut in their sterns, but the majority have a piece of hard wood board about a foot long and half as wide, with a notch for the oar at the upper end, inserted between two guiding strips, which are firmly secured in a vertical position to the inside of the stern. This contrivance greatly facilitates the operation of sculling, and enables the man at the oar to stand more erect and at ease than he otherwise could. It is placed on one side of the stern, and, being adjustable, may be easily removed when not needed.

Mulberry, oak, and horse-flesh are used for frames, and juniper and yellow pine for plank, while galvanized iron nails are most commonly used for fastening.

The Key West dinghies are "built by the eye," no model or lines being used. The builder having decided on how large he is going to make his boat, gets out his keel, stem, stern post, and stern board, fastens them together, and sets them up. He then puts up the two midship frames, which are secured to the keel, after which ribbands are run from the stem to the stern, outside the frames, to give the boat the proper shape. This having been done the other frames are made to fit the ribbands, and after they are all up the planking begins.

A dinghy which I saw a negro building at Key West was constructed in this manner. The following are the details of its construction, &c.:

The keel, stern board, risings, thwarts, seats, and plank were hard or yellow pine, the stem and timbers horse-flesh, and the keelson piece and ribbands cypress "footlings." She had eleven frames, seven strakes of plank on a side, two fixed and one adjustable thwart, a wide stern seat, two rowlocks on a side, two narrow ribbands running fore and aft in the bilge and nailed to the inside of the timbers. There was a beaded gunwale outside that was 1¼ inches wide, and a ribband inside the timber heads that was 1½ inches wide, and like the gunwale one-half inch thick. There was no covering over the timber heads as on most northern-built boats. Her greatest beam was a little aft of amidships. In other respects the general description previously given will apply to this boat, of which the following are the dimensions: Length, over all, 13 feet 6 inches; keel, 13 feet; beam, 4 feet 6 inches; width of stern, 3 feet 3 inches; depth, 17 inches; depth of keel (outside of garboard), 1¾ inches; depth of stern (above skag), 16 inches; width of thwarts, 1 foot; width (fore and aft) of stern seat, 15 inches.

The same style of boats are used to some extent by the market fishermen for going to and from their little sloops, though these are generally somewhat smaller than those which have been described.

It may be added that the number of dinghies carried by a vessel employed in the sponge fishery depends on how large a crew she may have. Generally, the vessels take one boat for every two men, exclusive of the cook, who, while the others are out fishing, takes care of the vessel, and sails her about wherever it seems necessary to go. The small craft, which carry 2 or 3 men each, and which often prosecute their work about the shallow reefs, sometimes take a dinghy for each man of the crew, and in fine weather the larger boat is anchored and the men leave her alone and go off singly to seek sponges.

3. APPARATUS.

The apparatus used in the sponge fishery is simple in its nature, and consists of only a limited number of articles.

The sponge-hook is a three-pronged iron claw, with a socket at its upper end, into which is fastened a wooden handle. The length of the latter is various, and is adapted to the depth of water in which sponges are sought. Formerly it was seldom that any one used a sponge-hook pole longer than 18 feet, but now, when fishing is often pursued in 35 to upwards of 40 feet of water, the poles must be lengthened out to correspond.

The water glass is constructed by simply inserting a pane of glass into the bottom of a box or common bucket, and making it water-tight. By thrusting the bottom of this contrivance into the water and looking through the glass a sponge hunter is able to clearly distinguish objects on the bottom of the sea, even when the ocean is agitated by a fresh breeze that would otherwise make it impossible to see anything. In the early days of the fishery, when sponges were sought in shallower depths, it was customary to throw oil on the water to smoothen it, when its surface was rippled by a breeze. But, while this method answered the purpose very well, under the conditions then existing, it was found inadequate when fishing in deeper water was attempted. As a result, the water glass was introduced about 1870 and has been used ever since.

The "bruiser" is a short, stout club, which is used for pounding sponges.

4. THE METHODS OF FISHING.

When the vessel has reached the locality where operations are to begin, the boats are got into the water and two men go in each, as has already been stated. The dinghies scatter about over the ground, or work close to each other, as circumstances may dictate, the movements of the boats being governed, of course, by the abundance in which sponges are found.

One man sculls the dinghy along slowly (using a single oar over the stern) while the other, who is termed the "hooker," sits on the midship thwart, or kneels with his breast across the gunwale,* intently watching the bottom through the water-glass which he holds in his left hand, while the sponge-hook lays ready within his grasp, extended across the boat. Trained by long experience, his keen eyes quickly observe every object on the bottom, and he instantly detects the presence of a sponge when one comes within the field of his vision. No sooner does he discover the prize for which he is seeking than he signals, by a motion of his hand, for his companion to stop the boat, which is deftly done by turning her around with the oar in such a way that her center still remains over the sponge. In an instant the long-handled hook is thrust into the water, and down it goes to the bottom, many

*A large sponge is fastened on the fisherman's breast to serve as a cushion, otherwise he could not endure to lie hour after hour across a boat's gunwale, and, even with this protection, serious consequences sometimes result from persons continuing to follow a business in which they must assume such unnatural positions.

feet below, where it unerringly fastens on to the sponge, which is quickly torn from its ocean bed and brought to the surface, when the man at the oar reaches over, detaches it from the hook and throws it in the boat's bottom.

The dexterity with which one of these fishermen will manage the long unwieldly sponge-hook, and grapple the objects which he seeks so many feet below the water's surface is said to be very remarkable. Fishing goes on all day, if the weather is suitable, with the exception of the time spent at dinner. About noon and at evening the boats return to the vessel, when the men eat their meals and spread their catches on the deck, where the sponges are put to die and to allow them to drain off the slime which runs freely from them.

While the crew is engaged in fishing the cook takes charge of the vessel, which is kept under sail, and allowed to jog back and forth over the ground. He also prepares the meals, and when the proper time arrives steers the vessel alongside of the boats to pick them up.

The time of closing the week's work is varied somewhat by the condition of the weather. If bad weather prevails it may close any day, since the vessels cannot work; but, ordinarily, if the weather is fine, the vessels stand inshore on Saturday night, and anchor in localities where they each have one or more so-called "crawls"—inclosures for soaking and cleaning their catch, each 8 or 10 feet square, and situated in 2 or 3 feet of water. The week's catch is landed and deposited in the crawls to soak; the time of doing this being Monday, if the vessel comes in Saturday night; but if she arrives on Friday night then the catch is landed on Saturday. The landing having been made, the previous week's product is subjected to the cleaning process, the sponges being beaten with the "bruiser" and squeezed by hand to remove any dirt, sand, or other extraneous substances that they may contain. They are then strung on rope yarns and hung about the vessel's rigging to dry. When sufficiently dried they are landed again, and spread on the shore, and a man is detailed whose duty it is to watch all the sponges under his charge, both in the crawls and on the beach; this precaution being necessary to prevent the depredations of thieves, who, if the property was left unprotected, might swoop down on a station during the absence of the vessels, and carry off the catch of a whole trip. When the vessel is ready to return to Key West all her sponges are taken on board and stowed in the hold.

The method of fishing adopted by many of the men who go on the small sail boats, those from 18 feet long to 5 or 6 tons, differs sometimes from that which has been described. The crews on these boats are always few in number, and, of course, if one man should stay on board to look out for the vessel it would make a material difference in the working power of the crew. The boats are, therefore, anchored, and all of the crew go out to fish. On special occasions, as has been previously mentioned, when the work is being done in shallow water, and the sea is calm, these boat fishermen go singly in the dinghes, and thus increase their chances for securing a good catch. This is called "off-handed sponging."

The larger vessels make trips ranging from six to eight weeks, and, in some instances, it was said that they had been absent from Key West as long as three months. The smaller craft do not generally stay out on their cruises longer than from two to four weeks.

5. DISPOSITION OF THE CATCH.

When the vessels reach port the sponges are discharged on a wharf and sorted into piles according to their several grades. This having been done the cargo is sold at auction—at least it is called an auction at Key West, though the conditions of the sale differ materially from those which are generally meant by the term auction, and are substantially as follows: The sponges having been arranged in proper order, the dealers assemble on the wharf during the forenoon to examine the several lots of which the cargo is composed. No person but one known to be an agent of a house engaged in the business is allowed to make a bid, and even these are not permitted to make more than one proposal for the sponges. At 3 p. m. of the same day on which the examination takes place, the buyers again assemble and submit written bids, the sponges, of course, being sold to him who makes the highest offer. The sponges are not weighed nor counted, but the different grades are bought in a lump, the buyers, from long experience, being able to estimate pretty closely the amount in any pile of goods.

After the sale, the sponges are loaded on carts and hauled to the warehouses, which are generally large and airy, a good circulation of air being secured through numerous large open windows on the sides of the buildings. These establishments have a large number of bins or pens, built along the sides, and into these the sponges are thrown after they have been cleaned, bleached, and culled into the various grades known to the trade. To prepare them for shipment they are thoroughly washed and spread in a large yard to dry or bleach.* After the sponges are well dried, the sand is pounded out of them, they are trimmed, culled, and packed in bales measuring about 18 by 18 by 30 inches. Screws worked by hand or hydraulic power are used to compress the sponges, the former method being adopted in the establishment we visited. The sponges are shipped to New York, where are several houses engaged in the trade, and which control the entire Florida catch.

* Rathbun tells us that "the process of bleaching or liming sponges has been extensively in vogue at Key West, but is now meeting with much discouragement from the trade, for while it renders the sponge much lighter in color, it also partly destroys its fiber and makes it less tough and durable." I noticed, however, that bleaching in this manner is still practiced to a considerable extent, though not, perhaps, as much as formerly.

6. FINANCIAL PROFITS OF THE SPONGE FISHERY.

The average annual gross stock of a first-class vessel of 30 to 40 tons, with a crew of 13 men, is variously estimated at from $5,000 to $6,000, while those most familiar with the business say that a stock exceeding $9,000 is seldom made.

The "lay" is very much like that obtaining most generally on New England fishing vessels, particularly those of Gloucester, the vessel furnishing food and equipment, and the crew receiving one-half of the proceeds of the sales, which is divided between them, the cook sharing like the others. A man who earns $300 to $400 a year is considered fortunate, while the average is estimated to be not exceeding $250.

B.—THE SMACK FISHERY.

The smack fishery of Key West has always, we were told, depended principally, if not wholly, on Havana for a market. Therefore, anything which affects the fish trade at that port seriously influences the prosperity of this particular fishery. Until within a few years past the duties levied on American-caught fish in Cuba were comparatively light, and the smack fishermen at Key West were prosperous. But when the present duty was put on it was almost prohibitory, and practically destroyed this branch of the fishery, or at the best caused it to be pursued under the most discouraging conditions. All who could do so without too great a sacrifice, sold their vessels, most of them going to Spanish parties at Havana. Those which remain, some ten sail, ranging from 29 to 46 tons, it is said are run at a loss, and we were assured that they can be bought at a very low figure. Several of them lay in Key West, temporarily unemployed, one was engaged in carrying kingfish (caught by boats) to Havana, and another had been employed in the fruit trade. Some of these were remarkably fine vessels of their class, well modeled and rigged, and constructed of the most durable material. But they are poorly adapted for anything besides what they were built for; therefore, when fishing is unprofitable, it is as difficult to sell them as to find paying employment.

THE FISHING GROUNDS.

The fishing grounds most generally resorted to by the smack fishermen are off the west coast of Florida, in from 2 to about 7 fathoms of water (and rarely so deep as 15 fathoms), the region lying between Charlotte Harbor and Anclote Keys, being, perhaps, the most favorite locality. Here, on the shore soundings, they fish for red snappers, groupers, and other species which are in favor in the Cuban markets. Prof. Felipe Poey gives the following list of the food-fishes carried from Key West to the markets of Havana, which, in this connection, seems of especial interest. Writing to Professor Jordan, from Havana, under date of March 9, 1882, he says: "I have received from an old fisherman (now dealing in fishes in the Havana market) the following list of fishes which are received in Havana from Key West, either living or preserved in ice:

"1. CHERNA = *Epinephelus morio* (C. & V.)

"2. PARGO GAUCHINANGO = *Lutjanus campechianus* Poey.

"3. PEZ PERRO = *Lachnolæmus suillus* C. & V.

"4. AGUAJI. The name of Aguaji is given to two species, both of which grow to a large size, viz, *Trisotropis brunneus* Poey and *Trisotropis aguaji* Poey. The species here meant I believe to be the former.

"5. JALLAO = *Hæmulon album* C. & V.

"6. BAJONADO = *Calamus bajonado* (Bloch).

"7. RABIRRUBA = *Ocyurus chrysurus* (Bloch).

"8. BIAJAIBA = *Lutjanus synagris* L. (*uninotatus* C. & V.)

"9. CABALLEROTE = *Lutjanus cabellerote* Poey. (Vide Poey, Enumeratio, in Anal. Soc. Esp. de Hist. Nat., IV, 100.)

"10. CABRILLA. The name of *Cabra* (*Cabra mora*) is given to *Epinephelus punctatus* Bloch (syn. *maculatus*, *atlanticus*, *nigriculus*, *pixanga*, *impetiginosus* (vide Poey Anal. Soc. Esp. Hist. Nat., IV, 91). There is also a *Cabrilla* (diminutive of *Cabra*), *Epinephelus lunulatus* (syn. *catus* Val.). I do not know which of these two may be meant.

"11. SIERRA = *Cybium caballa* C. & V.

"12. SARGO. There are several Sargos. I believe that the one here intended is *Sargus caribæus* Poey. Besides these I have myself observed the following:

"13. *Promicrops guasa* Poey.

"14. *Trisotropis falcatus* Poey.

"15. *Trisotropis petrosus* Poey."*

The object of fishing in such shallow water is to catch the so-called "hardy" groupers and other fishes that will live in a well very much better than if they were caught in deeper water. It is a fact fully established, I believe, that fish taken from considerable depths and brought to the surface, where the pressure is less, and other conditions somewhat different, will die much quicker in a smack's well than those caught in shallower water. At the best, great care must be exercised to prevent the fish from dying, since, if the vessel lays perfectly still where there is no tide way, the circulation of water in the well is often practically stopped, and consequently the fish are exposed to the danger of being suffocated. This is more liable to happen when flat fish, like halibut, for instance, are in the well, since these lay on the bottom of the vessel and cover up the holes through which the water enters. Of course, in a sea way, when the vessel is in motion, ample circulation is obtained. To secure this in calm weather, the New England smack fishermen, particularly those from Gloucester, when engaged in the halibut fishery forty years ago, generally "bailed out the well," as it was called; that is, the crew kept busy dipping water from the well in buck-

* Translation of a portion of a letter from Professor Poey, by Prof. D. S. Jordan, Vol. 2, Bulletin of the United States Fish Commission, page 118.

ets, and, of course, water from the sea ran into the well through the holes in the bottom, and thus a good circulation was secured. The English fishermen prevent halibut from interfering with the circulation by suspending them by their tails. The Key West fishermen usually adopt another method, and one that is feasible when a vessel is in smoooth water. Mr. Stearns, who is familiar with the fishery, tells me that each vessel has a live car on board, and when there is danger of the fish being injured by a lack of circulation in the well, they are put in the live car, and this is towed about until the desired results are obtained. The Key West fishermen also "bail out" the wells of their smacks.

2 VESSELS.

The smacks first used in the Key West fisheries were mostly, if not wholly, from ports on Long Island Sound, of which the New London vessels (sloops and schooners) may be taken as a type. These smacks, so far as their model, rig, arrangement of the well, and some other minor details are concerned, were admirably well adapted for work in this region, and as a consequence a considerable number of the Northern-built vessels were purchased by Key West parties. It was found, however, that the material used in the construction of the Northern vessels was not so durable as the native woods of Florida, and as the business developed and called for an increase in the fleet the demand led to the building of smacks at Key West. These, with few exceptions, are schooners, and they are modeled and rigged precisely like the smacks from New London, which they also resemble in the minor details of the arrangement of the well, ice pens, and cabin accommodations.* In a few cases, as has already been mentioned in discussing the sponge vessels, the cabins are built without berth-boards, a style that obtains very generally on other types of Key West fishing craft.

The following description of the schooner-smack Emma L. Lowe, one of the largest and finest of the Key West fleet, built in 1875, will give a fair idea of the leading characteristics of this class of vessels.† She is a carvel built, keel craft, with a good sheer, broad beam, and a reasonable amount of depth. She has a sharp bow, flaring somewhat above water; a recurved, slightly raking stem; long, projecting cutwater; high rising floor (the floor timbers of the midship section being nearly straight from the garboard to the turn of the bilge); rather quick turn to the bilge; a long, lean, concaved run; slightly overhanging counters; and a deep, square stern, the latter being somewhat thinner at the sides than in the center. The stern-post has only a moderate rake, and the vessel

* There is at present only one sloop smack owned at Key West, we were told, and she was built in New England.

† The builder's model of this smack has been presented to the National Museum, at Washington, by Mr. William J. Albury, who built her, and to whom I am indebted for many of the details of her construction, as well as for particulars of the sponge-schooner Lillie.

has less drag than the average fishing schooner of New England. The center of buoyancy is about midships, and the lines are well calculated to produce a fair sailing vessel, as well as one that would be eminently seaworthy in heavy weather; qualities that are in the highest degree desirable in a fishing schooner, and which this smack is reputed to possess in a high degree. She has a flush deck, a roughly-finished underdeck forecastle, where the cooking is done and part of the crew sleep; a trunk-cabin aft, the latter being large in proportion to the size of the vessel, while the finish is precisely the same as the prevailing style on the New London smacks, or, what is practically the same thing, those of the Gloucester schooners. The well, for the preservation of live fish, occupies the midship section of the vessel; it has heavy strong bulkheads at either end, and another in the middle, the former rising to within about a foot of the load-water line. On top of these bulkheads is laid the well deck, made of thick plank, the outside one of which generally goes through, flush with the outer planking, this style of construction being technically known as building the wells with "primings out." The entrance to the well is through the "curb" or "funnel," an aperture 3 or 4 feet long by 2 or 3 feet wide at the deck, but much longer below, and which is inclosed in strong planks extending from the well deck to the main deck, and securely fastened. There is no ceiling in the well, and, as a rule, only half the number of frames that are put in the same length in other sections of the vessel, the bulkheads supplying the place of timbers for obtaining the necessary strength and rigidity. The outside planking are perforated with the requisite number of holes to secure a proper circulation of water for keeping alive the fish that may be put in the well. The foregoing description of a smack's well applies generally to all vessels of this class and not to any one in particular.

The Lowe is rigged as a two-masted schooner, with a long fixed bowsprit and a single topmast. She carries no flying-jibboon. Her masts are each supported by two shrouds on a side. She sets five sails, namely, jib, foresail, mainsail, main-staysail, and gaff-topsail. The arrangement of the sails, as well as their cut, is the same as that on the New England fishing schooners of the same class, and is so generally understood that a detailed description seems unnecessary. The ballast is chiefly iron. The following material was used in the construction: Timbers of maderia; beams, outside planking, ceiling, and spars of yellow or hard pine; deck of white pine; fastenings, chiefly copper. She is 46.46 tons register, and cost to build and fit for sea $10,000. The following are the principal dimensions: Length, over all, 66 feet; on keel, 58 feet; extreme beam, 20 feet; width of stern, 15 feet; depth of hold, 8 feet; depth of keel, 15 inches; draught, aft, 8 feet, forward, 6 feet; height of bulwarks, 20 inches; length of trunk-cabin, 12 feet; width of same, forward end, 10 feet, after end, 9 feet. Spars: Bowsprit, outside, 19 feet; foremast, 60 feet; mainmast, 61 feet; main topmast, 25 feet; main boom, 42 feet.

3. METHODS OF FISHING.

Working as they do in shallow water, fishing can be carried on by the smacks only in fine weather. When the wind blows hard enough to get up a choppy sea, the vessels run into harbor or take shelter under a lee. As a result, much time is lost, and it often takes them five or six weeks to catch a fare of 10,000 pounds of fish. This, Mr. Stearns tells me, is about a maximum fare. The vessels generally fish at a drift, the men using hand-lines over the smack's weather rail. The gear differs somewhat from that used by the Pensacola red-snapper fishermen. A sinker is made fast to the end of the line, and at some distance above this are the snoods, with hooks at their ends, bent to the line, one over the other, like hooks on a trawl. In fishing, the lead or sinker is allowed to rest on the bottom, while the hooks trail out, one over the other, at a little distance above the ground.

Salt mullet are used for bait. Each smack generally has a small seine, and the crew catch their bait while in harbor and salt what they need for use.

The fish are crimped—pierced with a sharp-pointed cylindrical tube behind the pectoral fin, to let the air out of the swim bladder—as soon as they are caught, and they are then thrown into the well. As a rule, the well must be "swept" each morning, and the dead fish removed, the latter being salted or preserved in ice.

C.—THE MARKET FISHERY.

The market fishery at Key West is an important industry of the port, employing some 40 or 50 sail boats, half of this number being large and able crafts, which not only supply the city of Key West with fish for local consumption, but take quantities that are shipped to Cuban markets. Some of the boats confine their operations chiefly to the grounds situated at or near Key West, going out in the morning and returning to the market wharf in the afternoon to sell their catch, or to make any necessary arrangement for the next day's fishing.

1. THE FISHING GROUNDS.

There are two distinct fisheries carried on by the market boats. One of these has the kingfish (several species) for its object, while the other is for the capture of grunts, yellow-tails, and many other varieties of ground-feeding species. The most favorite ground for the kingfish is in the vicinity of Sombrero Key, but more particularly, we were told, on the south side of the key, over a stretch of 10 to 15 miles in the direction of Key West, and generally outside of the range of the coast line, over the bottom that slopes toward the Gulf Stream, and sometimes even in the inside waters of the latter. In this region kingfish are usually very abundant from November to April, therefore the locality has become somewhat celebrated as a valuable fishing ground, and is resorted to by the fishermen in preference to the waters nearer Key West, where the same species occur, but are not so plentiful.

The smaller species of food-fishes, with which the Key West market is well supplied, occur in greater or less numbers in the immediate vicinity of the harbor, about the adjacent keys, and on numerous coral patches known to the fishermen and which abound in the channel between the islands, within a radius of 10 or 12 miles, beyond which distance they are rarely sought, though occasionally boats go farther off. Indeed, so far as our observation extended, the boats seldom go, in winter, more than 2 or 3 miles from the market wharf, and we often saw them fishing within a short distance of a little mangrove key that is, perhaps, not more than a mile and a half from the market, and in many cases they were certainly not more than half that distance off. Many varieties of these fishes feed about patches of bottom in the channels, on which there is a coral growth, and we often observed them in great numbers immediately beneath the roots of the mangroves, on a little islet near the harbor, that was of coral formation, and about some parts of which the water was quite deep. Favored here with unlimited means of escape from their enemies by darting about among the mangrove roots, or hiding beneath the projecting points of the coral shore, it seemed to be a spot well suited to the habits of such species as could here find sufficient food either on the bottom or among the schools of tiny fishes that inhabited the same locality. The sudden approach of a boat invariably caused a general stampede among the larger species that have their haunts about the keys, and if one depended on first impressions he would invariably decide that the place was destitute of fish life, except, of course, he might see some of the little minnows scurrying away among the mangroves. But hold your boat perfectly still, and in a short time you will be both surprised and pleased by the numbers and varieties of fish that show themselves in the clear translucent waters beneath you, coming from you know not where, and vanishing as mysteriously at the slightest noise or unusual movement.

But this digression has been made more for the purpose of giving some idea of the habits of the fish than to define the fishing grounds, for the boats seldom go alongside the shores, at least not nearer than to anchor just outside the shallow reefs that generally surround the islets, where the depth drops suddenly from a few feet to several fathoms, and where is often a favorite locality for many kinds of food-fish.

There are some red-snapper grounds that are resorted to occasionally by the Key West fishermen. But these banks are not to be compared in importance to those off the west coast of Florida, if we may judge by the account given by those who have visited the former. One of these grounds is near the entrance of the ship channel to Key West Harbor, another is 2 miles east of American Shoal, one about 1 mile southeast of Pelican Shoal, and a fourth 2 miles east of Sombrero Key. These spots are small in area, with depths of 18 to 25 fathoms.

2. KEY WEST MARKET BOATS.

The Key West market boats are locally known as "smackees," a name applied, both here and in the Bahamas, to small vessels or boats provided with wells for keeping fish alive, the term literally meaning a small smack. Two classes of these boats are recognized, one being large enough to make trips to the fishing grounds, 25 to 35 miles away, and stay several days, while the other and perhaps less numerous class, locally designated as "single-day boats," are smaller and intended only for fishing near Key West Harber, going out in the morning and returning to market on the afternoon of each day. The larger boats are invariably sloop rigged, but some of the smaller class carry no jib.

Although the majority of these market boats are purely Bahamian or Bermudian in type, having in some cases been brought from Bermuda on the decks of trading vessels or sailed across from the Bahamas, and this model, as well as the rig, has been most generally copied by the people of Key West, it is nevertheless noticeable that the builders at the latter place have shown a tendency, in some instances, at least, to produce a craft more nearly resembling, in the shape of its hull, the deeper class of keeled fishing boats used along the New England coast. A few of the smackees have been improvised from the yawl boats of vessels stranded in the vicinity, by simply adding a top strake, building a well in them, and making such other changes as were required. These last may be considered as only accidental forms, and therefore to be omitted from any discussion of the typical smackee.

The most common form, or perhaps it might be called the Bahamian type of market boat, is carvel-built, wide and deep, with comparatively little sheer, a moderately sharp bow (the greatest beam about amidships), high rising floor, round easy bilge, moderately long, concaved run, a deep, heart-shaped, square stern, but no overhang, the rudder head being outside and the tiller working through a narrow long slot or hole cut in the upper part of the stern. They have small gammon-knee heads, deep keel, a curved stem and straight stern post, but there is much difference in the rake of the stem and stern post in different boats, some being nearly vertical while others are placed at a considerable angle, so that the craft may be many feet shorter on the keel than over all. The variations from the above, found in some of the Key West built craft, are that the latter have some overhang to the counter and more or less rake to the stern, so that the rudder head goes through the counter instead of working outside; a few of this type are also built with a skag aft; they generally have a more symmetrical sheer on top; are not quite so deep in proportion as the others, and, while superior sailers in ordinary weather, are conceded to be far less able and seaworthy in strong winds and rough water than the heavy-draught boat of the Bahamian model, which has a high reputation. It is asserted that the latter will often go out on a fishing trip and will work to windward in weather so bad as to drive the local pilot boats into harbor to seek shelter.

All of the smackees are decked with the exception of a cockpit aft, where the crew stand to fish or to sail the boat. The interior is divided into three nearly equal compartments. Forward is the little cabin or cuddy where the fishermen sleep, keep dry clothing, and spare gear. This is entered through a small hatch or companion slide aft of the mast. It is not provided with berths, so far as we could observe, an old sail more or less carelessly spread on the floor being used for a bed. Aft of the cabin is the well wherein the fish are kept alive, except when a boat may engage in the capture of kingfish, when, as will be detailed elsewhere, the fish are killed before being put into the well, where it is, nevertheless, found expedient to place them, as they will, when put in water, keep in good condition for about twenty-four hours. The well is somewhat peculiar in shape, being much larger at the botton than at the top, the sides and ends having a strong rake. An average-sized well is about 3 feet 6 inches long by 2 feet wide, on top, while at the bottom it is 6 feet long and 4 to 5 feet wide according to the size of the boat. It will thus be understood that it is both easy to select and take from the well any fish that may be in it which a customer may wish for. Many of these wells have a coaming about the top which flares outwards. There is also a coaming, about 4 inches in height, around the cockpit.

The material employed in the construction of these boats is the same as that of which the larger craft are built at Key West, maderia wood being used for frames and yellow pine for planking, while the fastening is chiefly galvanized iron. Copper paint is used on the bottoms and inside the wells, and a new coat is put on about three times a year.

Although some attempts have been made to modify the hull of the Key West smackee, so that it will conform more nearly with other boats used in the United States, little has been done towards introducing any other than the "Mudian rig," which seems to be universally popular with the fishermen. It is true that a very few of the boats have a boom and *gaff* mainsail, but it is apparent that this innovation is of the most limited kind, for the gaff rarely much exceeds in length the half-moon-shaped club attached to the mainsail head on other boats.

As has already been said, these smackees are sloop rigged, with few exceptions. The long tapering mast is stepped well forward, so that the boat will be perfectly manageable with a very diminutive jib, and when it blows strong the latter is reduced in size to a mere rag by being "bobbed;" its only use at such times is to pay the boat off when she tacks, and to prevent her from griping too much on her helm.

A large leg-of-mutton (or triangular) mainsail is carried, this being laced to the mast by a rope; while the foot, which is cut roaching and hangs loose, its middle curving downwards, is extended by a long boom, made of tough wood, that projects far over the stern. The foot of the sail is attached only at the clew and tack, and it appears that the prejudice in favor of loose-footed sails is as great here as it is among the fishermen of Great Britain. The head of the mainsail is sewed to a piece of board about the shape of half of a barrel head and approximately about the same size, though some of these clubs are larger. The bowsprit is fixed and is always short. The rigging is very simple. A single shroud, at the most, on each side, supports the mast, if necessary, though these are generally slack, while the jib-stay from the mast-head passes through the bowsprit end and sets up at the stem. The manner of reefing the jib, when it is used in strong winds, is called the "Mudian tie," and consists in tying up the head with a piece of small rope so as to materially reduce the size of the sail.

The mainsail is large, but is generally baggy, and in the latter respect would suffer by comparison with the flat-setting sails generally seen on Northern fishing boats.

With the exception of one or two boats of the smaller class that only one man goes in, the smackees have crews of two men each. The boats are provided with oars (13 to 15 feet in length) which may be used whenever required, though with such a large sail area as they have a very light air of wind pushes them along at a rate which makes it unnecessary to row.

The average size of the larger class of smackees is 18 feet on the keel, 21 to 28 feet over all, 6½ to 8 feet beam, and 4 to 4½ feet deep, with a draught equal to their depth. The mast would average in length 28 feet above deck, the boom is usually 2 or 3 feet longer than the boat, while the bowsprit is about 3 to 4 feet outside. The "one-day boats" average 14 to 16 feet over all, 4 to 6 feet beam, and 3 to 3½ feet deep. The boat Jimmy, of this class, one of the cat-rigged type, is 12 feet 6 inches long on the keel, 16 feet over all, and carries a mast 23 feet long, and a boom of 18 feet. The smackee Jeff Brown, built by William H. Pierce,* is a fair example of the type of the larger boats of this class now made at Key West. She was launched in 1883, and has the following dimensions: Length, over all, 24 feet; keel, 21 feet; beam, extreme, 9 feet 6 inches; width of stern, 5 feet 5 inches; depth, molded, 3 feet; draught, aft, 3 feet; keel, 8 inches deep amidships, 4 inches deep forward and 6 inches aft. Mast, 31 feet long; boom, 23 feet; bowsprit, 6 feet outside.

Dinghies are used in connection with the smackees, some of which differ only in size from those carried by the sponge vessels, while others are small skiffs of the sharpy pattern that seldom exceed 10 feet in length. Ordinarily these are not required, but they are sometimes useful for going to and from the land when the larger boat is anchored off at a distance from shore.

The following are the details of construction, &c., of a sharpy-skiff: She has a sharp, wedge-shaped bow, straight vertical stem, flat bottom,

* Mr. Pierce has presented the builder's model of this boat to the National Museum.

curving up in the after section, a long deep skag, square stern, and stern post outside of skag and stern. There are two thwarts, the ends of which rest against pieces of board (of the same width as the thwarts), that are fastened, in a vertical position, on the boat's sides. Four wooden row-lock cleats, each with a single hole, are nailed to the gunwale. The boat is built of yellow pine, and fastened with galvanized iron nails. The sides are each made of a single piece of board, and they are fastened at the ends to the stem and stern, while the bottom boards, which are each 3 or 4 inches wide, are placed transversely and nailed outside the lower edges of the sides, thus protecting the latter from chafe when the skiff takes the ground in beaching. The dimensions are as follows: Length, over all, 9 feet 9 inches; extreme beam (amidships), 3 feet 2 inches; width of bottom, extreme, 2 feet; width of stern, 2 feet; height of sides, amidships, 1 foot 1½ inches; of bow, 1 foot 4½ inches; at stern, 1 foot 5 inches, including skag. The latter was 8 inches deep aft, tapering to a point forward, its length being 3 feet 10 inches, and thickness 1 inch.

3. APPARATUS AND METHODS OF FISHING.

Kingfish drails.—The boats engaged in the pursuit of kingfish are each provided with four drail-lines. Each of these lines is about 13 fathoms long, being one-half of an ordinary 26-fathom white cotton line of a size that would weigh 10 or 12 pounds to the package of a dozen skeins. To one end of each line is attached a stout, round-bowed, black steel, flat-eyed hook. Two sizes of hooks are used, these being practically the same in size as the hooks used on halibut trawls from New England, and would correspond pretty nearly with Nos. 11 and 12 of the central-draught pattern. The largest hooks are used when there is a brisk breeze and the boats are going through the water at a good speed; while the others, which are only a trifle smaller, are preferred when the wind is light.

The hooks are ganged with brass wire, since the sharp teeth of the kingfish would quickly cut off a cotton line. The method of ganging is peculiar. A piece of stout brass wire (one-sixteenth inch in diameter) is bent into the form of a loop 2 or 3 inches in length, the two parts of the wire being brought together about three-quarters of an inch from the bend, from which they are parallel to their ends; the latter are turned back about half an inch in a sort of a compressed hook-like shape. This device is firmly lashed to the front side of the hook's shank by fine brass wire wound round and round, and when secured there is a loop projecting about three-fourths of an inch at the top, while all possibility of its being pulled out is prevented by the bent lower ends. Into this loop is now fastened a piece of wire one-sixteenth inch in thickness and 9 or 10 inches long, its upper end being twisted so as to form a bight or loop for the fishing line to bend into. Such a ganging is very strong and durable and will last a long time unless, of course, a hook may be lost by the parting of a line.

Hand-lines for ground fish.—The hand-lines used by the boat fishermen who catch the smaller species of market fishes are exceedingly primitive in their character. The line is essentially the same as the largest kind of mackerel lines, made of white cotton and usually about 10 to 12 fathoms long. To one end is attached a small kirby-bend hook (about the size of a No. 16 central-draught hook), the method of ganging being simply one or two clove-hitches taken with the end of the line around the shank of the hook. Some 2 or 3 feet above the hook the sinker is bent on, this being a piece of lead without any special shape and weighing a half pound or more, with one end flattened and a hole bored in it to admit a short becket, the other end of which is bent to the line. Each man generally uses only one of these lines.

Bruiser.—Clubs for killing the larger species of fish are carried, these implements being locally known by the name of "bruisers." Their shape and function are essentially the same as that of the "killers" used by the New England cod and halibut fishermen.

Bait.—The method of baiting the hooks for kingfish is peculiar, and admirably adapted to this fishery. It may first be said that when a boat reaches the ground a piece of pork rind, or a cotton rag—anything in fact that looks white in the water—is put on the hooks until some fish are caught, and it occasionally happens that such a lure may answer the purpose tolerably well. The devices sometimes resorted to for providing a lure, when a boat first reaches the fishing ground, were rather graphically set forth by a boatman of whom I asked the question, "What bait do you use before you catch any fish?" "Oh, anything we happen to have," he replied; "sometimes pork rind, a white rag, or something else that looks white. This trip I took his stockings" (pointing to his shipmate, a lad of seventeen or eighteen years), "and first rate bait they made, too. The fish bit fast, and we caught nearly thirty before we had a chance to put on any other bait."

The bait commonly used after fishing has begun is the skin of the kingfish, one or more of which are flayed during a trip to furnish a supply.

It is cut from the side of a fish in transverse triangular sections, each bait being 6 or 7 inches long and 3 or 4 inches wide at its broadest end. Two slits are cut in each bait, one near the apex of the triangle and the other nearly in the middle. The hook is then passed through the hole nearest the end and out of the other—the upper slit is pushed up the shank and over the eye of the hook—in such a manner that when being towed the bait folds together, showing only the silvery iridescent hues of the outside surface of the skin, and resembling in appearance some small fish as it goes skipping along at the surface.

The bait most generally preferred by the "single-day" fishermen, who catch the small bottom-feeding species, is cray fish. Next to this minnows—locally called "sardines"—are deemed the most attractive, while conchs are used when more desirable material is not obtainable.

Methods of fishing.—When a boat engaged in kingfishing reaches the locality where operations are to begin, she is sailed back and forth in various directions, towing two lines which trail behind, the baited hooks skipping along on or near the water's surface. The inner ends of these lines are fastened on the boat's quarter, nearly abreast of the middle of the cockpit, where they are convenient to the hand of the fishermen. Two other drails, baited and ready to be thrown out, are kept in the boat, and the moment that a fish is pulled in one of these "relief lines" (as it may be called for want of a better name) is thrown out, so that two lines are always kept towing. If it were practicable to use a larger number of drails, perhaps many more fish might be taken; but for various reasons this cannot be done. The kingfish is exceedingly active, and when hooked will dart about like a flash in various directions, unless he is immediately hauled in. Thus, if fish should strike several lines that could not be pulled in at the moment, the result would be their almost inextricable entanglement, a consequent waste of time, and the possible loss of the fish and gear. Another reason why a larger number of lines cannot be used is that when a school of kingfish are found they bite very fast and with extreme voracity, and at such times all the boats in the vicinity collect together and sail side by side, at very short distances from each other. One untended line might foul the gear of several other boats in this case, and the whole fleet might be thrown into confusion. Whenever kingfish are found in abundance a boat stands along, and the men keep themselves busily engaged in pulling in the large, vigorous, and gamy fish, until the latter cease biting, when the smackee is tacked and returns along the same track she has just passed over. And thus she continues to work in nearly the same locality until the fish are exhausted or cease biting.

It sometimes happens that a good fare, 200 to 250 fish, may be taken in a single day, and the catch is often large, but it is not unusual for the boats to be absent several days, and in some cases as long as a week. It will, however, be readily understood that other causes besides the abundance of fish may materially influence the time of a boat's absence from port. For instance, with calm weather, or with a heavy head wind it may occasionally take a long time to reach the fishing ground off Sombrero Key, and the success of the operations after arriving there is very much dependent on the wind and weather, as well as on the strength of the current and condition of the water, whether clear or not. Again, the kingfish is reputed to be very capricious about biting, and though it generally takes the hook with the greatest eagerness, there are times when it will not bite for several days; at least it cannot be caught in sufficient numbers to make it profitable to fish for it.

After spending the day in fishing, the boat heads for Key West to market its catch, or runs in at night and anchors under the shelter of one of the numerous keys that fringe the coast. Not unfrequently a fleet of a dozen smackees may be seen riding side by side, often lashed together, while their crews pass away the evening in recounting their experiences of the day, or gossiping about affairs at home, and perhaps some one who is musically inclined adds to the entertainment by playing on some instrument that he carries in his boat for such occasions.

As has been indicated, the kingfish are often found in abundance, and as it generally takes a hook very readily the fishermen frequently have the liveliest kind of a time in tending their lines. To haul in kingfish, with an occasional amber fish, hour after hour, many of the specimens weighing 20 to 30 pounds each, requires not only skill but a large amount of endurance, and it is safe to predict that a novice in the business would soon find himself suffering with blistered hands, even if the exceedingly vigorous exercise failed to fatigue him.

As the fish are brought on board they are hit on the head with the "bruiser," to stun them, after which they are unhooked and thrown into the well, where they remain until the day's fishing is completed. If enough have been caught to go to market, the fish are taken from the well and eviscerated as the boat runs on her course, after which they are thrown back again and remain in the well until port is reached. If the catch is not sufficient to go to market, the fish are generally split and salted, unless it is expected to go next day.

The fishermen say that kingfish will not live fifteen minutes in a boat's well, therefore it is necessary to handle them in the manner described. The methods of fishing adopted by those engaged in the capture of the small species, of which there are many varieties, are as follows: The boat is anchored on the ground, the lines baited and lowered to the bottom, each man using one line, which is all he can tend. As fast as the fish are pulled in they are carefully unhooked and thrown into the well. The boats usually start out in the early morning and return to the market wharf about 3 to 4 p. m.

There are certain species, like the angel-fish, for instance, that cannot be easily caught with a hook. These are captured by striking them with small grains. As a matter of course, the method of capture kills them, and they must be sold within a limited time, before they become unfit for food. Depending only on the local demand, it naturally follows that a fisherman may often be compelled to throw away fish that he has worked hard to catch but cannot sell.

As has been indicated, the capture of kingfish is prosecuted only from November to about the last of March. In April it is said the fish leave the coast, presumably to spawn. The fishermen think the fish go off in the Gulf Stream to spawn, after which it is believed they go in what is termed "The Bay," where they are supposed to stay until their return in the fall.

During the summer the larger boats that have been employed in winter catching kingfish turn their attention to anything that offers a chance for making money. Some of them fish for snappers, groupers, or anything that they can catch, and which will sell in the market, while others go for turtle for a few weeks or months, as the case may be.

4. DISPOSITION OF THE CATCH.

As a rule, the great bulk of the kingfish taken by the Key West fleet is sold and eaten in a fresh condition, but occasionally some fish are salted on the boats and a greater quantity are split and salted after they are landed, the surplus being disposed of in this manner. These salted fish are often dried, and to facilitate this and insure the more thorough drying of the fiber, the thick part of the fish is cut transversely, nearly to the skin, at distances of about an inch apart. There is no systematic method of drying, as one sees in curing cod, but the fish are hung across rails, spread on wood-piles, or disposed of in any other manner where they may have a chance to dry, a favorite method being to suspend them by the tail. Cured in this way they make tolerably good food, but it is altogether probable that a much finer article of food might be obtained by smoking the fish. Its texture, and the oil contained in its flesh, would no doubt make the kingfish excellently well adapted for curing in this manner, and it is certainly possible that when so prepared it might rival the halibut and meet with as great favor in our markets as some other kinds of smoked fishes that now command a high price and a ready sale. The fact that it is seemingly abundant and can be bought at a comparatively low figure—the average wholesale price not exceeding 2 cents per pound for fresh fish—favors its introduction as an additional article of smoked food. Experiments can be made in this direction without great expense, and if found satisfactory there is reason to expect that capital and experience will unite to utilize the product of this fishery in such a manner that it may reach a wider field than at present, create a greater demand for the kingfish, relieve the fishermen from their present dependence on the Cuban markets, and also open the way for the employment of a larger fleet and a greater number of men.*

The kingfish sold to the smack that runs to Havana, or by the fare to local dealers, had a fixed price (winter of 1884–'85) of $22 per 100 fish, the buyer taking his chance as to the size. In winter it is said that the average weight is about 12 pounds, and in spring about 8 pounds, though individuals are frequently taken that weigh as much as 30 to 40 pounds each. The fish retail at various prices. For in-

* Being fully impressed with the importance of this matter, I assumed the responsibility of calling Professor Baird's attention to the subject. In response thereto he directed me to purchase a lot of kingfish when the ship returned to Key West on her way north, so that an experiment can be made in smoking them. The fish were obtained, but have not yet been smoked; therefore the result of the experiment must be given at a future date.

stance, one may be sold for a lump sum, his weight being guessed at, while a certain price, as high sometimes as 8 cents per pound, is charged in other cases.

The market building is constructed in a peculiar manner, with a view to keeping the fish fresh as long as possible without ice. It is made of narrow boards separated from each other about 1½ to 2 inches, so that a free circulation of air can be obtained. When a fresh breeze is blowing the wind draws through quite briskly, enough so to assist in cooling the fish, which are either spread out on a long wooden table or bench or suspended by their tails from the rafters. The latter method is always adopted when the fish are not going to be sold right away, since the wind circulates more freely among them and keeps them cooler than when they are lying on the table. It is said that fish will keep perfectly fresh for twenty-four hours, when hung up by the tail, if there is a strong norther blowing.

A considerable percentage of the kingfish go to Cuban markets, and at the time of our visit the smack Aaron Kingsland was employed in carrying cargoes from Key West to Havana, making a trip in an average of about one week.

Just before the arrival of the smack at Key West, of which the fishermen are duly notified from Havana, as well as of the day she intends to sail for Cuba, the fleet of boats start out for the kingfish grounds, arranging their departure so that a good fare can be secured in time for them to return on the day that the smack takes in her cargo. We were fortunate in having the opportunity to witness the interesting and instructive operation of a smack loading with kingfish for Havana.*

The vessel lay under the lee of a long wharf that reaches out into the harbor, and hovering around her, from stem to stern, and several tiers deep, boats outside of boats, lay the fleet of little smackees, like a flock of sea birds, resting on the waves. They were just in from the fishing ground, and the fares of those nearest the vessel were being rapidly transferred to the smack's hold, where they were carefully packed in pens, tier upon tier, each layer being covered with fine ice. The method of icing the fish differs in no essential particular from that in vogue among the New England fishermen. The ice was hauled down on horse-carts and dumped on the wharf alongside the smack, whence it was transferred to her deck. Taken altogether the scene was an interesting and animated one. The fishermen gathered in squads on the vessel's deck discussing the various incidents of their trip, or speculating on the general phases of the fishery; the shouts passing between those on the boats, as each tried to learn what "luck" his compeers had met with; the monotonous repetition of the "tally" as the fish were taken

* A few days later I went on board the same smack lying at anchor in Havana. The captain told me that it usually took about a week to dispose of a cargo, the fish being generally sold at retail.

from the smackees; the swarthy faces of the Cuban crew* peering up from the dim light of the ice-house in the vessel's hold; the many remarkable ejaculations in Cuban Spanish, negro patois, and the peculiar dialect of the native white fishermen, made up a combination liable to impress even the most casual observer. The bustle attending the departure of boats that had discharged their fares, or the advent of new arrivals that came dashing in by the pier-head, under a press of sail, which, a moment later, fell in graceful folds on deck, added to the spirit of the scene, while the manner in which the little craft were handled gave one a fine impression of the boatmen's skill.

The smaller species of fish are always marketed alive, with few exceptions. A quantity of these fish are kept in the boat's well, but in addition each crew has a live car—in the shape of a cube, and about 4 feet on each side—built of boards, in which more or less fish are kept, the amount seemingly being limited only by the capacity of the receptacle. These fish are sold at retail by the boatmen, who take them from the car or boat's well, as the case may be. The car is kept fastened to the wharf, and to show the fish to customers one-half of the cover is turned back, and any fish that may be selected from the numerous varieties is dipped out with a scoop-net.

The following are some of the common names of the different species of food fish usually sold in the Key West market: Moonfish, pompano, yellow jack, grunt, yellow tail, red grouper, black grouper or gag, mutton-fish, red snapper, gray snapper, laying snapper, spotted hind, angel-fish, porgie, blue tang, chub, Jew-fish or guasa, Spanish hogfish, amber-fish, marget-fish, runner, parrot-fish, turbot, pug, jack-fish, bone-fish, sailor's choice, barracouda, bluefish, Spanish mackerel (?), kingfish, rock shell fish, horn-fish, tarpum, drum, redfish, mullet, sheepshead, scamp, glass-eyed snapper, squirrel-fish, permit, old wife, dog snapper, French grunt, whiting, bream, goat-fish, nigger-fish, four-eyed fish, shad, moray, gar-fish, ballahou, schoolmaster, flounder.

D.—The turtle fishery.

Although the turtle fishery of Key West is comparatively of less importance than some other branches of the fisheries pursued from the port, of which mention has already been made, it is nevertheless a well-recognized industry, employing some five or six sloops and schooners, of six to ten tons each, these vessels being of the same class as those engaged in sponging. Besides these vessels other boats engage in turtle-fishing to some extent at irregular intervals, but they cannot

*Although this smack belongs to Key West, she is manned entirely by a crew who are natives of Cuba: though residents of Key West, some of them were unable to converse in English. It is a fact perhaps not generally known, that a large percentage—estimated by some as high as 30 per cent.—of the population of Key West, came from Cuba, many of them being political refugees, and one hears Spanish spoken in the streets as frequently as English.

be included in the list of turtle hunters. Five men usually constitute a crew.

The turtles are sought for in the channels between the keys that are their favorite haunts. It is the habit of the turtle to feed in these channels, moving in and out with the flow of the tides. The localities frequented by turtles are called "turtle sets," and it is said that the hunters become exceedingly expert in finding these, as well as in capturing the animals they are in pursuit of. But the greatest skill is often of no avail, for so extremely uncertain are the returns, that it is asserted that a vessel may sometimes be a month absent from port without taking a single turtle, while another may be "lucky" enough to secure two dozen or thereabouts in three or four days.

The turtles are taken in nets similar to an ordinary gill-net, which are put out at night across the turtle sets so as to intercept the animals as they move in and out through the channels. The turtles get their heads and flippers entangled in the meshes, and in their struggles soon become so wound up in the twine that it is impossible for them to escape. The nets are made of coarse, strong twine; they are each 50 to 75 fathoms long, 5 to 7 fathoms deep, and have a mesh varying from 14 to 18 inches. The nets are hung to ropes in the ordinary manner of hanging gill-nets; wooden floats are strung along the upper edge, and lead sinkers are most commonly used. Turtle pegs are also sometimes used; but we were told that the Key West men depend chiefly on nets as a means of capture.

There is much variation in the size of the turtles, their weight ranging all the way from 6 pounds to 200 pounds or upwards. The smaller turtles, those ranging from 6 to 16 pounds in weight, are utilized to supply the local demand, and the price for these is about 10 cents per pound. The larger animals, those between 16 and 200 pounds in weight, are shipped to New York; but it does not pay to send any larger ones North. After being brought to Key West the turtles are put in large pens built underneath the piers—sometimes called "turtle crawls"—where they are kept pending their shipment. Those sold to New York parties average a price of 6 to 8 cents per pound. The largest turtles, those too big to ship, are, like the small ones, used to supply the local market. They are worth about 3 cents per pound before being butchered, but sell for about 15 cents in the market.

The returns from this business are very uncertain, as has already been indicated, but on the whole the men engaged in it are said to do fairly well, though we were unable to get any estimate of their earnings.

E.—THE SHORE SEINE FISHERY.

A limited fishery is carried on by the Key West fishermen, for a few weeks or months of each year, with drag seines that they throw around schools of fish near the shore and pull them to the land. Of course, when using such apparatus the operations are limited to such localities as have clean beaches, which are not numerous in this region, at least so far as our observation extended.

Flat-bottomed seine boats, of the sharpy pattern, are used. One of these that I saw on the beach in Key West was 20 feet long over all, 6 feet 3 inches wide amidships—its broadest part—4 feet wide on the bottom, and 20 inches deep. It had one stationary thwart, 3 feet from the stem, in which was a mast-hole, an adjustable thwart amidships, and another stationary one about 8 feet from the stern. At the stern was a platform, on which the seine is stowed, 5 feet 4 inches long, fore and aft, and placed 2½ inches below the gunwale. The boat had 11 sets of 1½-inch-thick timbers, and a small skag aft. The methods of seining in vogue on the Florida coast will be more fully discussed in another place.

According to Mr. Stearns there are about six seine gangs from Key West, averaging thirty men to a gang, employed in the fall mullet fishery from the beginning of September to the 20th or 25th of December. The fishermen and their boats are taken to the west coast of Florida in vessels which are also employed to transport the catch to Cuba.

The principal seining stations frequented by these fishermen are Charlotte Harbor, Sarasota, and Tampa Bay.

III.—NOTES ON THE FISHERIES OF WESTERN FLORIDA.

The fisheries of the west coast of Florida, particularly those which center at Pensacola, are specially interesting because of the marked improvement that has been made in their importance within a few years past. So notable has been the advancement in the fishery for the red snapper (*Lutjanus blackfordii*, Goode & Bean), for instance, that data collected and compiled for the census year of 1880 no longer convey any adequate idea of the present condition of the business.

For many months of the year the waters of Western Florida are said to swarm with various kinds of edible fish, some of which are the most delicious and highly prized of the ocean species. Some of these are migratory, and can be taken only during certain seasons, when they appear on the coast, while other species are non-migratory and are caught throughout the year.

The present favorable condition of the fisheries is largely due to the enterprise of a few firms, who have entered into the business with as much zeal as seems prudent in a new industry, and who, by obtaining concessions from the express companies and other transportation agencies, have made it possible to send fish to distant markets in good condition and at prices that are reasonable. Of course, it may be supposed that with the growth of the fisheries and the consequent increase in the amount of material to be transported, still more favorable arrangements may be made which may tend to the development and improvement of these industries, as well as to the advantage of the railroads that carry the fish. At the best, however, the fisheries of this section must labor under the disadvantage of being remote from large centers of population; and as a great proportion of the catch must be marketed in a fresh condition, and consequently be carried by fast freight, the cost of transportation will always be large. As an offset to this is the abundance of fish, certain varieties of which can be taken with less expense than in many other places, and it seems to me only a question of time when the demand will be such as to call for a very much greater quantity than is now taken, the result of which will be an enhancement of prices, the employment of more men and capital, and the consequent material improvement of the coast and offshore sea fisheries. But while we may reasonably assume that the fisheries of the Gulf may attain much greater proportions than they now have, it is not probable that they will ever reach an importance at all comparable with such fisheries as those of New England, simply because there are not the enormous resources to draw from for a large supply of material, and also because these southern species are not likely to fill so important a place in cured food as do the staple productions of our northern seas.

Such are some of the conclusions that have been arrived at, from a brief study of the fishing industries of this region, and it has been deemed best to present them here as prefatory remarks, bearing, in a general way, on the more specific notes which follow.

It is also proper to state that the notes presented here are based on such data as I was able to gather in a few hasty interviews with people who are familiar with the fisheries of Western Florida, as well as on my own personal observations. The chief aim has been to get an idea of the methods of fishing, and the vessels and apparatus used, thinking it might, at least, be possible to offer some suggestions for their improvement. At the same time a general idea has been gained of some other details pertaining to the various fisheries discussed. Such facts as have been gathered are combined in the following pages. That they will come far short of a complete discussion of the whole subject, even in the localities mentioned, I am fully aware, and therefore they are given for what they are worth, since the object aimed at is not to make a comprehensive report, but simply to give such salient points as will enable the reader to obtain an idea of the leading features of the industries referred to. Necessarily, too, the information gathered is chiefly concerning the Pensacola fisheries and those of the nearest points to it, since these were the only ones we had a chance to study, not having visited any other place on the west coast of Florida but the above-mentioned city, except Tampa, where I saw no one.

A.—THE RED-SNAPPER FISHERY.

The red-snapper fishery is specially interesting, because of its comparatively recent origin, as well as for the advancement it has made within the past few years, so that it may now be considered as being in the front rank of the fisheries of the Gulf coast. Its headquarters are at Pensacola, which now controls this industry, since the nearness of this port to the fishing grounds, combined with its railroad facilities, make it the most available market, and give it many advantages over New Orleans and Mobile, which cities have a few vessels employed in the business. With the exception of two vessels owned at Mobile, and which market their catch at that port, the entire fleet take their fish to Pensacola, where they are sold, or, in a few cases, shipped to consignees at New Orleans.

At the present time (1885) there are employed in the red-snapper fishery of the Gulf seventeen schooners and four sloops, with a total tonnage of 709.21 tons, and manned by one hundred and forty men, approximately. The total amount of fish taken by this fleet we were unable to obtain, but judging by such statistical data as are at hand, it cannot fall far short of 2,000,000 pounds.

In addition to the vessels, there is a more or less numerous fleet of sail boats, of various sizes, up to six tons, that find employment during the summer in fishing for snappers, and the aggregate taken by these is considerable.

1. THE FISHING GROUNDS.

In the early days of the snapper fishery the inshore grounds, where the water is comparatively shallow—10 to 15 fathoms deep—were most generally resorted to, and even at the present time, in spring and summer, fish are found in these localities, but not, however, in the same abundance as formerly. The most important fishing grounds now are those lying off shore, where the snapper can be found most abundant in winter, the season when the fishery for it is at its height. Previous to 1882 the chief part of the snapper fishing was done between Perdido Bay and Cape San Blas, in from 10 to 22 fathoms. Along this stretch of ground there is said to be, here and there, patches of hard limestone bottom, on which live corals and other forms of invertebrate life occur. These places are often, says Stearns, depressions or gullies, seemingly scooped out of the surrounding sand, and having a somewhat greater depth of water than the adjacent bottom. Patches of ground of this character are the favorite haunts of the red snapper.

Many of these spots have names, given them by the fishermen, to distinguish them from each other, though some of the grounds have not received the same consideration.

The *Trysail Bank*, a narrow gully, not more than 500 yards wide and about a mile long, east and west, bears south-southwest from Pensacola Bar, from which it is distant 23 miles. It has a depth of 19 fathoms.

Dutch Bank, with a depth of 13 fathoms, is a small patch that lies off Perdido Inlet, and can be found only by ranges.

Southwest Ground is a small spot bearing southwest from Pensacola light-house, from which it is 5 miles distant.

Middle Ground, on which many small boats from the navy-yard fish in summer, is 3 miles east of Pensacola Bar buoy. Like the others, its area is small.

Charles Henry Ground embraces a series of seven small patches lying between the bearings of south-southeast from Pensacola Bar and south by west from Santa Rosa Inlet, in 19 to 22 fathoms.

East Pass Grounds are several small patches of coral bottom, about 15 miles from land, with a depth of 19 fathoms, bearing south by east from the East Pass of Santa Rosa Island.

Besides those already mentioned, there is a series of small patches of ground lying between East Pass of Santa Rosa Island and Saint Andrew's Bay, in 12 to 22 fathoms of water. These have been important fishing grounds for several years, and are still much resorted to during the warm season.

The grounds which are now most generally visited in winter, and consequently of the greatest importance, are embraced in a somewhat narrow belt along what is termed the outer edge of the shore soundings, between the meridians of 85° and 88° west longitude. Along this stretch of sea bottom, which is more or less crescent shaped, are various patches of considerable extent, with depths varying from about 20 to 47 fathoms, where the red snapper occurs in greater abundance during the winter season than elsewhere so far as is known. The species is found to the southward and eastward of this, even so far as the Tortugas, and sometimes the fish are plentiful and bite freely, though, according to Stearns, there is this difference between the grounds east of the 85th meridian and those west of it: On the former, groupers are far more abundant than red snappers, outnumbering them at least two to one, while on the western grounds the case is reversed, for there the snappers are found in large schools, and average about twice as many in number as other species. The success of the Pensacola snapper fishery is unquestionably due, in a great measure, to the fact that this species has been found in such large schools on the western grounds and within easy reach of a market.*

The grounds lying between Cape San Blas and the Tortugas have been worked over, we are told, but mostly inshore, in from 5 to 15 fathoms, which region has been thoroughly fished by the Key West smackmen. Outside of the fifteen-fathom line, south of Tampa Bay, it is altogether probable that little fishing has been done, and here, as well as farther northwest, the red snapper may probably be found in abundance. As a rule, the Pensacola smacks do not go farther to the southeast than on a small ground that bears southeast ½ east from Cape San Blas, and

* The researches made by the Albatross between Tampa Bay and Tortugas (see report of the cruise) apparently proved that red snappers were even more abundant in this region, in 25 to 27 fathoms, than they are farther to the northwest. And while the grouper appeared to outnumber the snapper north of Tampa, or between it and Cape San Blas, the reverse was the case on the more southern grounds.

the center of which is in lat. 28° 43′ N. and long. 84° 27′ W. This, and the adjacent bottom, has been worked on about three years. As a matter of fact it is thought that it would scarcely be profitable at present for them to go farther from Pensacola, since it would take too long to reach market with a fare of fish if a vessel encountered head winds on her passage. Stearns says: "We have occasionally had some of our vessels go as far to the eastward as to be off Tampa, where, in summer, they have found patches of good ground, and a fair catch of snappers, all along the edge of the so-called deep water, in a depth of about 22 fathoms. In the summer of 1884 the schooner Sarah L. Harding went there to fish for groupers, which she was going to carry to Galveston. But where in former years groupers had been abundant a good school of snappers was found, a fare was obtained, and the vessel took her cargo to Pensacola."

Although it is now deemed impracticable to go farther from Pensacola than the vessels have been in the habit of fishing, there is no doubt but that the men would extend their cruises were they sure of fair returns on distant grounds, whenever the supply of fish on those now visited grows less. As the case now stands, a smack will generally strike fish before getting far beyond Cape San Blas, at the farthest, and though the catch may not be all that one might desire, still it would not be deemed wise to leave a certainty to search for better grounds farther off, which no one has yet any definite knowledge of. The fact, too, that on these eastern grounds there is said to be an abundance of groupers, a fish that has little value in the Pensacola market, would naturally deter the fishermen from making extended cruises which otherwise they might venture on.

One of the oldest offshore snapper grounds lies off Mobile, and is about 15 miles long northeast and southwest, and its width is, approximately, 2 to 5 miles; it has a depth of 37 to 42 fathoms, with a rough bottom, chiefly of limestone and coral. It bears south-southwest from Pensacola, from which it is about 65 miles distant. This ground has been worked out, so that at present fish are not very abundant in the first of the winter, but they are generally more plentiful in March, April, and May. It is said that in this locality more West Indian species of fish and deep-water surface swimmers are found than elsewhere on the northern side of the Gulf.

The *Old Cape Ground* is another bank that, for several years, has been accounted one of the most prolific regions visited by the snapper fishermen. Even at the present time it is one of the most important grounds along the coast. The center of this bears about southwest from Cape San Blas. The depths usually fished in, in winter, vary from 27 to 31 fathoms. There are no definite limits to the ground, but, according to what we were able to learn of it, its length is about 20 to 25 miles along the edge of soundings southeast and northwest, and its width from 3 to 7 miles. Farther to the southeast, and separated from the Old Cape

Ground by a stretch of barren bottom that lays about south from Cape San Blas, is the *New Cape Ground*. This bears from south-southeast to southeast from the cape, and has about the same extent as the old bank, while the depths do not differ materially from those of the other ground. The character of the bottom is much the same on all these banks, according to the fishermen, at least on the spots where snappers are found, and they say that where the arming of their leads will bring up black sand, or sand with black specks, coarse gravel, and live corals or bryozoa, they consider it good ground for fish.

It may not be out of place to say that quite extended researches have been made west of the Mississippi in search of snapper banks, the demand for fish in the Galveston and New Orleans markets, and the consequent high prices often paid being, no doubt, an inducement toward making these investigations. As early as the fall of 1880 two smacks, from Noank, Conn., which were fishing in the Gulf, made a cruise off Galveston in search of fishing grounds, but found no bottom suitable for red snappers to live on. Mr. Sewall C. Cobb also tells us that he spent the entire month of July, in 1883, seeking for red snappers, and sounding along the coast, from the southwest pass of the Mississippi to a point off the center of Padre Island, Texas, a distance of about 450 miles. The bottom, over all this extent of ground, was mostly mud and broken shells, and totally devoid of any fish life, so far as he was able to tell. He succeeded, however, in finding a small area, in 10 or 12 fathoms, bearing about east-southeast from Galveston, some 45 or 50 miles distant, where there were some outcropping coral rocks on the bottom; and here some red snappers were taken. It appears that two schools of fish were found, but in each case the individuals were of small size and they were not very abundant. The first lot taken averaged about 3 pounds apiece, while the fish caught from the other school weighed an average of 7 pounds each.*

In the summer of 1884 the Pensacola Ice Company sent another schooner off Galveston for red snappers, but the voyage was a failure, the vessel not getting fish enough to pay her provision bill.

Captains of merchant vessels who visit Pensacola have reported that red snappers are abundant off the coast of Mexico, particularly in the immediate vicinity of Vera Cruz. Mr. Stearns, who has inquired pretty closely into this matter, is of the opinion that these reports are exaggerated. He says there are some small spots in sight of the city of Vera Cruz where boat-fishermen take a few snappers, but he does not believe there are grounds extensive enough to support anything like an important vessel fishery.

The banks frequented by the red snapper having been discussed in a general way, it seems desirable that certain peculiar characteristics,

* Mr. Cobb showed me a large piece of coral rock that was pulled up on a fishing line, at this place, and which he brought home and still keeps as a souvenir of the trip. This rock would probably weigh 30 or 40 pounds.

that distinguished them from other fishing grounds, should be considered.

The red snapper has a habit of congregating in schools of limited extent, something like the mackerel and menhaden, instead of spreading over the bottom as do the cod, haddock, and many other species of ground feeders. It is therefore difficult to define precisely the limits of the areas that it inhabits. The best that can be done is to give a general idea of the locality and extent of the banks on which are small patches of ground where the snapper is found in abundance. It is not, however, known, even to the fishermen, whether or not the fish remain on a particular spot for a considerable length of time. It is only known that the fish cover a very limited area, and it is believed that they cannot be induced to leave the locality where they are found. A vessel will rarely stop in one position more than a day, and frequently only a few hours, before the school of snappers she is fishing on is broken up, or the fish become gorged with bait so that they will not bite fast enough to make it profitable to stay longer. Consequently, the vessel gets under way and goes to port or "tries around" to find another school. This being the case, it is, of course, quite impossible for anyone to say positively that snappers remain in one locality for days or weeks at a time. It may, perhaps, be safe to infer that when they have located in a place where the conditions are well suited to their existence, they remain there until the instinct of reproduction or other cause may induce them to change their position. This seems all the more reasonable, because it is only on certain kinds of bottom that the fish are found, the peculiarities of which have already been alluded to.

The character of the snapper grounds, so far as relates to the abundance of fish on them, and, of course, their consequent importance, has changed very materially, it is said, within the past three or four years.

It is claimed that this change is still going on, and that localities that were remarkable for the abundance of fish on them only a year or two ago are now of comparatively little importance. The best evidence that can be adduced in support of this theory is the fact that the vessels are continually obliged to extend their cruises further off in order to meet with success, and at present we are told that it would be of little use to attempt to catch fish on grounds where they could be taken in great numbers in the early days of the business. Whether this decrease in the abundance of the species will go on until it is no longer profitable to prosecute the fishery is a vital question. While this seems probable, one could scarcely be so dogmatic as to make such a prediction, unless, indeed, he had special opportunities for studying the fishery during a number of years. There are several reasons, however, which might lead one to anticipate a serious depletion in the numbers of the red snapper which do not obtain in the majority of food-fishes. First, it is local in its habits, and, unlike most of the migratory species, is taken at all seasons of the year; second, the region inhabited by the snapper (from a point about south from Mobile to the Tortugas) is a narrow belt, rarely exceeding more than 3 to 6 miles in width, and its total area is of comparatively small proportions; third, it must be borne in mind that certainly not more than one-half of this ground can be taken into account at present, since it is not fished on for snappers; fourth, it must also be considered that, even on this so-called snapper bank, fish are found only on small areas, that are more or less widely separated, and which, combined, constitute only a very small percentage of the whole ground; indeed, the localities inhabited by schools of snappers are not so numerous but that much trouble is oftentimes experienced in finding them, and not unfrequently one or two days are spent on the best grounds without good fishing being obtained; fifth, the great voracity of the snapper, and its readiness to take the hook, makes it possible to capture a large percentage of the individuals in a school, and it is fair to infer that in most cases their numbers will have suffered a very marked diminution before they cease biting. In many instances it is probable that nearly all the fish in a school are caught. It will be apparent that this is the case when it is understood that one or two thousand fish are sometimes taken in a few hours, the total weight of which would approximate 10,000 to 20,000 pounds.

In regard to its food, which unquestionably exercises a great influence on its movements, and the abundance of which perhaps confines it to certain localities, there are various statements based on observation. Stearns thinks that while groupers feed chiefly on crustacea and other material that may be picked off the bottom, the red snapper preys on fish, which is his favorite and principal food.

Cobb says "The snapper feeds upon the best in the sea, calico crab, blue crab, squid, polyp, and shrimp being his favorite diet."

I have myself taken a small bivalve from the stomach of a snapper. But those caught on the Albatross seldom had anything besides fish in their stomachs, though in a few instances small crabs were noticed. Fish were also often found in the stomachs of groupers.

2. THE FISHERMEN.

The fact that for many years the vessel fishery for red snappers was carried on exclusively by "Yankee fishermen," who came here in winter from New England, has naturally led to more or less eastern men being at present employed in the business. In the winter of 1884–'85 there were three New England vessels engaged in the snapper fishery from Pensacola, and certainly one schooner belonging to that port, which carried a captain and crew from the same section. In some other cases the skippers were from New England. Some of them spend the winter here, and go north in summer.

Mixed with these northern-born fishermen are many natives of the South, as well as a more or less liberal sprinkling of foreigners—Italians, Scandinavians, Minorcans, French, Spanish, &c.—some of whom come here in ships which they leave to engage in fishing. The average crew for a snapper-catcher is about seven men, and the total number of fishermen employed in this business is probably not far from one hundred and forty.

3. VESSELS AND BOATS.

The vessels employed in the red snapper fishery are for the most part of northern build, and are about equally divided in type between the tight-bottom schooners in common use north of Cape Cod, and the welled smacks of southern New England. They are mostly of small size, compared with the larger class of sea-going fishing schooners now employed from Maine and Massachusetts, and, as a rule, are quite old. Some of them were formerly employed in the Gloucester fisheries, and others from ports on Long Island Sound, or on the coast of Maine. A few—generally those of the smallest class—have been built in Gulf ports. Coming from so many sources, there is a marked diversity in these vessels, and no one of them could be described as characteristic of this special fishery. Those which came from northern New England are, as a rule, sharp, schooner-rigged, keel craft, and have the characteristic features of the clipper fishing schooners of the region where they were built. The principal change that has been made in them is in the substitution of a large, long-clewed, balloon main-stay sail instead of the rather short-clewed sail used in New England. None of them carry a flying-jib in winter, and only one or two have a foretop-mast and jib-topsail. The schooner Henrietta Frances, of Boston, did attempt to carry a flying-jib the present winter, but she soon lost her jib-boom, having broken it off in the short sea of the Gulf.

Although tight-bottomed vessels are now found as well or better adapted for the fishery than welled smacks, the latter were at first in favor, therefore smacks, both sloops and schooners, were then purchased for the trade. Comparatively little use is now made of the wells, since it has generally been found more satisfactory to ice the fish than to keep them alive. The northern-built smacks differ in no essential particular from those of the locality from whence they came. Those from ports on Long Island Sound are generally deeper, and somewhat fuller than the vessels from north of Cape Cod, but are precisely the same as one may see at Noank, New London, or at Fulton Dock, New York, where smacks 20 to 25 years old are still in use.

Some of these old smacks are said to be very seaworthy, and, though they are small, they are considered well adapted to the fishery in which they are engaged, and which, at present, is not sufficiently remunerative to warrant the employment of large and costly vessels. So far, it has not been found profitable to employ vessels much larger than 50 or 60 tons, and it is probable that this will always be a safe limit, since nothing can be gained by additional tonnage. This is due to the fact that the fishery must seemingly always be carried on with hand-lines from the vessel's side, or in dories, and in this case 8 or 9 men, at the most, will catch nearly as many fish as a much larger number. Therefore, any increase in the size of the vessels, above a certain limit, and addition to the number of men carried, must result in greater expense without a corresponding augmentation of receipts.

The following is a list of the vessels engaged in the red snapper fishery, from Gulf ports, in the winter of 1884–'85:

VESSELS MARKETING THEIR CATCH AT PENSACOLA.

OWNED OR CHARTERED BY THE PENSACOLA ICE COMPANY.

Schooner smack Niantic, of Pensacola, 45.87 tons; built in Connecticut.

Schooner smack J. W. Wherrin, of Pensacola, 25.59 tons; built in Massachusetts.

Schooner smack Ripple, of Pensacola, 28.82 tons; built in Connecticut.*

Schooner Ada, of Pensacola, 16.46 tons.

Steamer Millie Wales, chartered; burned in December, 1884.

Schooner smack Comet, of Stonington, Conn., 27.52 tons; lands her fish at wharf of Pensacola Ice Company.

Schooner smack Mary Potter, of Stonington, Conn., 36.23 tons; lands her fish at the same wharf as above.

OWNED OR CHARTERED BY MESSRS. WARREN & CO.

Sloop smack Maria Antonia, of Pensacola, 15.89 tons; built at New Orleans, La.

Schooner Clarence Barclay (tight bottom), of Pensacola, 25.03 tons; built at Salem, Mass.

Schooner Sarah L. Harding (tight bottom), of Pensacola, 31.31 tons; built in Maine.

Schooner John Pew (tight bottom), of Pensacola, 42.36 tons; built at Essex, Mass.

Schooner H. S. Rowe (tight bottom), of Pensacola, 56.50 tons; built at Essex, Mass.

Sloop Hope, of Pensacola, 5.46 tons; built at Pensacola.

Schooner Henrietta Frances (tight bottom), of Boston, Mass., 73.84 tons; built in Maine. Chartered.

OWNED BY MESSRS. E. E. SAUNDERS & CO.

Schooner smack Estella, of Pensacola, 38.57 tons; built in Connecticut.

Schooner smack Caro Piper, of Pensacola, 29.64 tons; built in Maine.

CHARTERED BY THE SANTA ROSA FISH COMPANY.

Schooner John Di Lustro, of Pensacola, about 21 tons; built at Pensacola, 1884.

VESSELS OWNED AT NEW ORLEANS AND MOBILE, BUT WHICH LAND THEIR FISH AT PENSACOLA.

Schooner smack Albert Hayley, of New Orleans, La., 47.95 tons; built in Connecticut.

Schooner smack Emma B., of New Orleans, La., about 31 tons; built in Mississippi.

Schooner smack Frances Ellen, of New Orleans, La., lost at sea by being capsized, January, 1885.

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* The wells on these smacks are used when practicable, but generally it is found more satisfactory to ice the fish, as has previously been stated.

Sloop smack Challenge, of Mobile, Ala., 29.24 tons; built in Connecticut; chartered by New Orleans parties.

Sloop smack Charles Henry, of New Orleans, 21.30 tons; chartered by New Orleans parties.

VESSELS LANDING THEIR FISH AT MOBILE, BUT OCCASIONALLY AT PENSACOLA.

Schooner smack Laurel, of Mobile, Ala., 33.07 tons; built in Maine.

Schooner smack Leonora, of Mobile, Ala., 32.02 tons.

From the foregoing it will be seen that, exclusive of the steamer destroyed by fire and the schooner capsized, there were twenty-one vessels, with a total tonnage of 709.21 tons, employed in the snapper fishery of the Gulf in the winter of 1884–'85.

In summer a number of sail-boats are employed, more or less regularly, in the red-snapper fishery. These are mostly of the class usually engaged in the oyster fishery in winter, and vary from 4 to 6 tons.

Among the sail-boats that are employed in the Pensacola red-snapper fishery, in summer, is one that deserves special mention, since in its rig as well as in some other peculiarities it is very distinctive in type.

It is a carvel-built, center-board boat, entirely open; with long, sharp bow; round bilge, fine run, and vertical, heart-shaped, square stern, the latter being rather light and very symmetrical. The rudder hangs outside, and is managed by a yoke, the yoke lines reaching forward of the mizzen-mast. This craft is rigged as a three-masted schooner, without jib, and carries three sprit sails, the mizzen only having a boom. The masts are adjustable and the smaller spars and sails can be substituted for the larger instead of reefing. So far as we know, this is the only three-masted open boat used in the fisheries of the United States, and we are not aware that on any other does the European custom prevail of substituting small sails for large ones when the wind increases. I am indebted to Mr. Stearns for the following interesting account of these boats, which, he says, are used by the negro fishermen of Warrington to go to the nearest snapper grounds during the summer.

They are owned chiefly by pilots and stevedores, who, having used them in their own trade during the winter, let them out in summer to reliable negroes for fishing, taking one share of the catch for payment.

Formerly, this type of boats was used almost exclusively by the pilots of Pensacola to board vessels at sea. The pilots would go from the shore at 2 or 3 o'clock a. m., and sail in various directions until sunrise, when the course was laid for home. A lookout was always kept from elevated stations on shore during the remainder of the day, and the sighting of a large vessel resulted in a general race between the whole fleet of boats.

Sometimes the morning run would take the most of the fleet 20 miles from land, and often very heavy winds and seas were encountered while out there.

At a later period, say eight or ten years ago, the stevedores were very actively competing with one another, and it became the custom to board vessels at sea to solicit the job of loading them. Various kinds of boats were tried for this purpose and the "pilot rig," as it is here called, was universally adopted as being the best. Whenever a vessel came in sight, there would be a dozen or more stevedores, and probably as many pilots, engaging in an exciting race for her; all using all sail and oar power. As the gains of success were large it became no object to spare money in perfecting the boats.

In 1878 and 1879 there was greater interest in the "pilot rig" boat than in almost anything else about Pensacola Bay. There were regattas in rapid succession, and the entries would range as large as 30 in number. In the day of the finest specimens they could and did outsail anything of equal size that could be found.

They have mostly been built by Robert Langford, who spent his whole time, with assistants, for ten years, exclusively in making these boats. The original model was the Whitehall pattern, but this has been greatly improved to meet the requirements of the trade in which they were employed.

Langford's boats are built with the greatest care, and are very expensive, but such is the excellence of their construction that, even with the rough usage which they receive they are durable, and prove a good investment in the end. Boats of similar rig and proportions were built at New Orleans and taken to Pensacola to compete with Langford's productions, but the former were all very badly outsailed.

Since large pilot schooners have come into use at Pensacola, and the stevedores have abandoned the custom of boarding vessels at sea, these boats have fallen into the hands of the fishermen. There are 12 or 15 of them now at Warrington that make a business of fishing about 8 months in the year. From four to seven men go in a boat, working for a share each. They leave Warrington at daylight, or before, and go from five to fifteen miles from the bar to small patches of fishing ground, and leave the grounds in time to carry their catch to Pensacola before the fish-houses are closed; or in cool weather, remain longer, and send the catch to market by one boat the following morning. Their daily catch ranges from 100 to 1,000 pounds of fish per boat, averaging probably about 400 pounds. The fishing gear is rigged similar to that used on the smacks, but is generally lighter. Ice is never used. These boats often sail 40 miles a day, going and returning, besides spending a large portion of the day on the fishing grounds.

Boats of this type are about 3½ beams to length, and their depth is practically the same in proportion as that of an ordinary Whitehall boat. They vary in size from 16 to 21 feet in length. The keel is shallow and quite wide in the middle for the center-board case. The centerboard is iron, and it is placed a little forward of amidships. A boat will have 3 or 4 thwarts according to its size. The stern is decked.

flush with the rail, for a length of 2 or 3 feet, and under this is a locker for food, &c.

The following are the materials used in constructing these boats. Timbers of mulberry or "tighteys," which are very strong and light; stem, keel, stern-post, and stern, of oak; plank of white cedar; gunwales of yellow pine, and thwarts of yellow pine or oak. The fastening and fittings are either copper or brass.

All have three sails, but the mainsail (or middle sail) is not carried except in light winds or when a boat is being driven hard.

The area of sail on these boats, says Mr. Stearns, is so large that they can be kept up in fresh winds, only by having a large amount of "live ballast." From three to seven men constitute a crew, and if a boat is racing all of these must be experts, and understand how to place themselves so that they may improve the stability and sailing qualities of the craft. Even with small sails and a moderate-sized crew, these boats will work to windward very rapidly, when most small craft will not "look" that way.

"I once came from Warrington in one during a gale," says Mr. Stearns, "when a 24-foot keel cabin sloop could not make any headway to windward. In ordinary winds and seas they will make a 3½ point course on a wind."*

The larger boats of this class cost $450, and the smaller ones from $250 to $300.

Each of the vessels carries from one to three dories of the pattern built in New England, from whence they are obtained. These are usually 14 to 15 feet long on the bottom.

4. APPARATUS AND METHODS OF FISHING.

Fishing-lines.—The hand-lines used in the snapper fishery are rigged in a very primitive manner, little attention being paid to elaboration and refinement of details, such as is common with codfish gear. But this lack of care in rigging the gear is because it would be superfluous, since the snapper usually bites so greedily that no refinement in the apparatus is required to entice it to take the hook, and also because the snoods and hooks are frequently carried off by sharks and jew-fish. Therefore, a fisherman who would spend hours in rigging a hand-line for cod-fishing, not neglecting the smallest detail that could add to its fineness and supposed attractiveness, will soon learn that all this care is not required in preparing snapper gear, and consequently will rig it as others do.

The lines are usually 50 fathoms long, of steam-tarred cotton, of a size weighing from 16 to 18 pounds to the dozen lines of 25 fathoms each. A lead sinker weighing 2½ to 3 pounds is fastened to the end of the

*I understand Mr. Stearns to mean that they will, when sailing close hauled, lay within 3½ points of the direction from which the wind may be blowing.

line. Two moderately long-shanked, round-bowed, eyed hooks are bent to the ends of a snood of smaller line (about 12 pounds to the dozen) of 10 or 11 feet in length, and this is fastened to the main line above the sinker by doubling the snood and passing the ends, with the hooks attached, through the bight and hauling it taut. One end of the snood is left to hang below the other about a foot. No swivels are used. The method of ganging is to pass the end of a snood through the eye of a hook, then around the shank and back underneath the standing part to form a hitch. The end, which is usually 6 or 8 inches long, is sometimes laid up on, and bent to, the standing part. More frequently, however, the end is simply cut off, or carried up and bent in a bowline to the standing part, no trouble being taken to lay the line together. The line is, in most cases, doubled above the hook to prevent its being bitten off.

Sounding-line.—Each vessel is provided with a sounding-line, which is also a fishing-line. The line itself does not differ from those previously described. The sounding lead weighs about 8 or 9 pounds, and has a cavity in its lower end to receive the arming, which is generally wax. A snood, about 3 feet long, with a hook attached to its end, is bent to the line some 2 to 4 feet above the lead. When the line is being used for sounding this hook is baited. Attached to the line, at a suitable distance above the lead, is a wooden toggle placed at right angles to the line, so that it can be grasped in the hand to throw the lead.

Trawl-lines.—It seems desirable to mention the fact that attempts have been made to utilize trawl-lines for the capture of the red snapper, this apparatus being precisely the same as that used in the cod and haddock fisheries from New England ports. For various reasons, however, trawls have not been found well adapted to this fishery. More fish can be caught on hand-lines than on trawls, for the following reasons: (1) the red snapper, as has already been stated, is found in schools of such limited extent that only a small part of a trawl could be set where the fish were, consequently the rest of the line would be put out to no purpose; (2) this being the case, the catch must necessarily be small, even if a fish was taken on every hook that crossed the school; (3) the snapper is so active and persistent in its efforts to escape that it frequently tears itself clear of a trawl-hook, especially if the latter is not well fastened; (4) the presence of sharks and large jewfish on the grounds in considerable numbers is a decided drawback to the use of trawls, even if other conditions favored it, for not only are fish liable to be torn from the lines or mutilated by these pests, but the apparatus is also exposed to the risk of being injured; (5) the snapper bites so freely at a hand line that more can be taken by this form of apparatus in a given time than by any other means that has been tried.

With the above objections to the use of trawls, and the additional one that they are far more expensive than hand-lines, there seems no reason to suppose that they will ever be profitably employed in this fishery.

Crimping tools.—The welled smacks, on which fish are kept alive, are provided with crimping-awls, sharp-pointed hollow tubes, of brass, set in handles so as to leave the handle-ends uncovered. These are used for crimping the fish, to let the air out of their swim bladders so that they can live in the well. Red snappers that are to be iced are also crimped to let the air out, but the tool used is generally a pitchfork or a pew—in fact, any sharp-pointed instrument that chances to be at hand—and less care is exercised than when the fish are to be kept alive.

Hand-haulers.—As a rule, the snapper fishermen use nothing to protect their hands, or to enable them to grasp the line more firmly. The extreme activity of the red snapper, when hooked, and the rapidity with which its bites, renders it impracticable to use woolen nippers similar to those worn by cod-fishermen on the banks. But a sort of hand-hauler is used by some of the Northern fishermen who come here, which is something like that which the boat fishermen of New England wear to protect their hands. This is much broader than the nipper, covering most of the hand; is double, and generally has a piece of woolen cloth between the two parts of knitted work.

Palmetto bindings.—Some of the New Orleans smacks, who ship their fish from Pensacola to the home port, carry quantities of palmetto leaves, which are used for binding or tying "bunches" of red snappers.

Other apparatus.—The pitchforks, fish-pews, gaffs, gob-sticks, &c., carried by the vessels employed in this fishery are essentially the same as those in use elsewhere, and need no special description.

Bait.—A vessel engaged in the snapper fishery usually carries from 300 to 400 pounds of salt bait on each trip. This is generally lady fish, bluefish, or skipjacks, though the common mackerel (*Scomber scombrus*) and the Gulf menhaden (*Brevoortia patronus*) are sometimes used. Salt bait is put on the hooks when the vessel first arrives on the ground, but after fishing has begun fresh bait is chiefly used, the hooks being "pointed" with pieces of the salted article which is considered the most attractive. Jewfish, groupers, porgies, leather-jackets, and sharks are used for bait; in fact, almost any fish that are caught on the lines, even to red snappers, though, of course, the latter are not taken for this purpose when fish of less value can be obtained, which is generally the case. The fresh bait has the advantage of being very much tougher, as a rule, than that which is salted, and therefore cannot so easily be torn from the hooks. Porgies are said to be more attractive bait than most of the other varieties used fresh, and we had an opportunity for noting that the red snapper prefer it to the grouper, both of which we tried on our hooks.

It is said that after the 1st of March the snapper is far more dainty than during the winter, and then choice varieties of fresh bait are required; lady-fish and bluefish are preferred.

There is nothing peculiar in the manner of baiting the hooks. The bait is cut into irregularly shaped pieces, about 2 inches in diameter, and of varying thicknesses. Two or three pieces are put on each hook, and sometimes more are used if the bait is thin.

Methods of fishing.—The methods adopted for finding and catching the red snapper are peculiar, and, so far as we are aware, differ from those of any other fishery, either in America or Europe. As has already been stated, a remarkable habit of this species is to collect in schools of limited extent on bottom generally composed of black sand, live coral, small rocks, and coarse gravel. As a result of this peculiarity, a vessel may be within a stone's throw of a fine school of fish, and not a single sign of their near presence be manifest to the fishermen, so far as getting a bite is concerned. The natural inference to one unacquainted with the business would be that no fish were near, but experience has taught that such a decision is liable to be erroneous. When, therefore, a vessel has reached the ground, and the depth and the material brought up on the lead are both indicative of the possible presence of snappers, the mate of the vessel begins throwing the sounding lead at short intervals, the hook on the line being baited before the sounding begins. So ready is the snapper to take the bait that it is confidently expected that one will be caught on the sounding line almost the instant it reaches bottom, should the lead strike the ground where there is a school of fish. This being the case, the vessel is not hove to at all. If the wind is light, she stands back and forth—usually by the wind—with a good full, but if there is a fresh breeze she must be luffed into the wind, to deaden her way, so that the lead will reach bottom. In either case the mate stands on the rail, grasping the main-rigging with one hand, and heaves the lead far ahead of the vessel, every few minutes; and such dexterity is acquired in this operation that it is currently reported that some individuals can throw a lead over 20 fathoms before it strikes the water. One who falls far short of proficiency in this part of the work is not accounted a good mate for a snapper catcher.

The sounding goes on continuously until a fish is caught, the vessel standing off and on, constantly crossing from one edge to the other of the fishing ground. As soon as a snapper is taken the main boom is guyed out, the jib hauled down, and the vessel hove to. While this is being done a buoy with anchor and line attached is thrown over to mark the spot, or else a dory is hoisted out and a man springs into her with his line, throws out his anchor to hold on, and immediately begins fishing. As soon as possible, all hands on board the smack get out their lines and begin to pull in the snappers as rapidly as they can. In a short time, however, the vessel drifts off the fish and not a single bite can be felt. It is now that the wisdom of putting a mark on the ground is apparent, for there is no difficulty in finding it, and the uncertainties of guessing are eliminated. Then, too, trials can be made on all sides of the first position, if deemed desirable, and the precise locality where fish are most abundant can be fully established. This point having been settled to the satisfaction of the skipper, the anchor is generally let go, so that the vessel, when a "scope" is paid out, may be as nearly over the center of the school as possible. Now the work of fishing begins in good earnest, and if the snappers bite well, which is usually the case, they are pulled in with a rapidity that is surprising. We are assured by the most reliable authority that the numbers taken in a limited time are very much greater than would be believed possible by one unacquainted with the fishery. Mr. Stearns tells me that smacks have taken as many as 1,700 to 1,800 fish in a single day, and on one occasion a fisherman who sailed in one of his vessels caught 400 fish as the result of one day's work.

When fishing begins, the snappers are usually caught within 6 or 8 feet of the bottom, but if the school is large and the fish hungry, they soon follow the lines up in the water, and in a little while can be taken by pairs only a few fathoms from the surface. At such times the energy and dexterity of the fisherman is fully tested, and he who is quickest at pulling in his line, unhooking his fish, rebaiting his hooks, &c., catches the greatest number of fish, and correspondingly becomes more valuable to his employer.

When the fish are to be kept alive in the well of a smack, much more than ordinary care must be taken of them, and consequently some of the rush is dispensed with and fewer fish are taken. As the snappers are pulled in they are carefully unhooked, and the crimping awl is quickly inserted under the fourth scale, behind the sharp, angular projection of the gill-cover, which is a distinguishing feature of their heads. This lets out the air with which they are almost always inflated, after which they are put into the well.

Fishing usually continues without cessation until the snappers cease biting. If darkness puts a stop to the fishing the vessel generally lays at anchor until the next morning, when she may get a second "spurt." It more commonly happens, however, that the fish cease to bite while there is yet daylight, the inference generally being that the school is very much broken up, though in some instances it is evident that the fish are still very abundant, since they can be felt knocking against the gear and occasionally nibbling at the hooks. But it is difficult to catch one. They take such a dainty hold of the bait at such times that it is only now and then that one is hooked firmly enough to bring him to the surface. It is probable that the fish are gorged with bait, since there is no other plausible reason that can be given for their change from remarkable voracity to almost total indifference to food. The common mackerel has a similar habit.

As soon as the fish cease biting, if there is still enough of the day left to "try around," the vessel gets under way and the process of sounding for a new school is begun and continued in the same manner as has been described, while the rest of the crew proceed to take care of the fish, if they are to be iced.

It occasionally happens that one, two, or even more days may sometimes be spent in searching for fish without finding a good school, and in winter fishing is often very much interfered with by continued rough weather. In strong winds the sea is short and nasty in this part of the Gulf, and it goes without saying that "sounding out a berth" cannot be successfully continued in heavy weather. If, however, a vessel is anchored on fish, they can be caught in pretty bad weather.

Although the men fish from the deck, as a rule, when the vessel is at anchor, it should be stated that sometimes in fine weather a portion of the crew go out in dories at various distances from the smack. Hand-lining in dories for codfish is very much more profitable than fishing from the deck of a vessel, but in the snapper fishery the conditions are so different that the same advantageous result is not always obtained, though occasionally the boats are able to find better fishing than can be got on the vessel.

Some of the snapper-catchers do not anchor, unless in exceptional cases, but prefer to fish at a drift and work back to windward whenever they have lost good fishing.

5. CARE OF THE FISH.

The method of caring for the fish that are kept alive has already been indicated, in part, at least. It remains to be said that much care must be exercised to prevent them from dying in the well from suffocation, in case of calms, when the vessel lies motionless. It is then necessary to get up an artificial circulation of water by "bailing the well," or adopting some other means to effect the same object. It is also necessary to sweep the well with a dip-net at intervals, and remove any fish that are dead. These are iced.

Those vessels which ice the whole of their catch carry about five or six tons of ice each trip, in winter. These are provided with a series of pens built in the hold, in which the ice is stowed and the fish packed.

The snappers are not eviscerated, but are carefully washed before being iced. They are then thrown into the hold and packed in the pens. A layer of broken ice, 8 or 10 inches thick, is first put on the floor of the pen, and on this is laid a tier of fish. Just here there is some variation in the methods adopted by different men. Some skippers are very particular about having the fish packed carefully in the pens by hand, and always laid on their sides in regular order in the tiers. But others simply pitch the fish in helter skelter, and pay no regard to the order in which they are placed.

After a tier of fish is put in the pen it is covered with pounded ice (the latter, however, not being very fine), then follows another tier of fish and more ice, until the compartment is nearly filled, a covering of ice several inches thick being put on top of all.

Groupers (red and black), scamp, and other marketable kinds of fish that are sometimes taken with the snappers, are iced in the same pens and in the manner above described. The groupers are little valued at Pensacola, and no one thinks of catching them in quantities as they do snappers, though a few are sometimes taken.

6. RUNNING FOR MARKET.

When a fare is obtained it is desirable for the snapper-catchers to make port at the earliest possible moment, because their cargo is a perishable one, and the sooner they can reach a market the better will be the condition of their fish. Therefore, as soon as it is decided to run in, all sail that the vessel will carry is piled on, and she is driven to her utmost. This is particularly the case if there is a possible chance of reaching Pensacola Bar before day closes, since, to avoid laying off the harbor all night, the vessel is crowded as much as she will bear, if there is wind enough. If, however, she cannot reach the bar before nightfall less sail is carried, for unfortunately, owing to a lack of suitable range-lights, it is not safe to attempt to cross the bar at night, particularly in bad weather. Occasionally this is done by the fishermen, but the risk of running aground is too great to warrant the attempt.

7. LANDING OF THE CARGOES AND DISPOSITION OF THE FISH.

When a vessel reaches the wharf the fish are hoisted from her hold in tubs to the storehouse, where they are weighed and packed for transportation. The method of packing varies somewhat, though it may be stated in general terms that all the iced fish, except those sent to New Orleans, are eviscerated before being packed for shipment. At New Orleans, fish that have been eviscerated do not sell well, we were told, though it seems strange that such a prejudice should exist.

I had the opportunity of seeing a fare of snappers packed at the storehouse of the Pensacola Ice Company. After being weighed, the fish were ripped down the belly with a knife, beheaded with a hatchet or ax, eviscerated, and packed with ice in barrels, without being washed.

Warren & Co. make a small slit near the vent of the fish instead of ripping it open; the intestine is cut near its posterior extremity, the head is then cut off and the viscera pulled out. Fish treated this way, and washed clean, look much more attractive than if ripped open. The snappers shipped by this firm to E. G. Blackford, New York, are not beheaded. The gills are taken out and the viscera removed in the manner described.

The red snapper is remarkable for the length of time it will keep in excellent condition in ice. Packed in barrels or boxes, in the way we have mentioned, it is sent all over the country, more particularly to the large cities; going as far as Boston in the Northeast, Chicago in the Northwest, Denver in the far West, New Orleans in the Southwest, and Jacksonville in the Southeast. Incidentally, the fish may reach a greater distance. Thus, they sometimes go to Galveston, and it is claimed that Minneapolis is supplied with them. Some of the cities inside these limits, such, for instance, as Saint Louis and New York, are among the best markets for the red snapper.

There are certain peculiarities about the method of shipping fish to New Orleans from Pensacola that are worthy of being noted. As has been stated elsewhere, there are a number of New Orleans smacks engaged in the snapper fishery that ship their catch from Pensacola to the home port. Arrangements are therefore made with the railroad managers to insure a box-car being placed at the disposal of the captain of a smack whenever he chances to need it, and he takes the responsibility of packing his fish in the car for transmission to his agent or the owner of his vessel at New Orleans.

On one occasion I saw the smack Albert Hayley discharging a cargo of fish at Pensacola and packing them for shipment to New Orleans. The greater part of the fish lay on deck tied up in "bunches" (with palmetto leaves), roughly estimated to weigh 25 pounds to the bunch. We were told that it is customary to ship this way to the New Orleans market and that a certain price per bunch is paid for the fish, the amount in this instance being $1 per bunch.

Part of these fish had been taken alive from the smack's well, and the rest had been iced; none were eviscerated. The fish were packed with fine ice in a box-car, the bunches being stowed so that the heads were up.

All of the fish shipped from Pensacola go by rail, except those sent to New York; these are generally shipped via the Savannah Steamship Company's line.

8. LAY.

As a rule, the captain of a vessel is the only person on her who receives a share of the proceeds, or, to put it in technical language, the only one who goes on shares. The rest of the crew are hired. The average wages for a mate, who must be a first-class fisherman and a man of considerable experience and judgment, is $40 per month. The other members of the crew are paid an average of $25 per month to each man. Boys are seldom carried, and the wages of the men are governed somewhat by their efficiency, a good fisherman, who is reliable and steady, commanding higher pay than one who is deficient in these qualities.

The settlement between the owners and captain is effected in the following way: All of the fitting expenses, including such articles as provisions, fishing gear, bait, ice, &c., and the wages of the crew, with the exception of the mate and the next highest-priced man, are deducted from the gross stock, the remainder being termed the net stock. The skipper receives one-fifth of this net stock as his "share," and 8 per cent. on two-fifths of the net stock as captain's commission. From her four-fifths of the net stock the vessel pays the wages of the two highest-priced men (one of whom is the mate) and the captain's commission; also, of course, her expenses for insurance, wear and tear of sails, rigging, and hull.

9. FINANCIAL PROFITS OF THE SNAPPER FISHERY.

The scale of prices paid by the Pensacola dealers is as follows: 3½ cents per pound for red snappers of 8 pounds' weight and less. Fish weighing more than 8 pounds bring 25 cents each. As the average of the latter is about 12 to 13 pounds, the price is, approximately, 2 cents per pound. The average price is, therefore, about 3 cents per pound. Taking this as a basis, we are able to get some idea of the business from the following notes on the amount of fish taken by several vessels belonging to the fleet of Messrs. Warren & Co.:

The schooner Sarah L. Harding, in ten months during the year 1884, caught 155,000 pounds of red snappers with a crew of six men. In December of the same year, with a crew of nine men, she landed 30,000 pounds of these fish.

The schooner John Pew in three and a half months, ending December 31, 1884, landed 110,000 pounds of snappers.

The schooner Clarence Barclay in six and a half months' fishing, in 1884, landed 110,000 pounds.

If a vessel gets 1,500 fish, weighing 7,500 to 10,000 pounds, each trip, it is considered a good fare. This is often exceeded, however, by the larger vessels now employed. While we were at Pensacola in the Albatross we learned of the arrival of two schooners, one of which had 3,500 snappers, and the other about 2,500.

The trips vary a great deal in length. A vessel may be fortunate enough to get a good fare and return to port after an absence of no more than two or three days. At another time she may be prevented from fishing by rough weather for a week after sailing, and other things may cause her to stay out two weeks. Even then she may be unfortunate enough not to find fish abundant, and may return to port with a half fare.

The three last months of the year—October, November, and December—are the best for this fishery, since at this season a greater catch is made than at any other time, and the demand is usually good. From the middle of March to the middle of June comparatively little is done. The fish can be caught in considerable quantities, but the demand drops off a good deal after Lent. It is more than probable that the demand for the red snapper is greatly influenced at this season by the many kinds and enormous quantities of other fish, from sea, lake, and river, that fill the markets of all the principal cities. Owing to this lack of demand for fish, as well as to the difficulties attending their preservation in hot weather, the vessels generally haul up for two or three months in summer.

10. HISTORY OF THE RED-SNAPPER FISHERY.

The fishery for red snappers began more than thirty years ago, according to Mr. Bartholomew, a veteran fish-dealer of New Orleans, but the date is not exactly known, because for many years after its inception it was so limited, and carried on in such a desultory and primitive manner, that little importance was attached to it as a fishery. Indeed, it may fairly be said that the catching of snappers did not attain proportions to entitle it to the distinction of a separate fishery until about 1870.

In regard to the discovery of the habitat of the species, the same authority says that the snapper grounds were found in a somewhat accidental manner. Sometimes, in going along the coast, the shore-seine fishermen would find themselves becalmed in their sail-boats, and not unfrequently they would drift several miles from the land. At such times they would put out hand-lines to catch barracouda, kingfish, and other varieties that are found near the land, in this region, during spring and summer. But occasionally the boat would drift over a school of red snappers, which would bite eagerly, so that sometimes considerable quantities were caught. At first the excitement and sport attending the capture of the fish was probably more of an incentive for the fishermen to take them than anything else, for it is said that comparatively little was then known, even by the coast population, of the food qualities of the snapper, and a small quantity sufficed to supply the demand. But the merits of the species came to be gradually known in the Gulf States, where it steadily grew in favor, and the demand increased proportionately, though it necessarily could not be large in a sparsely settled region. Notwithstanding, however, that the red snapper came to be highly prized in Southern markets, little or nothing was known of it as a food-fish in the North and Northwest until after 1870. It is a somewhat significant fact, as illustrating this point, that several years later the snapper was described by Messrs. Goode & Bean as a species new to science.

"In the year 1869 Maj. John C. Ruse and S. C. Cobb, who had bought out the stockholders of the citizens in the 'Ice Company,' proceded to add to that business the catching and selling of the Gulf deep-water fish. They bought the smack Gladiator, of 22 tons burden, and began in a small and irregular way the sale of that famous fish, the red snapper. Upon the death of Major Ruse, his interest was purchased by A. F. Warren, and so little was the business [of snapper fishing] valued, owing to the rates of express to various points, that the ice company added a coal business in order to keep their men and teams employed the year round. Little by little concessions were obtained from the express company until 1876, when L. H. Sellers became an active stockholder. In the mean time the fish business grew so as to require the catch of several Yankee smacks, who came into the Gulf during the winter, and returned North in May." *

The formation in 1871 of the Pensacola Ice Company, which included the above-named parties, is an event worthy of note, since this firm continued the fish business begun two years previously. For some

* Extract from article by S. C. Cobb, in Pensacola Commercial, December 10, 1884.

time, however, the supply of snappers was furnished chiefly by the "Yankee smacks," for the company owned no tonnage. The schooner J. W. Wherrin, the first smack bought at Pensacola expressly for the snapper fishery, was purchased by the Pensacola Ice Company in 1879. The next year the smack Ripple was bought, and in 1881 the schooner Niantic and steamer Millie Wales were added to the fleet controlled by the company. With the exception of the Millie Wales, that was recently burned, the company still owns the above-named vessels, besides which two smacks from Stonington, Conn., are chartered by the firm.

In the mean time, in 1880, Messrs. A. F. Warren and Silas Stearns, who for many years had been associated with the Pensacola Ice Company, withdrew from it and organized a fishing firm under the name of Warren & Co. This firm soon after began to purchase vessels, of which it now owns five and charters one—the largest fishing fleet controlled by any company at this port.

According to Cobb, "Messrs. Vesta and Mathews began in 1880, and the Santa Rosa Fish Company in 1882." The last of these has one vessel, while the firm of E. E. Sanders & Co., which engaged in the business in January, 1885, employs two smacks. Vesta and Mathews have no tonnage, but buy fish from vessels or boats as they have opportunity.

The present status of the red-snapper fishery at Pensacola, so far as the number of vessels and men employed, the catch and distribution of fish, &c., is given elsewhere, and certainly shows a growth that is gratifying, and which would seem to indicate a material increase in the future, when it may be reasonably supposed that the demand will have become much greater for this species than it now is. In regard to the general fisheries of Pensacola—of which that for the snapper forms the chief part—Cobb says there are employed "constantly from one to two hundred men; the product of their labor supports 1,000 of the city's population, with a probability that it will equal in value the entire lumber trade of the port in less than ten years." While this anticipation may be criticised as too ambitious, it nevertheless shows what those interested in the business have reason to hope for.

11. GENERAL CONSIDERATIONS.

In view of the fact that it is claimed by those who have had the best opportunities for observations that the red snapper is rapidly becoming scarcer on the grounds where it is now taken, it seems eminently desirable that the means for preventing this depletion should receive consideration. For, if it is true that a marked diminution has already taken place, there is then reason to expect that it will continue with an ever-increasing ratio until the species is so much reduced that there will no longer be any profit in fishing for it. That such an event will happen we cannot say, but it is safe to assert that it would be a great misfortune if it did, for not only would an industry be broken up, but the com-try at large would be the loser in being deprived of one of the finest of our edible fishes. What then can be done to prevent this? Only two ways of preventing it occur to me now: first, the discovery of new fishing grounds that may be worked while the old ones are recuperating; and, second, the application of such aid as may be given by fish-culture.

It is a matter of congratulation that the recent researches of the Albatross have demonstrated the important fact that there is a large area of ground yet unworked off Tampa, and south of it, where the snapper is seemingly more abundant than where it has formerly been sought. This opens up a new field for work, and if it is entered on before the old grounds are too much exhausted the latter may regain their former richness; but if this is not done in time, there will be little chance for them to recover. Of course, to go to these more distant grounds requires more or less "change of base." Either the fish must be landed at Tampa, or else swift-sailing vessels, of 45 to 50 tons, will have to be employed, if the catch is to be taken to Pensacola. And in the latter case it will probably be necessary to eviscerate the fish on board the vessels before they are iced, which would no doubt make a great difference in the time they could be kept in good condition. It is also possible that some improvements might be made in the ice houses on board the smacks, though experience has proved that comparatively little can be done here.

As to the artificial propagation of the red snapper, it must be confessed that so very little is known of its breeding habits at present that it is impossible to say what may be done in this direction. We do not yet even know the number of eggs it contains or whether they float in the water or adhere to the bottom, though we might expect that the former is the more probable.

It does seem highly desirable, in view of existing circumstances, that some capable person should have the opportunity of studying the breeding habits of this species, since data could thus be obtained that would be of the greatest importance should an emergency ever arise when it may be necessary to propagate the snapper by artificial means.

B.—PENSACOLA INSHORE FISHERIES.

In Pensacola Bay, and on the outside beaches in its vicinity, a fishery is carried on with open boats and seines for the species that can be taken near the shores and in the bayous and lagoons, while there is an oyster fishery in the bay, the product of which is marketed at the city.

1. THE MARKET SEINE FISHERY.

The seine fishery of Pensacola supplies the chief part of the fish used in the city for a considerable portion of the year, besides producing quantities that are shipped to other markets. Ten boats and fifty men find employment in this fishery in winter, but double that number engage in it from spring to fall.*

* I am indebted to Mr. Rudolph Hernandez, who has followed the market fishery for twenty years, for many facts concerning this industry.

The fishing grounds.

Pensacola Bay, as well as the shore bordering the Gulf in its vicinity, is remarkable for the extent of sand beaches that may be utilized for seine hauls. It would be useless to attempt to particularize concerning these, since there are such long stretches of good ground, that, perhaps, it may be said that there are comparatively few places where fishing may not be prosecuted. Besides the beaches that border on the bay and face the sea, there are good grounds for seining in the lagoons or bayous, several of which extend inland from the bay. The largest of these is the bayou that has its entrance near the ruins of Fort McRae, on the western side of the harbor's mouth, and this is considered a favorite fishing ground. As a rule the water is shallow for a considerable distance from the beaches, and, therefore, the seines are made to correspond, and are never deep, since the fish are hauled on the shore. From April to October is the best season on the sea-beach, where pompano, bluefish, Spanish mackerel, sheep's-head, sea trout, lady fish (the latter for bait for the red-snapper fishermen) are caught, besides several other kinds that are not marketable. Some of the latter are edible, though not in demand. During the same season fishing is carried on in the bay, chiefly for mullet, trout, croakers, chopers or spot, and pigfish, which are taken with several other varieties. In the spring and fall, when the fish are migrating along the coast, the best fishing is found on the Gulf shore. In winter, seining is carried on in the lagoons, where more or less fish are found at this season, and on the shores of the bay. Most of the species caught in summer, in the bay, are also taken in the winter, though many kinds are less plentiful.

Apparatus.

Boats.—The seine-boats of Pensacola average about 20 feet long, 7 feet beam, and 2 to 2½ feet deep. They are carvel built, open boats, with shallow keel, center-board, sharp bow, round bilge, long, low, rather flat floor, short run (with skag), and deep, heart-shaped, vertical, square stern, similar to the stern of an ordinary ship's yawl. At the bow, some 5 or 6 inches below the gunwale, is a sort of half deck or platform, 3 feet long, and there is another crossing the stern about 18 inches long, fore and aft. On the latter the skipper of the boat stands to throw out the seine, and also to "pole the boat," as the process of guiding her with a pole is called. This method of controlling the movements of the boat is preferable to any other in the shallow waters where seining is done.

The frame is usually oak, the plank of juniper or cypress, and galvanized iron is used for fastening.

The majority of the boats are cat-rigged, carrying a single large sprit-sail, but a few have two sprit-sails. A boat costs about $125.

Some of the boats, more particularly those used in winter, are ship's yawls, that have been bought at a low price. They are rigged like the others.

Each boat has a crew of five men who work on shares, the proceeds being divided into 6½ parts (if the skipper owns her), one share going to each man, one to the seine, and one-half a share to the boat. If the skipper does not own the boat, he gets one and a quarter shares, the extra one-quarter share being given to him to keep the seine in repair, and also for his care of the boat.

Seines.—The seines used at Pensacola are 75 fathoms long, when hung, and 85 meshes deep, the size of the mesh being 2½ inches, stretch measure. Two sizes of twine are used in their construction—Nos. 12 and 16—the smaller size in the wings and the larger in the bunt. Each seine has a large bunt bag 350 meshes in circumference at its mouth, and tapering to a point, its general shape being that of a cone. The cork rope and lead (or foot) line, to which the net is hung, are ⅞-inch Russia hemp bolt rope. The floats are "home-made," of white cedar or juniper root. The leads on the foot line weigh 2 ounces each. Three of these are on the foot line at the mouth of the bunt bag, and elsewhere they are put 15 to 16 feet apart. A pole—locally called a "staff"—is bent to each end of the seine, so as to keep the ends vertical in the water and the foot line close to the bottom. The lower end of each of these is weighted with 6 or 7 pounds of lead, to make it keep upright and "hug the ground."

The average seine will "fish" in 11 feet of water; that is, when set in that depth its lower edge will sweep the bottom so that fish cannot escape beneath it. Some of the seines taper at the wings, but others are uniform in depth. Two hauling lines are used with the seine, one 16 and the other 26 fathoms long. In setting the seine the short line goes out first, its end being left on shore when the boat shoves off, and the longer, or "boat line," is bent to the other end of the seine, to run to land after the net is out.

Nets.—It may be mentioned here that a few trammel nets are used, chiefly by Spaniards, for the capture of various species in the lagoons.

Methods of fishing.

There is no regular time for fishing. Some gangs work all night and go to market in the morning, while others begin at daylight and leave the beach for Pensacola about 2 or 3 o'clock in the afternoon.

The fish are generally seen before the seine is shot, and they are usually moving along the shore, particularly when migrating. A boat goes along until a school is seen, when the net is put out to inclose them in a half circle. If they are some distance from the shore the seine lines are used, but otherwise it is set without them. In the latter case one man jumps over, near the beach, with the end of the seine, which he drags far enough in to intercept the progress of the approaching fish. In the mean time the boat shoots rapidly away, circling around the school, the skipper throwing over the seine, the last end of which is soon landed. If this does not reach the shore, some line may be run out, but, more commonly, the men jump overboard into the shallow water and drag it in, part of them going to the other end. One man is left in the boat, which he quickly shoves aground, and then runs to join his companions and assist them in landing the seine. All this work is performed in the most rapid manner, for these Southern fish are exceedingly quick in their movements, and no sooner do they find themselves obstructed in their onward course than they dart about, seeking some opening to escape from, and oftentimes they jump the cork-rope and regain their liberty. The mullet is celebrated for the ease with which it will go over a cork-rope, as well as for its general habit of jumping, which has earned for it the appellation of "jumping mullet." The large bunt-pocket, which is a characteristic of the seines used here, is very useful for preventing the loss of fish, for, when frightened, they usually rush into this, as it seemingly offers a chance to escape, and before they can correct their mistake they are drawn to the shore. The catch is usually landed on the beach; such fish as are marketable are put in the boat, and the rest are left to die or are thrown in the water.

Disposition of the catch.

The fish taken by the Pensacola market boats are all sold fresh, sometimes by wholesale to dealers, who ship them to distant cities, and at other times they are hawked about the streets. Formerly, there was a police regulation by which the fishermen were prevented from hawking their fish until after 7 a. m. Those arriving before that hour usually engaged a stall at the market, where they exposed their fish for sale.

Prices, depending on supply and demand, fluctuate a great deal, and there is even a greater diversity in the daily earnings, which vary from a few cents to $5 per day for each man. The average year's work for a man in this fishery is estimated at $250.

2. SPRING AND FALL FISHERY AT THE EAST PASS.

At the East Pass of Santa Rosa Island a seine fishery is carried on in spring and fall that may justly be included with the market fisheries of Pensacola, since the catch goes to that city.

Capt. A. Destin was the pioneer of this fishery, which he began shortly after the close of the war (1861–'65). At first he salted his catch, and this was continued until 1876, since which time the greater part of the fish have been disposed of fresh to the dealers at Pensacola. The originator of this industry is now dead, but the business is still carried on by his family, who employ two or three boats and make an average yearly stock of about $3,000.

Messrs. Warren & Co. have established a camp at the Pass, and during the "run" of fish in spring and fall have one boat and a seine gang employed here.

Fishing is done wholly with drag-seines, in the manner already described, with the single exception that a man goes along the beach to watch for approaching schools of fish, whose presence he signals to his companions in the boat. This enables the fishermen to be prepared in time, and, if desirable, they can lay out the shore-end of their seine so that they have only about one-half of it to shoot after the fish come within its radius.

The fall fishing continues from October 1 to January 1, and the spring fishery from March 1 to June 1. At the latter date the weather gets too warm to keep the fish in good condition Years ago the fishery for pompano was discontinued in April, as soon as the fish had spawned, but now they are in high demand at a much later date, and, as a matter of fact, are said to bring higher prices than in the fall. The fish caught at the East Pass that are most valued for food are the pompano, Spanish mackerel, bluefish and sheepshead. Many other kinds, of less value, are also taken.

3. POUND FISHING.

Although the attempts to use fish pounds at Pensacola have so far resulted only in failure, it is worthy of note that this form of apparatus has been tried in these waters.

In 1881 Mr. Stearns built a pound at Pensacola Bay, but it proved unsuccessful, owing to the great numbers of large predaceous fish which destroyed the netting. Another pound was tried in 1884, at Grassy Cove, Santa Rosa Island, but met with a similar fate, being torn to pieces by tarpum.

4. OYSTER FISHERY.

The Pensacola oyster fishery is not a specially important industry. A few boats find employment in tonging oysters in winter, and in summer some of them engage in the red-snapper fishery, taking one or two tons of ice and going to the grounds nearest the land.

Some of the boats, Mr. Warren tells me, are of a nondescript form, having been improvised from ship's yawls, while a few are small decked sloops and schooners ranging in size from three to five tons. Both of these types, which we have mentioned, are round-bottomed, square sterned, keel craft, but they vary a good deal in form and general appearance.

The typical oyster-boat is, however, of a very different kind. It is made on the sharpie pattern, is flat bottomed, wide and shallow, carvel built, with sharp bow, wide, square stern, and carries a center-board. It is roughly built, has considerable camber to the bottom, especially aft, and is provided with a skag and stern-post. It has a half deck forward, and a deck 3 to 4 feet long at the stern, while wash-boards extend along the sides. It is generally built wholly of yellow pine, but red-cedar frames are sometimes used. According to Stearns, both the cat-rig and and sloop-rig is in vogue, in either case a boom and gaff mainsail being carried. The size ranges from 21 to 26 feet in length, and 7 to 8 feet in width. Two men constitute a crew. They usually content themselves with making one trip each week, and consider five to twelve barrels of oysters a fair take.

C.—Fisheries of Saint Andrew's and Saint Joseph.

The shore seine fishery is the only one prosecuted from these harbors. There has not yet been any hook-and-line fishing, and the abundance of sharks, saw-fish, and tarpum, or silver-fish, would make it difficult, if not impossible, to profitably employ gill-nets or pounds.

The seine fishery is prosecuted chiefly in the spring and fall, when various kinds of fish are migrating along the coast. At this time, for a few weeks or months, as the case may be, the business reaches quite important proportions, 25 boats and 150 men being employed from Saint Andrew's, and 3 boats and 18 men from Saint Joseph. A few of these men may, perhaps, do more or less fishing throughout the year, depending on it chiefly for a livelihood, but nearly all are farmers, whose principal dependence is on agricultural pursuits, but who thus utilize the time, in autumn, that cannot be turned to profitable account on their farms. Having harvested their crops, they leave their homes, which are often some distance inland, and go to the coast to gather the harvest of the seas. The majority of the scattered coast population are also farmers, to a greater or less extent, though many of these fish in spring as well as fall, and probably derive the chief part of their income from the sea.

1. FISHING GROUNDS.

The sandy beaches which stretch along the Gulf coast, and are numerous in the harbors and bays of this region, afford abundant opportunity for hauling seines, and these constitute the fishing grounds.

Mr. N. W. Pitts, of Saint Joseph, tells me that pompano, Spanish mackerel, bluefish, sheepshead, mullet, sea trout, redfish, and a few other less important species are taken on these grounds. There are also many kinds that are not marketable taken in the seines, these being called "sorry fish" or "waste fish."

Pompano are caught in the greatest numbers in May and June. Sometimes they are fairly abundant in April, and occasionally a few are taken in March.

Spanish mackerel and bluefish are caught in spring from April 1 to June 1, and in fall from October 1 to December 1. Sometimes the Spanish mackerel are caught in schools by themselves, but more frequently they are mixed with other species.

Sheepshead are also taken in the spring and fall, but are seldom seen schooling by themselves. Mr. Pitts says "they are a fish that run with others."

Mullet are caught from October 1 to December. At this season they go in schools along the shore, and are seldom fished for in a greater depth than 6 feet.

Sea trout are taken with other fish, in spring and fall.

Redfish are also caught in limited numbers, mixed in with other kinds. They are in little demand, and are never fished for as a specialty.

It may be stated that the capture of mullet is the principal fishery in the fall, and the other species taken at that time are usually caught with the mullet. It would appear from the statements of the fishermen, and from my own observations, that the food-fish on this coast have a habit of "running" together that is seldom seen in Northern waters; therefore, not only may the same locality be a fishing ground where many species can be taken, but a dozen kinds may be caught in one haul of the seine..

2. APPARATUS AND METHODS OF FISHING.

Boats.—The boats used for seining at Saint Joseph are of the sharpy type, and locally called "skiffs." According to Mr. Pitts, they are long, narrow, and deeper in proportion than this style of flat-bottomed craft is usually made, being 24 to 25 feet long, 3 to 5 feet wide, and 18 to 20 inches deep. They have a rather narrow stern, across which, on top of the gunwale, is a platform, 5 feet square, for the seine to lay on. There are four thwarts for the rowers to sit on. Sails are seldom used. The boats are rather roughly built, by the fishermen themselves, red cedar being used for frames, yellow pine for plank, and galvanized iron nails for fastening. Six men constitute a crew for one of these boats, and they are called a seine gang.

Seines.—The average length of a seine is 115 fathoms. For one-half its length, in the center or bunt, it has a uniform d[illegible] of 11 feet, when hung, but from this it tapers to 4 feet at the extreme end of the wings. The bunt-pocket is 26 feet long, its mouth made square, each side having 100 meshes, which is the depth of the seine in its bunt. The mesh is 2½ inches, stretch measure. Cork floats and lead sinkers are used on these seines.

Methods of fishing.—The methods of seining are essentially the same at Saint Andrew's and Saint Joseph as at Pensacola, the only difference being that no end ropes are used at the former places, the men always jumping into the water to drag ashore the wings of the seine if they do not reach the land.

3. CARE OF THE FISH.

The early-caught fish are often marketed fresh, but with this exception they are salted, and packed in "Boston barrels," that are obtained from Pensacola, to which port they are shipped from the North. About a bushel of salt is required for a barrel of fish.

The above applies more particularly to the fish taken at Saint Joseph. Many of those caught at Saint Andrew's, as stated elsewhere, are disposed of to the local country trade.

4. DISPOSITION OF THE CATCH.

Mr. Pitt says that the fish taken at Saint Joseph, both fresh and salt, are sold chiefly to Pensacola parties, and he gives the following list of prices, per barrel, of 200 pounds of salt fish: Mullet, $5; Spanish mackerel, $8; pompano, $10; sheepshead, $5; redfish, $3. The above are the prices paid on the spot where the fish are taken, by the firms, who usually send a schooner down along the coast to purchase the catch of the seiners. Bluefish are not salted, and redfish are in very little demand when cured in this way. Mr. Pitt says he "sold a few of the latter on one occasion, but that it was a mighty sorry sale."

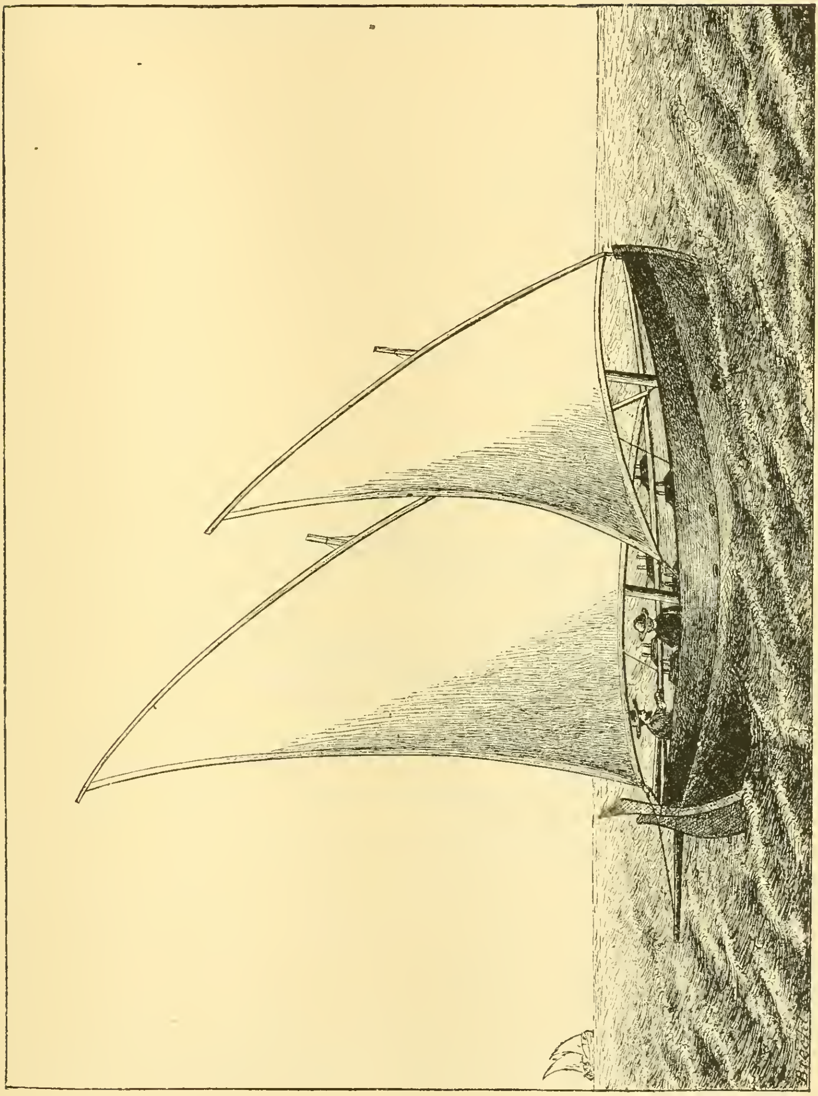
Mullet are most highly esteemed when they are filled with roe, but they are often so abundant along the coast that the supply far exceeds the demand. And when they are in this condition they can be caught more [illegible]sily than at other times, for they cannot jump over a cork rope and e[illegible]cape so readily as they generally do.

With an increasing population in the country the demand for these coast fish must necessarily grow to large proportions. And there seems reason to believe that the fishery may be extended and increased to meet this demand until it becomes a very important industry.

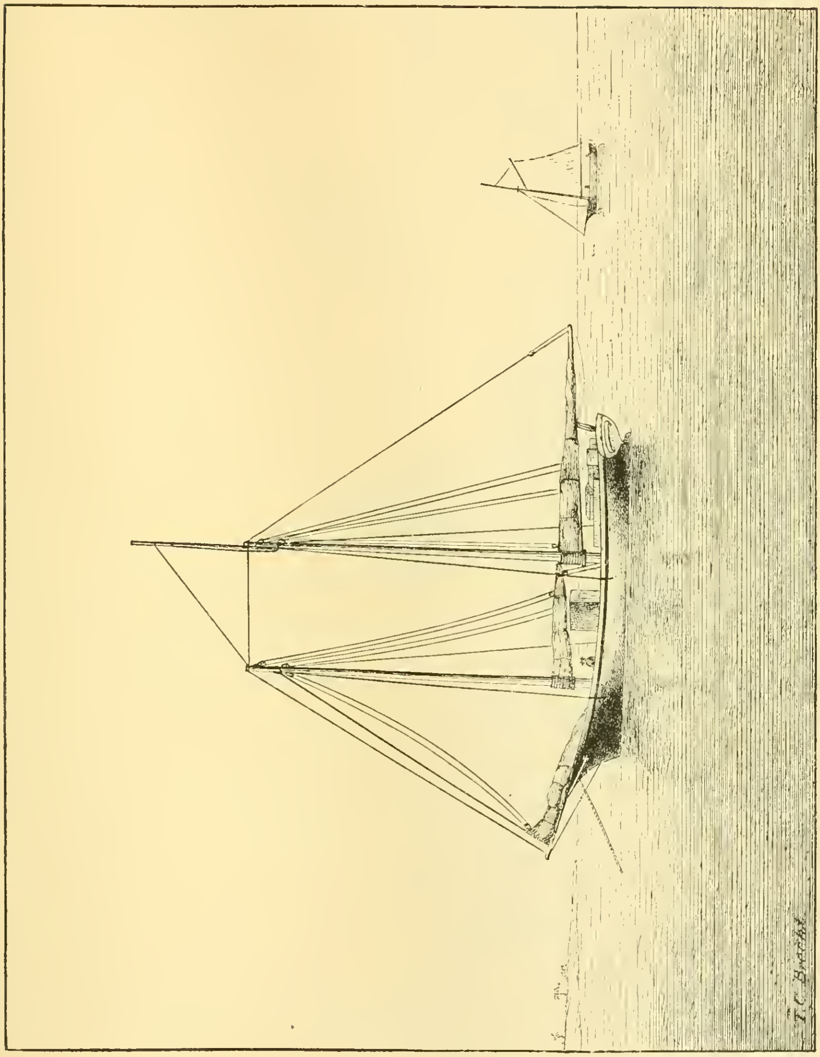
Many of the farmer-fishermen improve the opportunity they have in the fall to supply themselves with fish to last for many months, if not for the year, while a considerable percentage of the fish they sell are disposed of to the country trade; probably, in most cases, to their immediate friends and neighbors.

5. FINANCIAL PROFITS AND LAY.

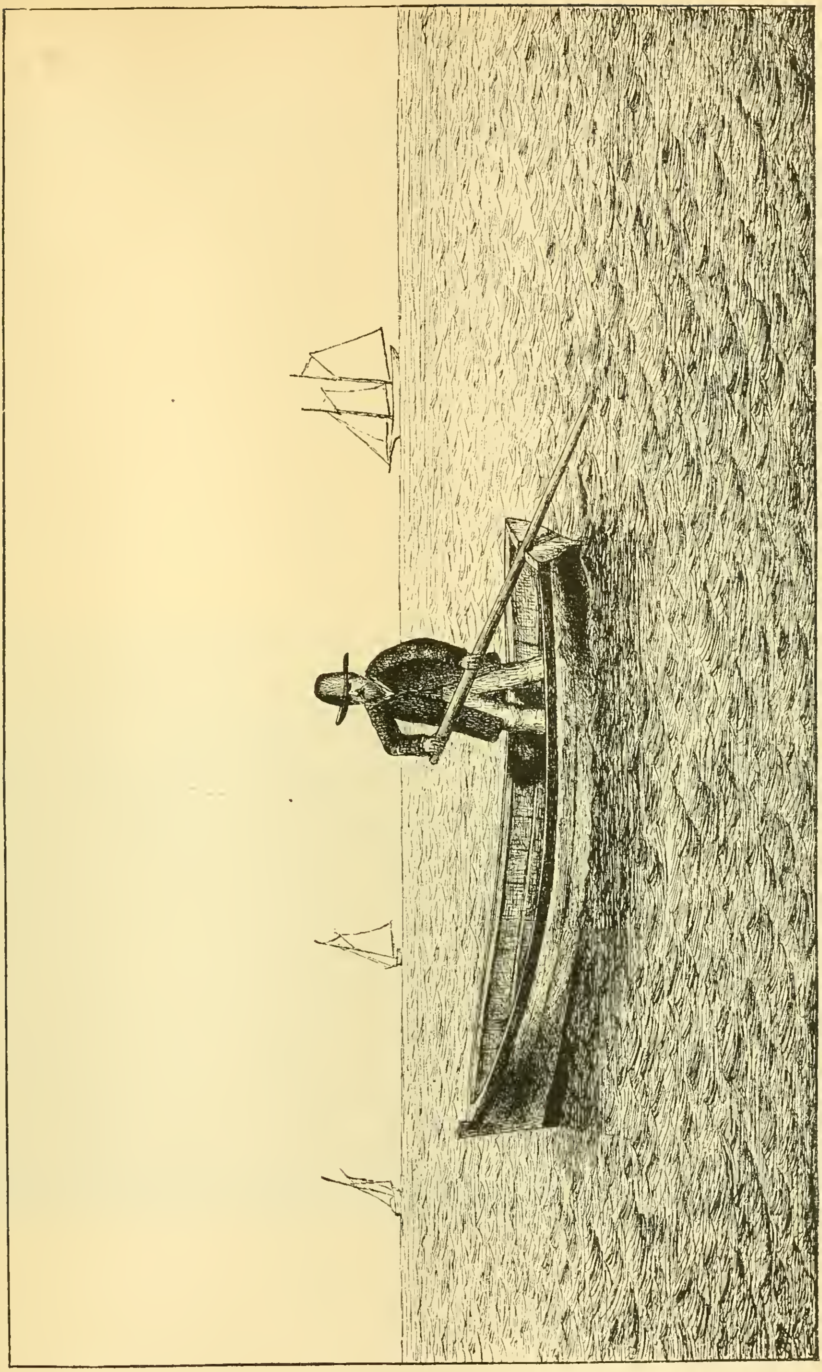
An average stock for a seine gang for three months in the fall is estimated at $[illegible]. Some of the crews are hired, receiving $12 to $20 per month and their board. Others go on shares; the proceeds of the sales are divided into seven equal parts, of which the boat and seine together take one, and each man one.



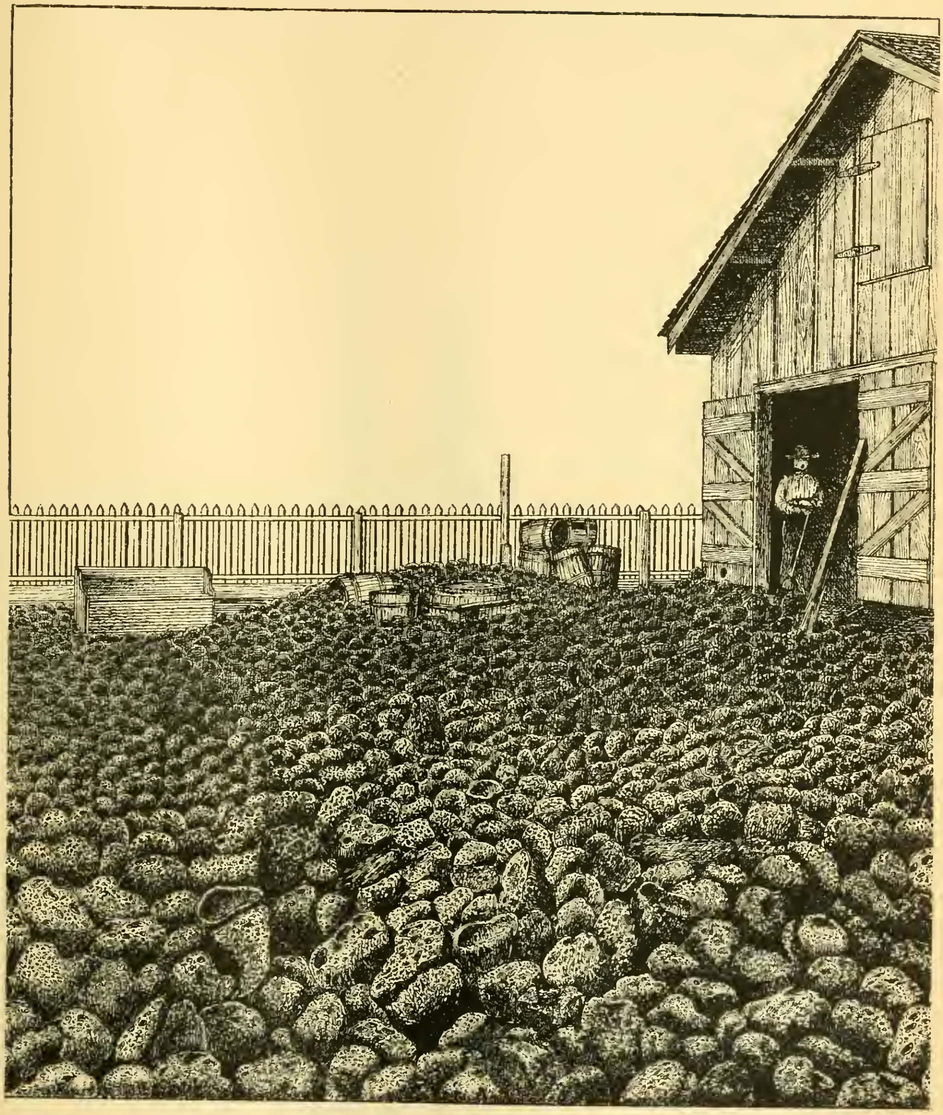
Cuban Fishing Boat.



Florida Sponge Schooner.

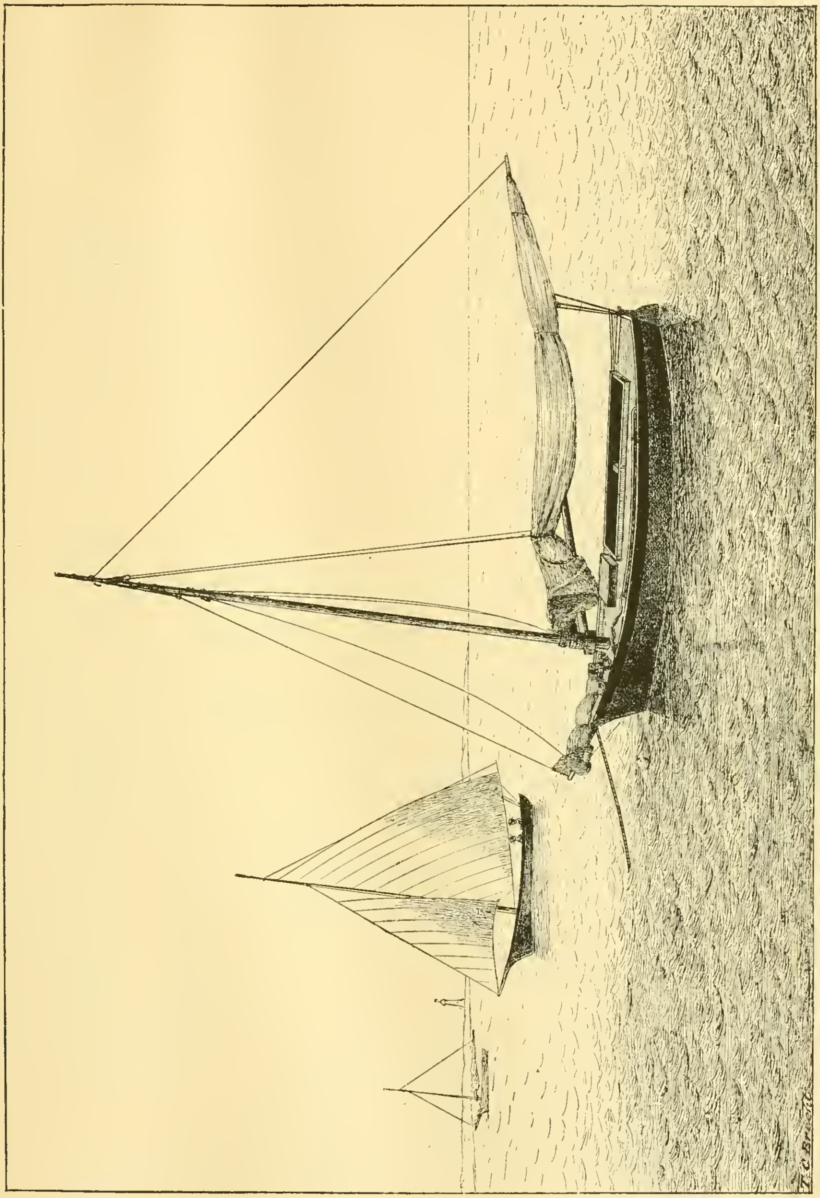


Sponge Dinghy.

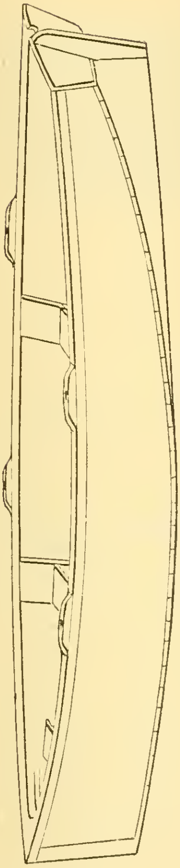


Sponge Yard at Key West.

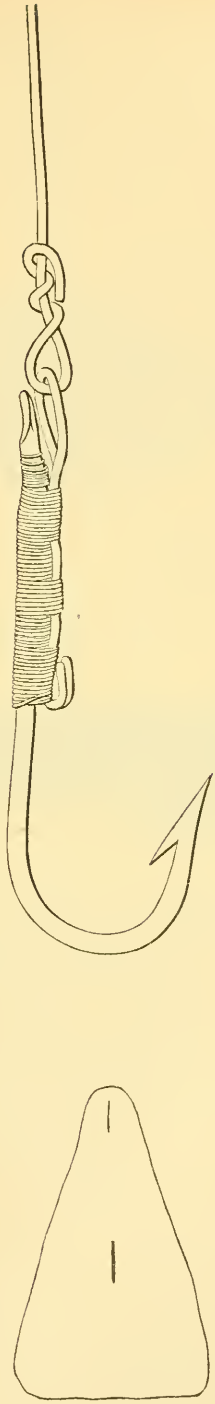
Key West Fishing Smack.



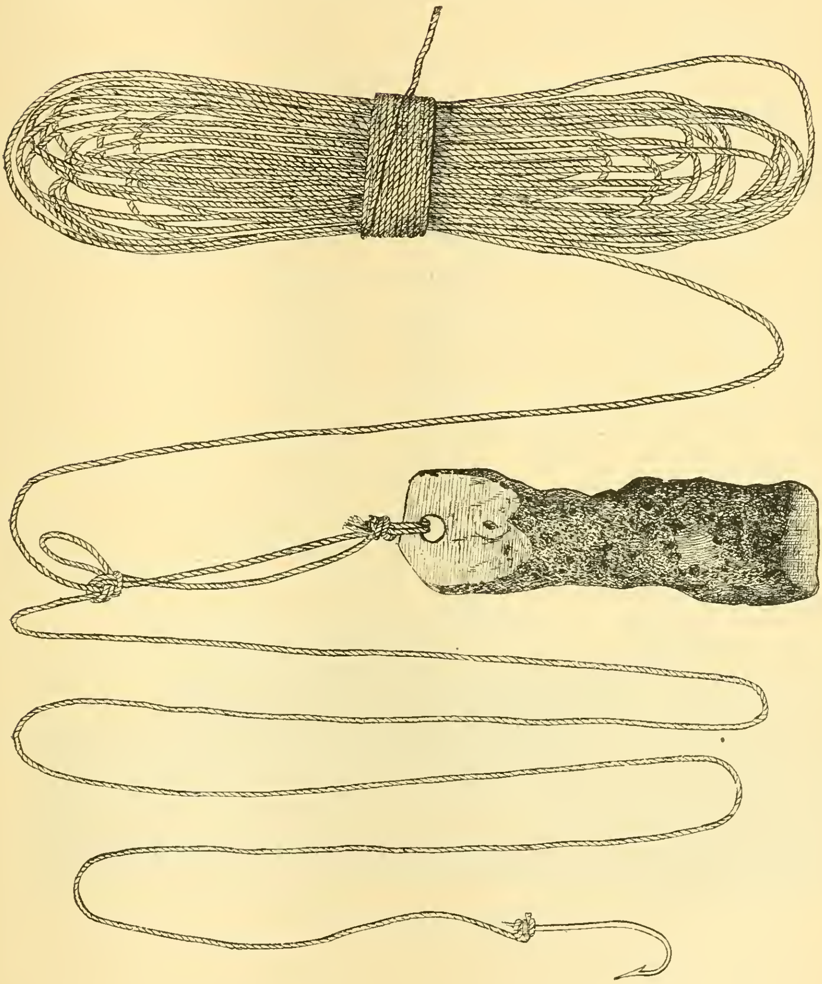
Key West Smackee.



Florida Sharpie.

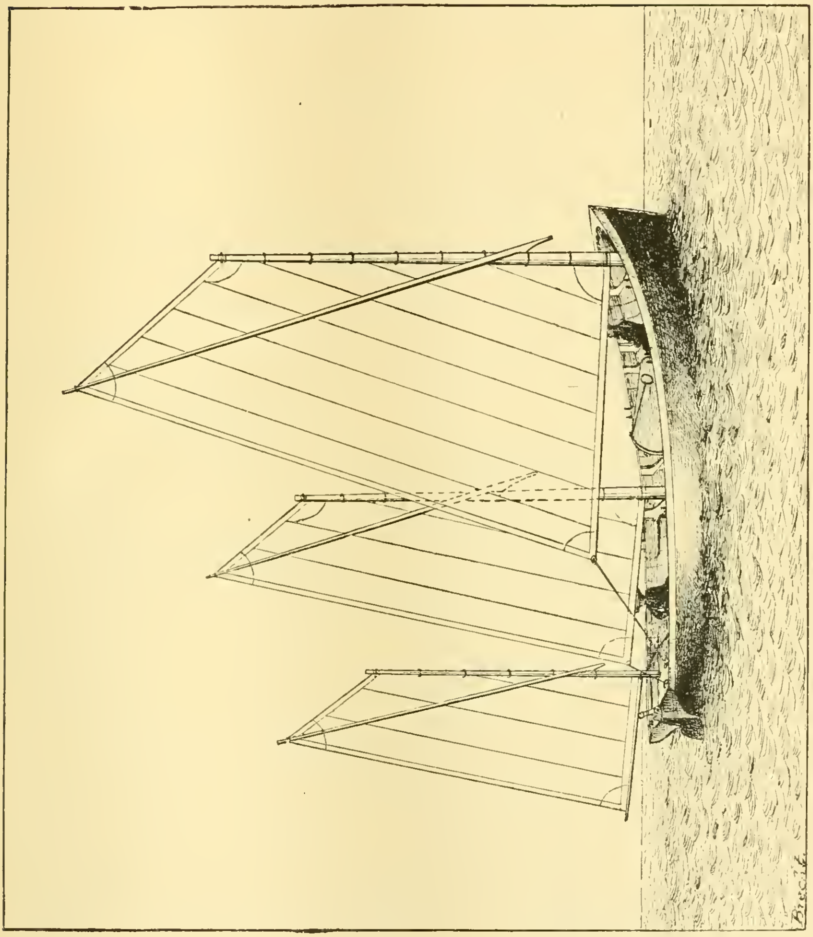


Hook and Bait used for catching Kingfish.



Hook, Sinker, and Line used for catching small species of fish at Key West.

Pensacola Fishing Schooner.



Three-masted Fishing Boat of Pensacola.

INDEX.

[NOTE.—The references are to the page figures in brackets.]

XV.—EXTRACTS FROM THE NORWEGIAN FISHERY STATISTICS FOR 1884.*

By Boye Strom.

The cod fisheries.—In 1884 these yielded 50,435,500 codfish, 99,636 hectoliters of liver, and 47,765 hectoliters of roe, having a total value—including fish-heads sold—of $4,163,732.68.† The average price of 100 round cod (containing liver and roe) was $8.25.

For the sake of comparison we give below the statistics of the Norwegian cod fisheries for the five years preceding 1884:

Years.	Number of fish.	Liver.	Roe.	Value.	Average price per 100 round fish.
		Hectoliters.	*Hectoliters.*		
1879	63, 494, 000	182, 173	59, 277	$3, 666, 776	$5 78
1880	68, 272, 800	193, 286	70, 598	3, 360, 526	4 93
1881	55, 153, 000	133, 114	60, 330	2, 927, 900	5 31
1882	50, 338, 000	66, 861	48, 459	3, 410, 032	6 78
1883	33, 403, 000	38, 493	30, 703	2, 664, 456	7 98

From the above figures it will be seen that the yield of the cod fisheries in 1884 was much larger than in 1883, but that it does not come up to that of the years 1879 and 1880. The five years' period from 1879 to 1883 is not suitable for comparison, because both the largest and the smallest yield ever recorded occurred within this period. If we go back as far as the year 1866—the first year for which we have somewhat complete statistics of the cod fisheries—we find that the average yield for the 18 years, 1866 to 1883, was about 50,000,000 codfish per annum. The fisheries of 1884 may, therefore, as far as the number of cod caught is concerned, be regarded as about the average.

This result is principally owing to the spring fisheries in Finmark. It will be remembered that these fisheries had decreased very much during the preceding years, and especially in 1883 proved almost a total failure; and as at the same time the cod fisheries east of Finmark, on the Russian coast, were said to have increased considerably, there was reason to fear that we had arrived at a turning-point in the cod fish-

* "*Tabeller vedkommende Norges Fiskerier i Aaret* 1884." From *Norges Officielle Statistik*, 3d series, No. 11, Christiania, 1885. Translated from the Danish by Herman Jacobson.

† Throughout this article reductions are made to dollars and pounds by considering the crown worth $0.268, and the kilogram equal to 2.2046 pounds. The hectoliter contains nearly 26½ gallons wine measure, or about 2⅞ bushels.

eries, and that these fisheries would gradually cease on the coast of Norway, where for a long number of years they had always—though varying a good deal—been more or less successful. In 1884, however, these fisheries had again reached their average yield, namely, about 16,000,000 fish, against 3,500,000 in 1883, 7,200,000 in 1882, 12,800,000 in 1881, 23,600,000 in 1880, and 19,300,000 in 1879.

The Lofoden fisheries, which in 1883 had the smallest yield since 1871, were not much more successful in 1884. In the Lofoden district proper, and during the fishing season, 17,000,000 codfish were caught—about the same quantity as in 1883. If we add to this the number of fish caught after April 14, and the fish caught near the outer group of islands (in all, 6,354,000 fish), the total yield of these fisheries is brought up to 23,354,000. During the five years preceding 1884 the total number of codfish caught near the Lofoden Islands and the outer group of islands (Vesteraalen) was as follows:

	Number.
1879	33,201,000
1880	31,312,000
1881	34,931,000
1882	32,931,000
1883	22,088,000

The Romsdal fisheries in 1884 yielded the following quantities:

	Number.
Söndmöre	2,755,400
Romsdal	788,100
Nordmöre	3,253,000
Total	6,796,500

During the five years preceding 1884 the fisheries in these districts yielded:

Years.	Söndmöre.	Romsdal.	Nordmöre.	Total.
1879	3,759,200	885,000	2,131,900	6,776,100
1880	4,589,500	1,600,000	3,371,100	9,560,600
1881	2,265,400	606,000	1,643,700	4,515,100
1882	2,449,200	745,000	3,619,700	6,813,900
1883	2,283,300	434,500	1,532,700	4,250,500

From the above figures it will be seen that the yield of the Söndmöre fisheries, although somewhat larger than in the preceding three years, was nevertheless below the average, while the Nordmöre fisheries were very good.

The cod fisheries in the Tromsöe district, which as early as 1883 had a yield somewhat above the average, namely, 996,000, in 1884 yielded 1,241,800. The Fosen [or South Trondhjem] fisheries were also considerably better than in previous years, the yield being 1,765,900 codfish, while in 1883 the number was about 1,000,000. The Namdalen fisheries yielded 424,400 fish, against 854,000 in 1883.

But it was not merely by the quantity, but also in quality, that the cod fisheries of 1884 far excelled those of 1883. It is true that the cod in 1884 was not so fat and did not contain so much liver as in average years, when one counts on getting one hectoliter of liver from about 350 fish; but the difference between 1883 and 1882 was very considerable. Taking all the cod fisheries together, it took, in 1882, 753 fish, and in 1883 even 868 fish to yield one hectoliter of liver; while in 1884 50,435,500 codfish yielded 99,636 hectoliters of liver; it therefore took on an average 506 codfish to make one hectoliter of liver.

As regards the prices paid at the fishing stations, we refer to the statement given below, which shows the average prices of the products of the cod fisheries in 1884, as compared with previous years:

	1884.	1883.	1882.	1881.	1880.
Cleaned cod, per 100	$6 13	$6 43	$5 68	$3 94	$3 38
Liver, per hectoliter	5 56	5 08	4 82	3 51	3 48
Roe, per hectoliter	9 23	8 30	3 16	4 10	4 42
Fish-heads, per 100	18	25	21	13	16
Round cod, per 100	8 25	7 98	6 78	5 31	4 93

From the above figures it will be seen that, generally speaking, the prices were higher than in 1883, although even in that year they were unusually high. Liver and roe especially fetched higher prices in 1884 than in any previous year. In consequence of these prices the total value of the cod fisheries in 1884 rose to $4,163,733, a larger amount than in any year since 1866, with the sole exception of 1877.

The fat-herring fisheries.—In 1884 these yielded 344,090 hectoliters of fish, which, calculated at the average price of $1.99 per hectoliter, makes the total value of these fisheries in 1884 $685,076.34.

During the five years preceding 1884 the yield of these fisheries was as follows:

Years.	Quantity.	Value.	Average price per hectoliter.
	Hectoliters.		
1879	443,000	$1,038,232	$2 34
1880	720,000	1,534,654	2 13
1881	605,000	1,009,020	1 67
1882	350,000	758,440	2 17
1883	948,000	2,033,048	2 15

The spring-herring fisheries.—The total quantity of spring-herring caught was 261,981 hectoliters, which, calculated at the average price of $1.48 per hectoliter, would make the total value of these fisheries $387,396.95.

During the period from 1879 to 1883 these fisheries produced the following:

Years.	Quantity.	Value.	Average price per hectoliter.
	Hectoliters.		
1879	89,000	$210,380	$2 36
1880	61,000	230,700	3 78
1881	85,000	236,912	2 79
1882	50,000	100,500	2 02
1883	37,000	123,548	3 37

The sprat and other small-herring fisheries.—The total quantity of sprats and other small herring caught in 1884 was 157,471 hectoliters, which, calculated at the average price of about 50 cents per hectoliter, would make the total value of these fisheries $78,605.74.

During the period from 1879 to 1883 these fisheries produced the following:

Years.	Quantity.	Value.	Average price per hectoliter.
	Hectoliters.		
1879	130,000	$69,948	$0 54
1880	212,000	138,343	65
1881	187,000	83,884	45
1882	103,000	65,928	64
1883	147,000	107,200	73

The mackerel fisheries.—The total quantity of mackerel caught was 5,348,700 fish, which, at the average price of $3.69 per 100, would make the total value of these fisheries $197,094.43.

During the period from 1879 to 1883 these fisheries produced the following:

Years.	Number.	Value.	Average price per 100 fish.
1879	6,080,000	$182,508	$3 00
1880	5,743,884	186,558	3 24
1881	6,165,000	206,092	3 34
1882	5,064,000	187,332	3 70
1883	5,116,000	198,856	3 89

The summer fisheries for ling, coal-fish, torsk, &c.—The total quantity of fish caught could not be ascertained. The total value of these fisheries was $776,960.41; while in 1883 it was $1,170,088; in 1882, $667,588; in 1881, $582,900; in 1880, $388.150; and in 1879, $367,428.

The salmon-trout and sea-trout fisheries.—These fisheries yielded a much better result in 1884 than in the preceding five years. The total quantity of fish caught was 1,082,789 pounds, which, at the average price of 12 cents per pound, would make the total value of these fisheries $132,707.97.

During the period from 1879 to 1883 these fisheries produced the following:

Years.	Quantity.	Value.	Average price per pound.
	Pounds.		
1879	745,155	$90,048	$0 12
1880	756,178	102,403	14
1881	809,088	107,468	13
1882	639,334	86,028	13
1883	806,884	103,448	13

The lobster fisheries.—The number of lobsters caught was 1,099,828, which, at the average price of $10.18 per 100, would make the total value of these fisheries $111,922.15.

During the period from 1879 to 1883 these fisheries yielded the following:

Years.	Quantity.	Value.	Average price per pound.
	Pounds.		
1879	1,118,000	$91,656	$8 20
1880	1,205,616	108,455	9 00
1881	1,146,000	101,036	8 81
1882	1,256,000	113,364	9 03
1883	1,224,000	117,920	9 64

The oyster fisheries.—The total quantity of oysters caught was 230 hectoliters, which, at the average price of $8.66 per hectoliter, would make the total value of these fisheries $1,991.78.

During the period from 1879 to 1883 these fisheries yielded the following:

Years.	Quantity.	Value.	Average price per hectoliter.
	Hectoliters.		
1879	336	$2,064 40	$6 15
1880	228	1,506 15	6 60
1881	267	1,910 84	7 16
1882	303	2,164 90	7 14
1883	208	1,434 60	6 90

The total value of the Norwegian coast fisheries in 1884 was therefore $6,535,488.45.

During the period from 1879 to 1883 the total value of the coast fisheries was as follows:

1879	$5,719,286 70
1880	6,051,296 62
1881	5,257,186 09
1882	5,391,488 12
1883	6,519,824 40

During the period from 1882 to 1884 the value of the coast fisheries, according to the different kinds of fish caught, was as follows:

Fisheries.	1884.		1883.		1882.	
	Total value.	Per cent.	Total value.*	Per cent.	Total value.*	Per cent.
Cod fisheries	$4,163,733	63.7	$2,664,456	40.9	$3,410,032	63.2
Fat-herring fisheries	685,076	10.4	2,033,048	31.2	758,440	14.1
Sprat fisheries	78,606	1.2	107,200	1.6	65,928	1.2
Spring-herring fisheries	387,397	5.9	123,548	1.9	100,500	1.9
Mackerel fisheries	197,094	3.0	198,856	3.1	187,332	3.5
Summer fisheries	776,960	11.8	1,170,088	17.9	667,588	12.4
Salmon-trout fisheries	132,708	2.3	103,448	1.6	86,028	1.6
Lobster fisheries	111,922	1.7	117,920	1.8	113,364	2.1
Oyster fisheries	1,992	......	1,340	......	2,144	......
Total	6,535,488	100	6,519,904	100	5,391,356	100

* The values in the 1882 and 1883 columns were expressed in even thousands of crowns in the Norwegian tables.

The Storeggen Bank fisheries.—These were carried on by 25 vessels with a crew of 308 men. The fish caught (principally ling and torsk) had a total value of $28,056.38.

The statistics of these fisheries for the period from 1879 to 1883 were as follows:

Years.	Number of vessels.	Crews.	Total value.
1879	6	74	$9,648
1880	11	136	15,276
1881	11	132	15,008
1882	15	195	19,564
1883	21	261	39,932

The shark fisheries in Finmark.—These employed 5 boats, 43 vessels, and 206 men. The total value of the livers obtained (5,010 hectoliters) was $23,732.20. In 1883 and 1882 the quantity of livers was less, namely, 4,272 and 4,799 hectoliters, respectively; but owing to the low prices of oil the value was about $5,494 and $2,010 less. During the period from 1877 to 1881 the value varied between $8,040 and $13,400.

Other fisheries in the Polar Sea.—These fisheries employed 38 vessels, with a total tonnage of 1,545, and 375 men. They yielded 18,619 seals, 319 walruses, 148 white-fish, and 810 hectoliters of liver, having a total value of $80,145.40, against $70,752 in 1883, $41,272 in 1882, $42,076 in 1881, $54,672 in 1880, and $58,424 in 1879. Besides the above, 2 vessels from Vardöe brought home 400 seals, valued at $1,072.

The whale fisheries.—These yielded 446 whales, value $255,618.40. During the period from 1877 to 1883 these fisheries gave the following results:

Years.	Number of whales.	Total value.
1877	32	$19,028
1878	130	70,752
1879	123	61,640
1880	145	64,372
1881	279	103,984
1882	391	198,052
1883	541	265,052

The seal fisheries.—These fisheries near Jan-Mayen and in the sea between Iceland and Greenland employed 16 steamers, with a tonnage of 4,492 and a crew of 900 men. The total value of these fisheries was $306,592.

The bottle-nose fisheries.—These employed 9 vessels (one being a steamer), with a tonnage of 911; and yielded 211 bottle-noses, valued at $38,592.

Total value of Norwegian salt-water fisheries in 1884.

Coast fisheries	$6,535,488 45
Bank fisheries	28,056 38
Shark fisheries	23,732 20
Other Polar Sea fisheries	80,145 40
Whale fisheries	255,618 40
Seal fisheries	306,592 00
Bottle-nose fisheries	38,592 00
Total	7,268,224 83

The following twelve tables give more full details in regard to the coast fisheries in 1884:

TABLE I.—*Number of fishermen engaged in the cod, fat-herring, and mackerel fisheries in* 1884.

Districts.	Cod fisheries.	Fat-herring fisheries.	Mackerel fisheries.
Smaalenene			150
Akershus			111
Buskerud			30
Jarlsberg and Laurvig			877
Bratsberg			72
Nedenæs			230
Lister and Mandal			1,231
Stavanger	475	50	1,256
South Bergenhus	500	450	49
North Bergenhus	200	993	
Romsdal	16,419	1,651	
South Trondhjem	3,388	3,099	
North Trondhjem	1,490	407	
Nordland	36,188	10,554	
Tromsöe	2,420	6,520	
Finmark	15,662	100	
Total	76,742	23,824	4,006

TABLE II.—*Value of the coast fisheries in* 1884.*

Districts.	Cod.	Fat-herring.	Sprat and other small-herring.	Spring-herring.	Mackerel.
Smaalenene			$1,627	$70,537	$6,185
Akershus			2,436	456	1,573
Buskerud			737		449
Jarlsberg and Laurvig			908	22,358	45,664
Bratsberg				21,001	4,796
Nedenæs				30,766	6,547
Lister and Mandal			663	6,997	72,001
Stavanger	$1,739		7,914	150,509	59,622
South Bergenhus	482	$28,602	36,974	20,455	257
North Bergenhus	1,795	2,249	7,353	724	
Romsdal	567,143	24,373	8,705	63,594	
South Trondhjem	142,547	52,464	80		
North Trondhjem	33,716	5,226			
Nordland	2,206,775	396,410	1,769		
Tromsöe	98,261	175,471	7,296		
Finmark	1,111,275	281	2,144		
Total	4,163,733	685,076	78,606	387,397	197,094

* The figures in this table are given in even dollars.

TABLE II.—*Value of the coast fisheries in* 1884 *—Continued.

Districts.	Summer fisheries for cod, ling, &c.	Salmon-trout and sea-trout.	Lobsters.	Oysters.	Total.
Smaalenene	$4, 905	$1, 555	$6, 486	$322	$91, 617
Akershus	2, 018	1, 421	21	10	7, 935
Buskerud	4, 824	3, 093	54	80	9, 237
Jarlsberg and Laurvig	20, 634	4, 586	9, 041	598	103, 789
Bratsberg	7, 855	1, 578	2, 057	....	37, 287
Nedenæs	6, 161	4, 884	10, 721	....	59, 079
Lister and Mandal	11, 331	23, 826	30, 788	....	145, 606
Stavanger	8, 790	12, 745	36, 656	54	278, 029
South Bergenhus	10, 783	7, 957	10, 554	50	116, 114
North Bergenhus	7, 464	8, 955	4, 309	101	32, 950
Romsdal	20, 081	8, 825	1, 235	115	694, 071
South Trondhjem	53, 600	32, 835	....	576	282, 102
North Trondhjem	15, 817	11, 207	....	32	65, 998
Nordland	147, 722	5, 827	....	54	2, 758, 557
Tromsöe	60, 439	2, 551	....	....	344, 018
Finmark	394, 536	863	....	....	1, 509, 099
Total	776, 960	132, 708	111, 922	1, 992	6, 535, 488

* The figures in this table are given in even dollars.

TABLE III.—*Details of the cod fisheries in* 1884, *showing the number of fishermen and boats.*

Districts.	Total number of fishermen.	Fishermen using—				Total number of boats.	Boats equipped with—			
		Nets only.	Night-lines only.	Lines only.	Two or more of these.		Nets only.	Night-lines only.	Lines only.	Two or more of these.
Stavanger	475	....	....	....	475	125	....	....	....	125
South Bergenhus	500	....	....	450	50	200	....	....	180	20
North Bergenhus	200	....	....	....	200	62	....	....	....	62
Romsdal	16, 419	1, 334	2, 441	862	11, 782	2, 905	173	386	213	2, 133
South Trondhjem	3, 388	622	4	252	2, 510	825	116	1	68	640
North Trondhjem	1, 490	111	52	104	1, 223	371	21	26	27	297
Nordland	36, 188	10, 229	23, 019	1, 641	1, 299	8, 900	1, 782	6, 192	572	354
Tromsöe	2, 420	....	1, 421	114	885	876	....	500	42	334
Finmark	15, 662	20	4, 709	2, 393	8, 540	4, 799	5	1, 486	551	2, 757
Total	76, 742	12, 316	31, 646	5, 816	26, 964	19, 063	2, 097	8, 591	1, 653	6, 722

TABLE IV.—*Quantity of codfish caught in* 1884.

Districts.	Number of cod taken.	Liver.	Roe.	Number of fish-heads sold.
		Hectoliters.	*Hectoliters.*	
Stavanger	22, 000	50	46	22, 000
South Bergenhus	6, 000	12	10	6, 000
North Bergenhus	20, 000	35	39	....
Romsdal	6, 796, 500	9, 171	9, 541	5, 016, 000
South Trondhjem	1, 765, 900	2, 840	3, 000	1, 430, 000
North Trondhjem	429, 900	557	400	100, 000
Nordland	24, 171, 400	42, 092	32, 606	21, 615, 000
Tromsöe	1, 241, 800	2, 714	1, 402	165, 000
Finmark	15, 982, 000	42, 165	721	12, 589, 500
Total	50, 435, 500	99, 636	47, 765	40, 943, 500

TABLE V.—*Value of the cod fisheries in* 1884 *and the average prices paid.*

Districts.	Value of the different products.				
	Fish without liver and roe.	Liver.	Roe.	Fish-heads sold.	Total value.
Stavanger	$1,238 16	$227 80	$214 40	$58 96	$1,739 32
South Bergenhus	363 41	54 67	48 24	16 08	482 40
North Bergenhus	1,447 20	159 46	188 14	....	1,794 80
Romsdal	419,096 26	44,833 18	88,120 54	15,092 69	567,142 67
South Trondhjem	105,220 28	11,534 72	21,976 00	3,816 32	142,547 32
North Trondhjem	27,319 92	2,965 69	3,216 00	214 40	33,716 01
Nordland	1,577,627 56	274,807 20	313,576 88	40,762 80	2,206,774 44
Tromsöe	75,792 54	12,996 66	9,254 31	217 08	98,260 59
Finmark	886,037 48	206,529 65	4,419 05	14,288 95	1,111,275 13
Total	3,094,142 81	554,109 03	441,013 56	74,467 28	4,163,732 68

Districts.	Average prices.				Estimated price per 100, with liver, roe, and heads.
	Without liver and roe, per 100.	Liver, per hectoliter.	Roe, per hectoliter.	Fish-heads, per 100.	
Stavanger	$5 63	$4 56	$4 66	$0 27	$7 91
South Bergenhus	6 06	4 56	4 82	27	8 04
North Bergenhus	7 24	4 56	4 82	....	8 97
Romsdal	6 17	4 89	9 24	30	8 35
South Trondhjem	5 96	4 06	7 32	27	8 07
North Trondhjem	6 35	5 32	8 04	21	7 84
Nordland	6 53	6 53	9 62	19	9 13
Tromsöe	6 10	4 79	6 60	13	7 91
Finmark	5 54	4 90	6 13	10	6 95
General average	6 13	5 56	9 23	18	8 25

TABLE VI.—*Details of the fat-herring fisheries in* 1884.

NUMBER OF FISHERMEN, BOATS, AND SEINES.

Districts.	Fishermen.	Men using nets.	Men using seines.	Net-boats.	Seines.
Stavanger	50	40	10	10	1
South Bergenhus	450	90	360	60	34
North Bergenhus	993	....	993	....	61
Romsdal	1,651	36	1,615	18	104
South Trondhjem	3,099	630	2,469	235	156
North Trondhjem	407	220	187	100	12
Nordland	10,554	6,234	4,320	2,235	310
Tromsöe	6,520	5,872	648	2,171	58
Finmark	100	100	....	50	....
Total	23,824	13,222	10,602	4,879	736

QUANTITY, VALUE, AND AVERAGE PRICE.

Districts.	Quantity.	Caught with nets.	Caught with seines.	Value.	Average price per hectoliter.
	Hectoliters.	*Hectoliters.*	*Hectoliters.*		
Stavanger	....	....	....	....	....
South Bergenhus	17,790	10,000	7,790	$28,602 30	$1 61
North Bergenhus	1,020	....	1,020	2,248 52	2 20
Romsdal	28,100	150	27,950	24,372 99	87
South Trondhjem	46,780	2,050	44,730	52,463 68	1 12
North Trondhjem	3,500	700	2,800	5,226 00	1 49
Nordland	147,380	98,150	49,230	396,410 06	2 69
Tromsöe	99,450	52,588	46,862	175,471 39	1 76
Finmark	70	70	....	281 40	4 02
Total	344,090	163,708	180,382	685,076 34	1 99

TABLE VII.—*Details of the mackerel fisheries in* 1884.

Districts.	Total number of fishermen.	Men using drift-nets.	Boats having drift-nets.	Total number of fish caught.	Fish caught with drift-nets.	Value of fish caught.	Average price per 100.
Smaalenene	150	150	50	115, 400	107, 000	$6, 185 44	$5 36
Akershus	111	33	14	31, 720	18, 220	1, 572 62	4 96
Buskerud	30	....	....	10, 200	....	448 90	4 40
Jarlsberg and Laurvig	877	877	236	1, 197, 000	1, 180, 000	45, 664 52	3 81
Bratsberg	72	64	24	130, 700	117, 500	4, 795 86	3 67
Nedenæs	230	206	75	155, 000	146, 400	6, 546 97	4 22
Lister and Mandal	1, 231	1, 181	325	2, 233, 380	2, 207, 680	72, 000 88	3 22
Stavanger	1, 256	1, 125	295	1, 469, 000	1, 452, 900	59, 621 96	4 06
South Bergenhus	49	27	9	6, 300	6, 000	257 28	4 08
Total	4, 006	3, 663	1, 028	5, 348, 700	5, 235, 700	197, 094 43	3 69

TABLE VIII.—*Details of the sprat and other small-herring fisheries in* 1884.

Districts.	Quantity.	Value.	Average price per hectoliter.
	Hectoliters.		
Smaalenene	700	$1, 627 56	$2 32
Akershus	840	2, 435 58	2 90
Buskerud	630	737 00	1 17
Jarlsberg and Laurvig	1, 030	907 72	88
Lister and Mandal	1, 092	663 30	61
Stavanger	15, 420	7, 914 04	51
South Bergenhus	82, 344	36, 973 82	45
North Bergenhus	11, 730	7, 352 58	63
Romsdal	13, 305	8, 704 64	65
South Trondhjem	300	80 40	27
Nordland	13, 000	1, 768 80	14
Tromsöe	14, 300	7, 296 30	51
Finmark	2, 780	2, 144 00	77
Total	157, 471	78, 605 74	50

TABLE IX.—*Details of the spring-herring fisheries in* 1884.

Districts.	Quantity.	Value.	Average price per hectoliter.
	Hectoliters.		
Smaalenene	65, 803	$70, 537 60	$1 07
Akershus	195	455 60	2 34
Jarlsberg and Laurvig	23, 434	22, 357 63	95
Bratsberg	18, 098	21, 001 55	1 16
Nedenæs	24, 400	30, 766 40	1 26
Lister and Mandal	5, 071	6, 996 68	1 38
Stavanger	81, 950	150, 508 80	1 84
South Bergenhus	13, 220	20, 455 37	1 55
North Bergenhus	450	723 00	1 61
Romsdal	29, 360	63, 593 72	2 17
Total	261, 981	387, 396 95	1 48

TABLE X.—*Details of the salmon-trout and sea-trout fisheries in* 1884.

Districts.	Quantity.	Value.	Average price per pound.
	Pounds.		
Smaaleneno	8, 426	$1, 555 20	$0 19
Akershus	7, 319	1, 421 47	19
Buskerud	17, 593	3, 092 72	18
Jarlsberg and Laurvig	25, 009	4, 585 75	18
Bratsberg	8, 267	1, 577 72	19
Nedenæs	36, 729	4, 884 30	13
Lister and Mandal	178, 903	23, 826 00	13
Stavanger	96, 072	12, 744 74	13
South Bergenhus	63, 656	7, 957 19	13
North Bergenhus	69, 315	8, 955 49	13
Romsdal	80, 181	8, 824 70	11
South Trondhjem	276, 554	32, 835 36	12
North Trondhjem	107, 660	11, 206 69	10
Nordland	63, 168	5, 826 86	09
Tromsöe	33, 245	2, 550 82	08
Finmark	10, 692	862 96	08
Total	1, 082, 789	132, 707 97	12

TABLE XI.—*Details of the lobster fisheries in* 1884.

Districts.	Quantity.	Value.	Average price per 100.
	Number.		
Smaaleneno	76, 000	$6, 485 60	$8 53
Akershus	200	21 44	10 72
Buskerud	500	53 60	10 72
Jarlsberg and Laurvig	101, 450	9, 040 98	8 91
Bratsberg	30, 700	2, 056 90	6 70
Nedenæs	122, 395	10, 720 80	8 76
Lister and Mandal	240, 240	30, 787 84	12 82
Stavanger	337, 638	36, 656 50	10 86
South Bergenhus	129, 750	10, 554 11	8 13
North Bergenhus	49, 450	4, 308 90	8 71
Romsdal	11, 505	1, 235 48	10 74
Total	1, 099, 828	111, 922 15	10 18

TABLE XII.—*Details of the oyster fisheries in* 1884.

Districts.	Quantity.	Value.	Average price per hectoliter.
	Hectoliters.		
Smaaleneno	30	$321 60	$10 72
Akershus	1	9 65	9 65
Buskerud	10	80 40	8 04
Jarlsberg and Laurvig	52	598 44	11 51
Stavanger	5	53 60	10 72
South Bergenhus	8	49 85	6 23
North Bergenhus	21	101 04	4 82
Romsdal	25	115 24	4 61
South Trondhjem	70	576 20	8 23
North Trondhjem	3	32 16	10 72
Nordland	5	53 60	10 72
Total	230	1,991 78	8 66

XVI.—THE MANUFACTURE OF KLIP-FISH.*

When the Scotch, Icelandic, or Newfoundland method is spoken of, this does not imply that the greater or less excellence of the klip-fish depends principally on the method according to which it is manufactured. There are only two methods, viz., dry-salting and salting in brine. The various other so-called methods are simply variations caused by climatic and other differences; and what suits in one country may not suit in another. The main point is, that the method, no matter whether it is Norwegian, Scotch, or Icelandic, should be followed carefully in all its details. Without carefully and thoroughly treating the fish during all the different stages of its manufacture, no first-class article will ever be produced. Careful treatment is the fundamental principle of every kind of manufacture of all kinds of fish products, no matter what method is employed. We cannot state this with too great emphasis, and we shall refer to it again and again in our articles on the manufacture of various fish products.

Air, water, and heat are the necessary conditions of decay. If one of these is wanting or only exists partially, there will be no decay. Thus, articles of food will not decay in cans from which the air has been removed, or in a certain temperature; and ice and hermetically sealed cans are used for preserving articles of food in good condition for a long time. Dried meat and fish will also keep for years, as long as the quantity of water contained in them is not increased above a very small amount. When salting and drying are employed as means of preserving fish, the principal object is to diminish the quantity of water in the fish. In manufacturing klip-fish this object is reached in three ways, by applying salt, by drying in the air, and by pressing. The object in view could be reached by each one of these ways. If, for instance, fish are salted several times at certain stated periods they will finally become as hard and dry as klip-fish. By drying fish in the air the same end is reached, and even by mere pressing an article will be obtained which, though insipid, will keep well. The salting process, however, has also another effect, as the salt prevents the development of the germs of decay, and by entering all the textures which were formerly filled with moisture, fills all the pores and small apertures, thus preventing the air from entering.

* "*Tilvirkning af klipfisk.*" From *Norsk Fiskeritidende*, Vol. III, Bergen, January and April, 1884. Translated from the Danish by HERMAN JACOBSON and TARLETON H. BEAN.

Codfish contains: Fresh, 81.98 per cent water, 1.44 per cent salts; salted, 49.72 per cent water, 20.53 per cent salts; dried, 16.16 per cent water, 1.56 per cent salts. As has been stated above, three different means are employed in the manufacture of klip-fish to diminish the quantity of water. A well-prepared boneless klip-fish contains 36.82 per cent water, and 15.5 per cent common salt. Some of the water contained in the fresh fish is extracted by means of the salt, which reduces the percentage of water from 81.98 to 49.72, and some is extracted by applying air and by pressing the fish, which also serves to extract some of the salt. A codfish weighing 3 kilograms [6½ pounds] which, when fresh, contains 2.459 kilograms of water, will as klip-fish contain a little less than 0.4 kilogram, more than 2 kilograms having been extracted by the manufacturing process. Its weight will therefore be about 1 kilogram, of which there are—

	Grams.
Mostly nutritive substances	477
Salt	155
Water	368

The three means referred to for extracting water from the fish are employed to a different extent, some people using more salt, others drying the fish more, while others press them more, according to the varying conditions of climate. In Canada, where the air is warm and dry, pressing is little used, and this principally to give the fish a smooth appearance and also to subject it to a sort of fermenting process, while in countries which have a cooler and moister climate pressing forms an essential part of the manufacturing process. If the fish are to lie in salt for a short time only, more and finer* salt is used than if they are to remain in salt for a long time. To what degree the water is to be extracted depends also on the length of time in which it is presumed the fish will be used up. Here, as in all manufacturing processes, it will prove true that the preserving is done at the expense of the flavor and partly of the nutritive value. If fish are brought into the market which are not quite dry, this can only be called a rational manner of carrying on the fish trade, if it is supposed that the fish will be consumed in a short time. This is profitable both for the buyer and for the seller, as the former gets a better article and the latter a better weight and a decrease in expenditure. But how many of our fish are sold as fresh goods? Nearly the entire quantity of manufactured fish which we produce must, on account of the fishing season and climatic conditions, be manufactured in a comparatively short time, and the exports, which remain very nearly the same all the year round, must for a considerable part of the year be made from the stock of fish on hand. We are in this respect not situated so favorably as our competitors who manufacture

* In case they remain in salt only as long as is necessary. If the fish are to be kept for any length of time, more and coarser salt is used.

their fish gradually after the fish have remained in salt the necessary length of time. During the period from 1876 to 1883 we exported on an average from June to December, inclusive, 57 per cent of the entire quantity of fish manufactured during the year, and from January to May, inclusive, 43 per cent. During that period, therefore, almost one-half of the entire quantity of fish had been kept in the warehouse six months and longer. It is therefore a great mistake to carry on the manufacture on a large scale exclusively with the view to sell fresh goods. Furthermore, if we take into consideration the fact that the fish are going to be transported a considerable distance, many of them to warm countries, and in many cases at the warmest season of the year, the principal object should be to manufacture an article which will keep well.

The value of a klip-fish depends on its looks and whether it will keep. These two conditions, however, need not always be found together. A fish which does not look well may keep well, while a fine appearance is not always an indication that a fish will keep well. In manufacturing fish for the world's market, both these objects should be kept in view. The possible advantages which, owing to a fortunate combination of circumstances, may be obtained by paying less attention to the production of an article which will keep well are very small if compared with the loss occasioned by the spoiling of the goods while kept in the warehouse. Taking the raw material, the salt, and the expense of fitting out the fishing expeditions as the normal value of the fish, the difference in the expense for labor or the difference in weight occasioned by more or less careful drying is small in comparison with the risk.* In giving, in the following, the leading principles in the manufacture of klip-fish we would state that these principles have reference both to the production of a fine-looking article and of one which will keep well, and that we shall treat them without regard to the time when, the place where, and the manner in which the producer disposes of his goods.

THE RAW MATERIAL.—Difference of size and fleshiness have a considerable influence on the value of the fish, but as this is principally owing to the sorting we shall not dwell on it here. The first condition for obtaining a first-class article is, therefore, that the raw material should be fresh. The circumstances under which our fisheries take place, namely, the winter season, and the use of more nets than in other countries, make it necessary that also old fish should be used for klip-fish. Klip-fish manufactured from old fish are of much lighter weight, and have a darker color than those made of fresh fish; the flesh becomes broken and loose, especially near the backbone, the skin becomes loose in some places, the bones turn red, the abdomen also turns red and becomes thin, and gets dark stripes, occasioned by the oil which is soon secreted from the liver. The longer the fish has been allowed to lie,

*This risk is with us generally run by the exporters; and it therefore seems all the more strange that they do not make a greater difference in price.

the more noticeable will these defects become. As regards line fisheries it is not of so much consequence whether the fish are allowed to lie for awhile, as in the net fisheries.

If complaints have been made abroad as regards the Norwegian fish, the cause must be sought principally in the condition of the raw material; for our cod fisheries are principally carried on during the severest season of the year, and to a great extent in waters which are without any shelter. Moreover we use nets to a great extent, while this apparatus is comparatively unknown in the cod fisheries of other nations. Even lines are but little used outside of Scotland and the French fisheries on the Newfoundland Banks; and consequently there will always be found more old fish among the Norwegian codfish than among those of other nations. If the complaints have become more numerous during the last few years, this is owing to the greater development of this industry, as a larger quantity of the fish caught are made into klip-fish than was the case in former years. The following were the exports of klip-fish during the periods named:

Table of exports.

Periods.	Klip-fish.	Klip-fish, dried fish, &c.†	Percentage of klip-fish.
	*Kilograms.**	*Kilograms.*	
1830–1835	6,700,000	23,000,000	29
1851–1855	14,100,000	30,500,000	46
1871–1875	30,200,000	48,600,000	62
1882	40,100,000	55,300,000	73

* 1 kilogram = about $2\frac{1}{5}$ pounds. † Including all cured fish.

More old fish, therefore, are salted now than in former times, when they were hung to dry whenever there was a chance. But as long as old fish find a sale, and can be manufactured into klip-fish without incurring loss, there is no reason why these fish should not be used for klip-fish. The price, however, will of course depend on the quality, and regard should be had to this circumstance when the fish are bought. Line fish, and to some extent also net fish which are two days old, will still make a first-class article; but the difference is already noticeable enough, especially in the net fish, to cause a difference in price. If the fish are still older, the price will be still lower, for they will only make a second class article. Fresh fish, or fish which are supposed to make a first-class article, should be salted by themselves.

The manner in which the fish are treated by the fishermen has a great deal to do with their quality. Fish should therefore not be trodden upon, kicked, or pushed, or be exposed to the weather. In Newfoundland poles are therefore used for conveying the fish from the boat to the shore, and in Scotland boxes are carried in the vessels, so as to afford protection to the fish. Every fishing boat should be well supplied with tarpaulin, which may prove useful in many respects.*

The next thing in order is to kill the fish in such a manner as to allow the blood to run out, which makes it whiter. Although this manner of killing the fish is acknowledged to increase the value of the article, it is by no means as general as it should be. As far as we know, it is in vogue only among the French and Scotch, and among the Icelanders when fishing is carried on from a vessel. Wherever it can be done, this method should be employed. No time is lost thereby, as it can be done while the line is run out. It requires, of course, a little more labor, and fish killed in this way ought therefore to bring a higher price. On board the vessel fish killed in this manner ought to be salted by themselves, as the quantity will never be very large. In this manner a considerable portion of the cod from our large cod fisheries could be prepared, and become fully equal to the Iceland fish. The extra price of 1 ore [about ¼ cent] per fish, which of late years has been paid for fish killed in this manner, gives a little additional money to the fishermen, amounting to about 10 crowns [$2.68] per thousand. This is the average earning per fisherman during the Loffoden fisheries, and an addition of 10 crowns should therefore not be despised.

A principal condition for obtaining a first class article is, that the fish should be washed before it is put in salt. The Norwegians are the only nation who do not wash their fish. All other nations wash their fish with the greatest care, and even use for this purpose special brushes or rags. The washing had best be done after the fish has been split, in tubs filled with sea-water which should frequently be changed. Special care should be taken to clean the neck, the portion under the dorsal fins where much slime is apt to accumulate, and the lower part of the backbone. All blood should be carefully removed, which is best done by a pressure of the thumb. During the washing the black skin is removed. After the fish has been washed, it should be allowed to lie for awhile, so that the water may run off.

In former times washing was common in Norway, as may be seen from a decree of September 12, 1753, where it says that the thin black skin shall be removed from all fish which are to be salted while they are fresh, imposing a fine on every one who should violate this rule. During the last two years attempts have been made to wash the fish during the winter fisheries. If these attempts have not been accompanied by the expected result, the reason must be sought in the circumstance that they were conducted on too small a scale. In manufacturing klip-fish, so many different things have to be taken into account that no conclusions can be drawn from a few experiments. The experiments

* It may be used to protect the crew both in the boat and on shore. With the boat fastened by the painter or by a hauling-line to the yard and sail, in whose sheets suitable weights are placed, depending from it, the crew, when huddled together under a tarpaulin, will be as comfortable as in a little room.

made last year have shown, however, that washing produces an article distinguished by its extraordinary whiteness, which can only be accounted for as a consequence of the washing. Another proof of the advantages of this process is furnished by the frozen fish, which is distinguished from other fish by its whiteness, which is owing simply to the cleaning process which it has undergone in freezing.

It is not probable that washing the fish should have an injurious influence; for, as we stated above, the Norwegians are the only people who do not wash their fish. The older the fish, all the more necessary it is that it should be washed. The washing of fish, which have been allowed to wait very long, should however be done cautiously, as such fish do not stand much handling. Fish which have been washed should, if only a limited number are washed, be salted by themselves. If the Sondmore manufacturers have, as they think, made the discovery that washing decreases the weight of the fish, they certainly cannot furnish any plausible reason for their assertion. We can understand, however, in what way this idea has originated. As far as we know, only those fish are washed which are brought in by vessels having a deck (which therefore go farther out to sea than mere fishing boats), and if klip-fish manufactured from the fish brought by these vessels weighs less, the simple reason is that it is from 2 to 8 days older, and therefore more shrunk. Common sense also tells us that the time when the fish, during the washing process, comes in contact with water, is too short to exercise any influence on the substances which are soluble in cold water, and that any possible influence of the washing is fully counteracted by the appliance of brine. The only loss of weight which can possibly be occasioned by the washing is the loss of the dirt and slime which is thereby removed. We have often seen fishermen, probably acting on this economical principle, drag fish along the fields through which they were passing, so as to increase the weight of the fish by an addition of dirt. But the advantage which is thought to be obtained thereby is purely imaginary, for all this dirt is, as far as the dried fish are concerned, for the greater part removed by the rain, and as far as klip-fish is concerned, by the cleaning; what remains will rather occasion loss, as it is apt to spoil the appearance of the fish.

As regards the extra labor occasioned by the washing, the fishermen who made experiments in this respect in 1882 declared that if the fisheries are not extraordinarily large, washing can be done without engaging an extra force of laborers, and that the most practical apparatus for the purpose consisted simply in a pump fastened to the outside of the vessel, tubs, woolen rags, and perforated benches, to allow the water to run off. When there is frost, the fish should, as soon as washed, be put in the hold of the vessel, and there be laid on benches so the water can run off.

Frozen fish.—In cold weather the fish either reach the shore in a frozen condition, or freeze while they are laid aside to be split. If the fish are split while frozen, they turn dark and furnish an inferior article. One should therefore hang the fish in the water outside the vessel in a net, but not let them stay in the water any longer than is necessary. As a general rule one or two hours will suffice. In a manual for preparing salt-water fish, published in 1839 by the department of finance, commerce, and customs, it is recommended to let the fish freeze in a tub containing brine. If the fish are fresh, such freezing will not hurt them; but if old—even two days only—their flesh becomes loose and breaks, and only an inferior article is obtained. In cold weather fish should not be salted under the open sky; for if they are put in salt when in a frozen condition they will not make a first-class article.

PRICES.—The raw material may be of greatly differing value, and regard should be had to this circumstance in buying and treating fish, by sorting the fish from the very outset as carefully as the given space will allow. The advantage of doing so will appear both in drying and selling the fish. We also deem it our duty to call attention to a mistake very commonly made in fixing the prices; in buying the fish too much regard is paid to temporary circumstances, so that fish are bought at prices which are unreasonable. It should be remembered that all cod fisheries close in October, and that none of them begin before May, with the exception of the Norwegian and Iceland fisheries,* so that the fish which we catch during winter have to compete with those of future fisheries of other nations. It should further be remembered, that of the 100 million kilograms (in round figures) of klip-fish which are annually brought into the European market, not one-half, and of the 200 million kilograms which are brought into the world's market, not one-fourth comes from Norway. And of this comparatively small portion only about one-half comes from the Loffoden fisheries. The only rational basis for fixing the prices must be found in our own fisheries, and in a comparison with the development which the fisheries have reached in other countries. The safest guide in this respect is statistics, even if they should be of somewhat ancient date. The study of the fishery statistics is therefore essential for a rational fish trade. It is quite natural that the exporters in giving orders relative to the buying of fresh fish to their own agents, have regard to possible combinations in the near future, partly because their order will be small compared with the entire quantity of fish in the market and partly because they can get their own fish into the market before new fish from other countries can reach it. They can, therefore, pay higher prices when it is their interest to obtain a certain given portion. But for other buyers there is no reason to "follow the prices," as it is called. The klip-fish prices of the preceding year exercise a considerable influence on the buying of fresh fish, although less than in former times, owing to the introduction

* And also the Faroe fisheries, which, however, are but small. In winters when there is not much ice, there are some fisheries on the south coast of Newfoundland, and also near the Shetland Islands.

of the telegraph. But this is not a sound basis either; for the prices at which fish sell will principally depend on the result of fisheries which do not begin until our fisheries have come to a close, and regarding which the telegraph keeps the dealers posted. The fish trade will always be more or less of an uncertain business, whose results it will be difficult to predict. There is all the more reason, then, why circumstances which are of but little importance, but which may exert a hurtful influence, should not be allowed to enter into the calculation.

SPLITTING.—The splitting should be done carefully, so as not to damage the fish. Old fish especially should be treated with the greatest care, and not be thrown about as is so often done. The knives should be sharp and be run close to the backbone, so as not to cut off any of the flesh. Along that part of the backbone which is to remain, the point of the knife should not enter deeper than to run along the upper edge of the vertebræ, as otherwise the fish is split open too much during the pressing. The backbone is cut off at least three links below the sexual aperture in an oblique direction, so as to cut across 2 or 3 links. The cutting of the backbone must be done very carefully, so as not to injure the string which runs along its upper edge, as this is to remain in the fish. The portion of the backbone which is to come off, is torn out.

SALTING.—This may be done either in boxes, the so-called dry-salting, or in tubs, the so-called brine-salting. The latter method was generally employed during the last century, and fish were then often salted in tubs, to be manufactured into klip-fish at some later time. Brine-salting is at the present time used only in Scotland. In Norway it could hardly be used, as it presupposes that the drying process begins as soon as the fish have absorbed enough salt. If this cannot be done, the fish are salted again in boxes. This method has been described in our last volume, to whose pages we refer, and shall here confine ourselves to a brief description of dry-salting. This is done by laying the fish in rows, and making piles of fish one row over the other. When laid on the pile the fish should be well drawn out and smoothed down, for whatever folds it may get in the pile it will retain. Care should also be taken that in placing the fish on the pile the abdomen does not come in contact with the cut portion of the backbone of other fish. The piles should be so arranged as to allow the brine to flow off freely, as otherwise there is danger of its turning sour. The center of the pile should therefore be its highest point. Some people who intend to sell fish in brine, in which case the fish are often sold by weight, pile them up in such a manner that the brine remains standing on the fish, and that consequently the fish become partly brine-salted. The attention of buyers should be directed to this method, as such fish will contain a considerable quantity of water, and are very difficult to dry. The buyer should also examine the brine to see whether it possesses the proper degree of freshness. Even the Scotch, who use brine-salting, do not let the fish lie in the brine any longer than is absolutely necessary. If the season does not allow the fish to be dried, they are taken out of the brine and are placed in well-covered piles, some salt being sprinkled between each layer of fish. To give the fish a second salting is customary among the Icelanders, although they dry-salt their fish. For the first salting they use 1 ton of Liverpool salt to 160 kilograms of dried fish, which corresponds to 6½ tons of salt per 1,000 Loffoden fish of the usual size. After the fish have lain in salt two or three days they are subjected to another salting, this time one-eighth ton of salt being used per 160 kilograms of fish; after they have remained in the salt for another two or three days they are considered ready for washing and drying. A second salting (using a less quantity of salt than during the first) is also done by English fishermen when they salt the fish in boxes on board their vessels, as well as by all those nations (the Swedes alone excepted) who salt their fish in kegs. In the United States the fish are also salted a second time when they have been unloaded from the vessels; but this is done only because they are dried as they are needed for the market. A second salting may be recommended, but it hardly pays unless there is danger that the fish will turn sour. In salting fish the salt should be distributed evenly over the whole layer, as otherwise some parts of the fish will be salted too strongly. If salting is done under the open sky, the piles of fish must be well protected both on the top and on the sides. Care should also be taken to avoid an accumulation of water at the bottom of the pile.

KINDS OF SALT.—As regards the kind of salt to be used, it is difficult to lay down a rule which will hold good in all cases. We formerly used the gray French salt, which in 1839 was recommended as the best. At present Cadiz salt is generally used in Norway. The Scotch and Icelanders use Liverpool salt; the Canadians during the cold season and for large fish use coarse Liverpool salt, in the warm season and for small fish, fine Cadiz salt. In the United States Trapani salt is preferred to the Cadiz salt, owing to the red plant which is often found on it. In Newfoundland, Cadiz and Lisbon salt are used; to some extent also Liverpool salt for codfish and Trapani salt for herring. The French near Newfoundland use St. Ives or Cadiz salt, using their own salt only for preserving bait. The kinds of salt in general use are, therefore, Cadiz, Lisbon, Liverpool, St. Ives, and Trapani salt. These salts contain about the same amount of cooking salt, as follows:

	Per cent.*
Liverpool salt	92.7
Lisbon salt	91.2
Trapani salt	90.4
Cadiz salt	87.5
St. Ives salt	84.2

* According to an analysis made by Professor Waage. This percentage, however, varies slightly in the different years. An analysis of Liverpool salt, made by Mr. Jensen, showed a percentage of 94.2 cooking salt.

As regards its weight there will in reality be very little difference between the above-mentioned kinds of salt, and we feel safe in stating that not too much importance should be attached to the kind of salt, at least as regards its place of origin. The essential requisites are that it should be clean and have grains of even size, as unusually large grains will produce spots on the fish and give it too salty a flavor in some parts. For fish which are to remain in salt for any length of time coarse salt which does not melt easily is to be preferred.

QUANTITY OF SALT.—The quantity of salt to be used depends on the kind of salt, or the length of time the fish are to remain in salt, and on the size of the fish. Small and lean fish should have less salt than large and fat fish; a rule which is not always carefully observed. On the Lofoden Islands a larger quantity of coarse and not easily dissolvable salt should be used in the beginning, not only because in the beginning of the fisheries the fish are larger, but also because they have to lie in salt a longer time. In Norway the quantity of salt is determined by the number of fish, while in other countries it is determined by their weight when dry, which is the more sensible plan. As we stated before, the Icelanders use 7 tons of Liverpool salt per 1,000 kilograms of fish, or per 1,000 fish when 18 of them go to the *vog* (a Norwegian weight), and 5½ tons when 23 fish go to the *vog*. This quantity was used in experiment No. 2,* described on page 28 of the report for 1883, and proved too much, which is quite natural, considering that the Iceland fish remain in salt for only one week. The fact to which we desire to call special attention is, that it is impossible to fix a certain quantity of salt for a certain number of fish, for a difference of 5 fish per *vog* of dried fish will, if, for example, Liverpool salt is used, make a difference in the quantity of salt used amounting to 1½ tons per 1,000 fish. The Scotch use still less salt, viz., 4½ to 5 tons per 1,000 kilograms dried fish, owing to the fact that they salt their fish in brine. Per 1,000 kilograms dried fish there are used of Cadiz salt 4.2 tons in Canada, 4.5 in Newfoundland in summer, and 5.8 in Labrador. In all these countries the fish remain in salt only from one week to two weeks at the most. If the fish are to lie dry-salted for some time, the quantity of salt should be somewhat greater. Regarding the relation of the kind of salt to the quantity used we must direct attention to the circumstance that, although most salt has about the same degree of saltness, there is considerable difference in the weight. While 1 ton of fine Liverpool salt, loose measure, weighs 99 kilograms [518 pounds], one ton of coarse-grained Lisbon salt weighs 131 kilograms. Packed more tightly, the weight of the former is 136 and that of the latter 162 kilograms. One ton of loosely packed Lisbon salt, therefore, contains 27.7 kilograms more cooking salt than the same measure of Liverpool salt, and less of the former should therefore be used if a certain measure is to be employed as a unit for the quantity of salt needed.

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* 1,000 fish were found to weigh 779 kilograms, or 23 to the *vog*.

The relative quantity of cooking salt in the different kinds of salt has been calculated by Mr. Wallem and published in his report on the Berlin Exposition.

Amount of cooking salt per ton.

	Kilograms.
Liverpool salt contains	91.8
St. Ives salt	108.6
Trapani salt	113.0
Cadiz salt	113.0
Lisbon salt	119.5

According to this calculation one ton of Liverpool salt, of 100 kilograms, would be equal to 0.85 ton St. Ives salt, 0.81 ton Cadiz or Trapani salt, and 0.77 ton Lisbon salt.

To return to the experiments made in 1882, we find that in experiment No. 3, 3.09 tons Cadiz salt were used per 774 kilograms dried fish, and that this was too little. In a former experiment we found that 5.53 tons Liverpool salt for 779 kilograms of fish was too much. According to this proportion 5.53 tons of Liverpool salt should be equal to 4.48 tons of Cadiz salt, which therefore would also be too much. 3.09 tons of Cadiz salt was therefore too little and 4.5 tons too much for 775 kilograms of fish. The suitable quantity of salt would therefore be somewhere between these two figures. According to the above calculations 6½ tons Liverpool salt or 5.3 (more exactly 5.265) tons of Cadiz salt would be sufficient for 1,000 kilograms dried fish, or if weight is used, 650 and 663 kilograms salt respectively. The Cadiz salt has less saltness than the Liverpool salt, and therefore more in weight should be used, although the difference is only 13 kilograms per 650, but as it is heavier, less by measure should be used, the difference here being very considerable, viz., 1.2 tons per 6.5.

To use a certain measure of salt as a unit for the quantity of salt to be employed is less reasonable than to take a certain number of fish as the unit for determining the quantity of salt, as both will vary. The best way will be to use a certain weight of salt for a certain weight of dried fish, for the difference in saltness between the various kinds of salt is comparatively speaking so small, that the same weight may for all practical purposes be considered to contain the same quantity of cooking salt,* and, with regard to the weight of the fish when dried, a skilled eye will soon be able to determine this with a tolerable degree of accuracy. It appears from the above that 650 kilograms of salt, no matter what kind is used, will be sufficient for 1,000 kilograms dried fish. No absolutely binding rule can be laid down before some more experiments have been made, and it is to be hoped that the Society for the Promotion of the Norwegian Fisheries will soon be enabled to make these experiments.

*Of the other principal ingredients of salt, sulphate of lime (gypsum), sulphate of magnesium, and chlorate of magnesium, possess strongly hygroscopic properties.

Fish which have been salted too much become stiff in the salt; when the fish are cured, however, they become soft again.* Excessive salting may be corrected during the washing and pressing, but, if possible, it should be avoided. In regard to this matter we repeat the following quotation from the Report of the Board of Fisheries (given on p. 185 of the last volume): "Excessive salting is used by some persons to increase the weight of the fish, but no greater mistake could be made, for not only is the juice extracted from the fish, thus making it lighter, but as the drying process progresses, a crust of salt forms on the fish, and its value is diminished."

RULES.—We would, in accordance with all that has been said above, lay down the following rules:

1. All fish should be treated with great care both by the fishermen and the manufacturers.
2. The curing should be done as soon as the fish reach the shore.
3. Fish caught with the day line and the deep-water line should be killed as soon as they reach the boat.
4. All fish should be washed, and a few hours should be allowed for the water to flow off.
5. Frozen fish should not be salted before lying in water for some time to let the ice become loose.
6. In splitting the fish, the backbone should be cut obliquely three links below the vent, so that the string running along the backbone remains in the fish. The bone is torn out.
7. Each day the fish are allowed to lie before being cured makes a difference in the price, which will fall rapidly the longer the fish are allowed to lie. Fish which have been killed so as to let all the blood run out bring a higher price.
8. All fish which have been treated with particular care, or which are supposed will make a first-class article, are salted separately.
9. The salt should have grains of even size.
10. For fish which are to lie in salt a considerable length of time coarser and less dissolvable kinds of salt are used.
11. The quantity of salt is calculated on the basis of a certain weight of salt to a certain weight of dried fish.
12. When heaped up in piles the fish should be well stretched and smoothed down, and the salt be distributed evenly. The brine should be allowed to flow off freely.
13. If the salting is done under the open sky, the piles of fish should be kept well covered and have a firm foundation, so that no water can gather at the bottom.

To these we add, conditionally,—

14. For 1,000 kilograms dried fish use 650 kilograms salt. Our own idea is that somewhat less might be used; for the turning sour of the fish, which is sometimes caused by a long period of bad weather while

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* The Labrador fish are therefore never stiff.

the fish are being dried, can be prevented by frequently changing the fish in the piles.

THE PROPORTIONS OF SALT.—If one wishes to use the quantity and number of fish as a unit he must simply weigh his salt and divide the weight by 650. With regard to the conversion of fish in weight to fish in individuals, the difference of one fish in a *vog* [36 Danish pounds] makes a difference of 55 and 56 hundredths fish in 100 kilograms. Hence, if we assume the salted fish to weigh 130 kilograms per barrel, we should, according to the rule here mentioned, use, upon the basis of 18 fish to the *vog*, 5 barrels of salt to 1,000 fish; 19 fish to the *vog*, 5 barrels to 1,056 fish; 20 fish to the *vog*, 5 barrels to 1,111 fish; 21 fish to the *vog*, 5 barrels to 1,167 fish; 22 fish to the *vog*, 5 barrels to 1,222 fish; 23 fish to the *vog*, 5 barrels to 1,278 fish.

Or if we take a thousand fish as the standard, when there are 18 fish to the *vog*, 5 barrels of salt; 19 fish to the *vog*, 4.735 barrels; 20 fish to the *vog*, 4.5 barrels; 21 fish to the *vog*, 4.285 barrels; 22 fish to the *vog*, 4.092 barrels; 23 fish to the *vog*, 3.912 barrels.

A difference in weight of two fish per *vog* [18 kilograms] in the dried state therefore causes, if the salting is uniformly done and salt whose weight is 130 kilograms per barrel is employed (the average weight for the kinds of sea salt here mentioned), a difference of a few barrels in the quantity of salt. A difference of five fish per *vog* requires a difference of $1\frac{1}{10}$ barrels in the amount of salt.

The washing out should take place on the shore whereupon the fish are to be dried, and it should be done in clean, fresh sea-water, and not in river water. By washing them in the latter they lose their fresh, bluish color, become dark gray, and acquire an unpleasant smell. The fish are thrown out in the water one by one as they are needed, so that the washing out may take place without interruption, but never more at one time than the workmen can clean up immediately, or, at all events, in the course of a short time. In throwing out the fish it is necessary to observe whether the water is rising or falling, and also its depth, so that the washers may always be able to reach the fish thrown out. A washer of average ability should be able to wash fifty or sixty fish in an hour. The fish are to be thoroughly cleansed, all the blood and slime should be carefully removed, and the black membrane (*peritoneum*) is to be taken off if this was not done before.*

Special attention must be given to the *rygfolden* ("blood bone") if this is not cut off as it should have been; also to the ear bones. In the cleansing process woolen mittens are required. When the fish have been washed they are laid down in slanting piles in five to six layers† with the bellies downwards, so that the water may run off. The lowest layer is placed with the skin side down, the remainder with the skin side up. The substratum must be bare ground, free from irregu-

*If the fish have been washed before pickling, the washing out will be much easier.

†If in many layers, the lowest fish become too dry.

larities, and with suitable inclination, or *kuppelsten*. The last is preferable, especially if the ground slopes somewhat. If boards are at hand they should be used both for the floor and the covering. The fish should remain in these heaps at least twenty-four hours, or as nearly so as the state of the weather will permit.

When there is considerable difference in the size of the fish, they should be assorted before pressing, in order that the larger and the smaller fish may be treated separately. If the cargo is not sufficiently large to warrant the assorting of the fish, the larger and thicker fish must be placed undermost in the press-layers, and the smallest, on the other hand, should be uppermost. Old fish must be treated with greater caution than those which are salted fresh. If the fish is too salt it should be allowed to lie in the water from one hour to several hours longer. The workman himself must decide how long. Should it become necessary afterwards to remove the superfluous salt by pressing, the manufacture will occupy a longer time.

THE DRYING PLACE.—In the United States, as well as in Canada, Newfoundland, and Labrador, most of the fish are dried on scaffoldings or "flakes." These consist of a kind of grating laid on a trestle. Sometimes the grating is made to turn so that it may have a greater or smaller inclination to the horizon, according as one wishes to expose the fish to the influence of the sun or protect them from it. In some places there is used for the same purpose a frame-work over the grating, supplied with curtains, which can be put on and removed at pleasure. The grating consists either of laths or of spruce and pine strips (*furrukviste*), which are cut the year before, so that they may be thoroughly dry. If the last is used the floor of the scaffolding is made in the following manner: Over the lengthwise strips, which rest on the trestle, are laid cross-bars at a distance from each other of from 4 to 6 inches, and across these are placed twigs which are fastened with laths at each fifth or sixth foot of their length. When the bottom is made of twigs, drying is accomplished more slowly than when it is made of laths, as the circulation of air is less free. Where one has both kinds, he should use the first during the closing portion of the drying process. The height and breadth of the scaffoldings vary. In Canada those which are used for the drying of the smaller fish have a height of 4 feet and an equal breadth,* whereas those which are used for the drying of the larger fish are 12 to 14 feet in height and as much as 100 feet broad. For the convenience of the men there is constructed on this a board walk, so that they may readily handle the fish.

In Scotland, also, scaffoldings are used to some extent. The advantage of the scaffoldings is that the fish get a circulation of air both above and below, whereby the evaporation of the water takes place more rapidly, while at the same time they are not exposed to the danger of becoming sunburned. Furthermore, on these the fish are not exposed

* See *Norsk Fiskeritidende*, 1883, p. 12.

to surface-water, or so much affected by dust and other filth as when they are dried on the beach or on a hillside. Finally, the fish become heavier, as they retain more salt than when the drying takes place mainly with the aid of pressure.

The use of the scaffolding in the countries here named is due partly to a want of natural drying places, but chiefly to the fact that the manufacture occurs mostly in summer. Canada and Newfoundland lie between about 43° and 50° of north latitude, or in the same latitude as France, and their southern situation, with the climatic conditions consequent thereupon, has made the use of scaffolding a necessity. This must, therefore, not be considered as a special method, but as a mode of drying called forth chiefly by necessity.

The scaffolding is expensive, wherefore cheaper methods of drying are also employed in places where the conditions allow it, or where there is difficulty in obtaining the necessary wood-work. Thus there are constructed besides the scaffolding some artificial drying places of stone cairns or gravel heaps with shingles. In Newfoundland the latter have an underlayer of bark upon which is placed a layer, 4 or 5 inches thick, of shingles. The stone heaps are used chiefly in Iceland and in Scotland; the gravel heaps, on the other hand, mostly in British North America. In many places stone fences also are used. The artificial drying places of stone here mentioned, have the advantage previously referred to in speaking of the scaffolding (though in a less degree), of a circulation of air on both sides, while the surface water has free drainage.

In Firtiaarene,* in Norway, an experiment was made with scaffoldings; but they were found too expensive in proportion to their advantages. There can be no doubt that these as well as the artificial stone heaps are preferable to a hillside, but when they are not used it is because there is a sufficient number of natural drying places, and because the climatic conditions among us make these more available than among most of our competitors. These make it necessary for us to employ to a greater extent the pressing process in order to remove the moisture from the fish, since there is not sufficient heat to accomplish this by evaporation.

As we also know the advantages from the use of scaffoldings and stone structures, &c., their use demanding less pressing and consequently giving a greater weight, we dispense in drying with the hillside. That these also can produce first-class products the Norwegian klip-fish has given and still gives the best evidence. But it causes more labor and produces less weight.

If a hillside is used the drying place should slope from the sun, and especially towards one of the points between north and east, so that it will be open to the winds from these quarters, and protected from the westerly and southerly winds. It ought to be sloping and level so that

*At the present time small lots are dried on laths on the wharves at Bergen.

the rays of the sun may not by reflection be concentrated on any single point. The fish which are dried in such a place will readily become sunburned. Rough ground or ground with ridges is advantageous, since there is some circulation of air under the fish, and the drainage of water is free. Before the drying begins the place must be freed from grass, moss, &c., and must be swept clean. To remove the turf immediately before the beginning of the drying in order to secure more room is injurious. This work should be performed beforehand, for one should avoid as far as possible everything that may cause dust, because if this gets on the fish in the beginning it can never be removed.

DRYING.—This is performed somewhat variously in different countries according to the climatic conditions. In one respect, however, there exists a complete agreement; it is in the universal dependence upon the conditions of the weather and the uniform results everywhere following upon these conditions. Softening (*sleiphed*), sunburning, saltburning, and flies are drawbacks which operate against one in America as well as in Europe, and the problem for the manufacturer is to counteract them as well as he can. The remedies are the same on both sides of the Atlantic, whether one uses sheds, scaffoldings, stone heaps, or slopes. They can be included into one word, which we never weary of repeating—carefulness. A great many "disasters," as they are called, may be prevented, but very few can be repaired. We shall treat of drying in its details under Norway, and thereupon give a short synopsis of the conditions which exist in other countries, as far as these are not touched upon in previous pages.

NORWAY.—When the water is run off after washing, for which at least twenty-four hours should be allowed, drying begins as soon as the weather is favorable, by carrying the fish to the drying place, for which purpose hand-barrows are employed, and laying them out with the flesh side up. If the weather is dry and good, the fish may remain out over the first night, but the skin side must be turned up towards evening. On the forenoon of the next day the flesh side is again turned up, and in the afternoon the fish are collected into layers containing thirty to fifty each. When they have been laid out two to three times they must be well stretched, especially in the belly. As this work is of great importance to the appearance of the fish it must be carefully performed. It requires much time, and one should rather sacrifice a day to it than undertake it in a hurry during the collecting of the fish before night. When the fish have been out three or four times,* or when they have become so dry as to admit of being put in press, which is indicated by the breaking of the belly upon bending it, they are placed in the first press layer. In this they remain five to eight days, according to their dryness at the time of putting them in, whereupon they are relaid in another press layer so that the uppermost are underneath, and in this they remain for an equal length of time. Thereupon they are again

* Before each time of taking in the fish they are laid more and more in piles.

laid out, if the weather permits, but only every other day, and before which time they are put in piles, which are again formed during the days when the fish are not out. If they have been laid out four or five days the drying will usually be finished. The fish is not sufficiently dry as long as it continues moist under the dorsal fins, or is not sufficiently hard to withstand the pressure of the thumb without retaining the impression. Under ordinary conditions the drying will occupy about six weeks.

These are the principal features of the Norwegian method of drying. We cannot go further into details, because one frequently has a whole day for drying, while at other times, again, only a few hours. Frequently a week or more may pass by during which one may be unable to get the pickled fish out, while at other times it may be necessary to allow a day of good weather to pass unused in order to allow the fish to remain in piles. If there is good drying weather in the beginning, the fish should not be laid out every day, but should remain in small piles one or two days in order that they may not dry too rapidly, as thereby they become brittle and do not look so well. The power of deciding when they should be laid out and the size of the piles in which they may be placed, if they are oversalted, demands practical skill, which must be obtained through long experience. We can, however, give a few directions showing how one must proceed in certain individual cases:

If adverse weather occurs during the drying, the fish should be heaped up every day or every other day as soon as the opportunity offers, and the piles should be made smaller in order to give freer circulation of air. To spare labor in these respects is bad economy. By repiling, the fish become whiter and they are not so readily exposed to become *sleip*. A little rain in the beginning need cause no anxiety. Towards the close of the drying process, however, it should be avoided, as it makes the fish yellow. If, notwithstanding your efforts, they become *sleip*, this can be remedied by dipping or washing them with brine or by strewing a little salt between the layers.

If the fish become *sleiped* in the store, a result of bad drying, wipe the moisture off, and afterwards give them one or two days of drying.

If the weather has been warm during the day, the fish when they are collected before night must not be pressed in piles until they are cooled off, as otherwise they will readily become salt-burned. If one is obliged on account of squally weather or for some other reason to take in the fish while they are warm, and the next day is unfavorable for laying them out, they must then be piled up again.

In warm and still weather one must be careful also in laying out the fish for drying that they do not become sunburned, especially if the sun has had time to heat the ground. In Canada, during intense sunshine, they cover the fish with spruce boughs or canvas. If these are not at hand, the fish on the warmest side during still and intense sunshine must be thrown in heaps of ten or twelve in such a manner as to present as little surface to the sun as possible. When the fish, after having remained in press, have become sufficiently stiff to admit of being "raftered" (laid on edge), one must observe, during the conditions of weather just named, that they are not turned broadside to the sun; but the *sparrerne* must be turned according to this.

The fish must not be too dry before they are placed in the first press layer, else they will with difficulty "repel salt."* At first the brine is turbid and has a bitter saline taste; later it becomes clear as water and acquires a milder taste. If the brine becomes turbid afresh, the fish must be placed in smaller piles so that they will not be pressed any more.

When the fish are laid in piles, the best way to place them is just as herring are crowded in a barrel. It is necessary to observe precisely that the belly of one fish is placed in the middle of the back of another. When the *floen* is filled on one side, the beginning must be made on the opposite side, provided only one person is engaged in the work. The layers are heaped vertically and perfectly straight from the bottom to the top.†

In relaying the press layers it must be observed that the napes, which at the first pressing were turned outwards, should be laid inwards. If the fish in repiling appear to be too dry this can be remedied by sprinkling them with fresh water.

The piles must always be well protected from rain and sun. They ought properly to be placed on some elevation and in such a manner that the surface water cannot reach them. A foundation of pebbles is the best. In the absence of these wood is used. The undermost layer is placed with the skin side down, the remainder with the skin up.

The heaps from the beginning of the drying ought to be covered with stone, and the weight of the stone should increase progressively as the drying advances. Weight must be divided uniformly over the cover.

The dried fish are removed after they are finished, and are brought either on shipboard or placed in well-covered heaps.

Some manufacturers recommend laying the fish in the sun with the skin side up, if it has been over-salted or if it is salt-burned, as the salt is thereby drawn from the flesh side. Turning occurs more frequently the further the drying process advances. The fish should never be stowed away when they are warm.

In damp weather the fish in the warehouse should be well covered, but in dry weather, on the contrary, air them by opening the windows and doors. It is likewise desirable to repile them every second or third month, partly to air them and partly examine them, so that the

* See "Rules for the guidance of the fishing population on the manufacture and treatment of klip-fish." Aalesund, 1880.

† Rules for the guidance of the fishing population on the manufacture and treatment of klip-fish. Aalesund, 1880.

damaged ones may be taken out and improved. Oat straw, between the layers is said to absorb the superfluous salt, giving the fish a good color and preventing it from becoming slimy or *middet*.

UNITED STATES.—After the fish have been taken out of the vessel* they are washed, and are then placed in piles with a little salt between each layer (kench cured), or they are laid in strong pickle in the vat, which holds about 400 kilograms. They are afterwards dried according as they are wanted for the market. The dry-salted appear to be the best and receive from one to several weeks drying, according to the market, while the brine-salted, being mostly used inland, are dried only one to three days. Pressing is never employed.

CANADA.—On the first day after washing the fish they are placed with the skin side up, towards evening they are turned and are left lying out during the first night, if the weather is suitable. Later they are collected before night and are laid the first time two and two together. According as the drying advances they are placed at night, or in unfavorable weather, in larger and larger heaps, the number in which, however, never exceeds 50 fish. When they are nearly dry they are placed in round heaps containing as much as 5,000 kilograms, which are covered well and loaded with stones. In the heaps they remain at least five to six days, after which they are dried on shingles for one day in front of the store-house. When the fish are in heaps for pressing they frequently remain in that condition for a long time, even until they must be shipped, when they receive "the last sun."

NEWFOUNDLAND.—Here the fish are not placed in the press heaps† until they are nearly dry, when they are kept in them fourteen days, after which they receive four to five days' drying inside of the store-houses. Every evening they are placed under the store-houses in large piles. They are considered sufficiently pressed when the dust salt begins to appear on the outside.

LABRADOR.—When the fish are three-fourths dry, which occupies four to five days of drying, they are placed for ten days in press layers in order to "work," after which they are considered to be finished.

FRANCE.‡—After the fish have been taken out of the vessel they are

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* Those who fish on George's Bank, to which the voyage occupies three weeks, use one bushel [30.28 liters] or 28 kilograms of salt to 150 kilograms of split fish, which corresponds with 560 kilograms of salt to 3,000 kilograms of raw fish, while in our country we recommend 650 kilograms to 1,000 kilograms of dried or 3,000 kilograms of green fish. Those who fish on the Grand Banks of Newfoundland, and are absent from two to three months, use twice as much salt.

† It may be superfluous to remark that by "press heaps" we mean the piles in which the fish (*principmœssigt*) remain untouched for a certain time.

‡ See Candidate Wallem's report on the Berlin Exhibition, 1880, page 219. The method here mentioned is employed, moreover, unchanged, which is especially remarkable since the author assumes that possibly some improvement has taken place. The French fish manufactured in Newfoundland are exported directly without going over to France.

washed in fresh water, which possibly has given rise to the name *lavè*, by which they are known in Italy, and then they are suspended from cords in covered dry sheds, where they receive from three to six days of drying, according to the market. They are not pressed. Since, on account of the proximity of the markets, they can be shipped by rail or steamer, according to necessity, it is not necessary to lay much stress upon their durability.

SCOTLAND.*—After fourteen days' drying the fish are placed in press heaps for ten days, after that dried for one week, placed again to "sweat" four to six days, whereupon, after two to three days' drying, they are finished.

ICELAND.†—The drying process here is about the same as among us, except that the fish are placed in the press somewhat later.

Thus in the countries in which klip-fish is manufactured the drying is done on similar principles. The chief difference exists in the extent of the pressing and in the time before placing the fish in the press. Where the temperature or the condition of the drying places allows the diminution of the moisture of the fish to take place by evaporation, whether this is produced by heat or circulation of air, pressing is less needful in proportion to the extent of the operations than when the water must be removed by mechanical means (pressing). Where the drying takes place chiefly by evaporation, the object of the press heaps is principally to allow the fish to undergo a kind of fermentation. Where the drying, on the contrary, occurs chiefly or in part by pressing, the fish must be placed earlier in the press heap before the outside crust becomes so hard as to prevent the penetration of the pickle. If the fish of our competitors appears to be more salted than ours, it is not because they use more salt,‡ but because the salt which the fish have absorbed either becomes crystallized in them or dissolved, while a portion of the salt dissolved in the water escapes when this is removed by pressing. When certain manufacturers in your country use little pressing in order to increase the weight, which is done at the expense of the preservation, they must be discouraged. In this method, it is true, the fish retain a little more salt, but at the same time, also, a corresponding quantity of water which diminishes the durability of the fish; for, as we have seen, moisture is one of the elements which promote decay. The greater the amount of this in proportion to the weight of the fish the more rapidly softening takes place. The water must therefore be removed by evaporation, a thing, however, which can be accomplished in a protracted drying season under favorable conditions for drying. Therefore, if one wishes to employ less pressing he must use more drying,

* See *Norsk Fiskeritidende*, 1883, pp. 185, 186.

† See Annual Report for 1883, pp. 3-10 (Appendix 2).

‡ Except in Iceland.

provided the durability is to remain the same. A drying place which allows circulation of air on both sides is essential for this purpose.

Because of the antiseptic qualities of the salt a strongly salted fish is more endurable than one which is less strongly salted. The capacity of the fish to take salt is, however, limited. To dissolve one portion by weight of salt requires 2.85 times the same quantity of water. If we assume that 100 round fish will weigh 3,000 kilograms, about 2,460 kilograms of this weight will be water, whereby 863 kilograms of common salt can be dissolved. Whatever is in excess of this weight will remain undissolved.*

WEIGHT OF THE FISH.—With regard to the proportion between the weight of the fish in the fresh, salted, and dried conditions, which is dependent upon the quantity of water, salt, and nourishment it contains in these different conditions, we have little information based upon accurate observations or chemical analysis.

We have already given an analysis of Norwegian klip-fish, made by Candidate Jensen, one of the teachers in the Technical School of Bergen. An analysis by the same chemist of a well-dried Iceland klip-fish which weighed 1.5 kilograms gave the following result: Water, 42.23 per cent; salt, 19.90 per cent. The proportion between a Norwegian and an Iceland klip-fish of 15.10 kilograms should be: Norwegian klip-fish, 552 grams water, 232 grams salt, and 716 grams mostly nourishment. Iceland klip-fish, 633 grams water, 298 grams salt, and 569 mostly nourishment.

Of the examples examined, which were specially selected materials, the Norwegian fish thus contained 147 grams, or nearly 10 per cent less water and salt than the Iceland, or 10 per cent more nourishment. A chemical analysis of the klip-fish of other countries will certainly likewise show that they contain a varying percentage more of salt, possibly also of water, than the Norwegian. When people, therefore, in these countries get during drying "better weight," this is to be accounted for partly by the fact that the fish in such places contain more of the comparatively worthless materials, water and salt, which the buyers pay for as fish, provided the price per kilogram is the same. Many of our manufacturers oppose this measure, but they forget that in our drying with circulation of air on one side only we get, if that spares the salt, too much water retained in proportion to the salt. An analysis of the Iceland fish shows a surplus of 5.41 per cent of water and 4.41 per cent of salt. If we wish now to retain 4.41 per cent more salt, we must also retain 4.41 times 2.37 per cent of water, which is the proportion between salt and water in a Norwegian klip-fish,† provided we do not use

* With regard to herring the excess of salt over 32 kilograms, or one-quarter of a barrel to a packed barrel of the fish, remains undissolved.

† The proportion between salt and water in an Iceland klip-fish is as 1 to 2.12, thus, comparatively, more salt to the water, wherefore also it is more durable.

more drying for the lightly pressed fish than we use in proportion for the fully pressed fish. The one means of increasing the weight without diminishing the durability is to retain the salt and remove the water; but this can be done only by evaporation, not as is attempted in our country by light pressing and medium drying. These processes, it is true, give increased weight, but durability is sacrificed. By strong salting, on the other hand, we can gain weight, but the fish thereby lose in return nourishment and are exposed to the danger of becoming salt-burned.

The weight of the fish is most closely dependent upon the time during which it has remained in salt, as its elements which are soluble in water are taken up by the pickle. We lack, however, the necessary materials for deciding how much it loses thereby in weight. On the other hand, fish which have remained long in salt yield a better weight of klip-fish, as the salt finds time to penetrate everywhere, and thereby its capacity for salt is increased. Finally, the greater or less plumpness of the raw product certainly has an influence on the weight of the klip-fish.

Concerning the relations between the weight of green and dried fish in different countries we are in possession of fixed data concerning only a few. We append below the result of some experiments instituted in the United States:

Weight.		Loss.		Remarks.
Split.	Dried.	Weight.	Per cent.	
Pounds.	*Pounds.*	*Pounds.*		
18.31	11.94	6.37	34.8	Twenty-two days drying. The ordinary dried fish
15.12	10.12	5.00	33.1	
10.75	7.50	3.25	30.2	
7.62	4.94	2.68	35.2	
4.44	3.06	1.38	31.1	
23.50	14.62	8.88	37.8	Thirty-seven days drying.
14.88	9.14	5.74	38.6	
7.50	4.38	3.12	41.6	
5.00	3.00	2.00	40.0	
2.25	1.38	0.87	38.7	

According to this table, in one case 100 kilograms of green fish yield 66.8 kilograms of klip-fish, in the other case 61.2 kilograms. In Scotland they calculate that 100 kilograms of raw fish will yield 39.3 kilograms; in Iceland, 50 kilograms;* in Norway, 33.3 kilograms; in Sweden, 40 kilograms (ling); and in Newfoundland, 36.4 kilograms of klip-fish. The difference consists chiefly, it is true, in the saltness.

Concerning the proportion between the weight of salted and dried

* Employing the analysis previously named as a basis of calculation and excluding from the reckoning the loss of materials dissolved, 100 kilograms of fresh Iceland fish should have yielded 47.4 kilograms of klip-fish, and the Norwegian 38.4 kilograms. On this basis the Icelanders should use 1 kilogram of salt to 1.43 kilograms of klip-fish, or every third kilogram of raw fish, while we, in our calculation, estimated on the loss of weight of 66 per cent.

fish there is given below the result of some experiments made in the United States:

Salted in the vessel.	Dried.	Weight.	Per cent of loss.	Remarks.
30.19	25.81	4.38	14.5	Common dried. From St. George's Bank.
21.41	19.31	2.13	9.9	
11.00	9.69	1.31	11.9	
6.06	5.31	0.75	12.4	
5.00	4.69	0.31	6.2	

According to this, 100 kilograms of salted fish yield on the average 88 kilograms of klip-fish. Some experiments made in our country gave the following result: Finmark fish, 100 kilograms salted gave 49 kilograms klip-fish; Loffoden fish, 100 kilograms salted gave 48.5 kilograms klip-fish; domestic fish, 100 kilograms gave 51.7 kilograms salted.

According to statement in the description of the cod fishery at Iceland in 1883 by First lieutenant Trolle, which will be considered in a later number, he obtained from 100 kilograms of salt fish an average of 71.8 kilograms of klip-fish.

Chemistry is becoming more and more employed for the examination of our food stuffs, and perhaps the time is not far distant when it will be of practical importance to the klip-fish trade so that one need not pay for salt and water as fish.

ASSORTING.—On inquiry into the means of promoting a better manufacture, it has always been advanced, and rightfully, that a change cannot be effected until in the purchase from producers a greater difference of price is made between the different qualities; or, in other words, until in the *purchase we discriminate between the various qualities and draw a sharper line between them* than is done at present. Herein the producers as well as the shippers appear to be unanimous.*

If we now find ourselves *in statu quo*, it is principally because of the difficulty in becoming unanimous as to the practical solution of the question whether there is more profit for speculation in an unassorted sale and purchase, which has exercised its influence on both sides and contributed to the lack of attempting any decisive step towards working a reform.

In assorting klip-fish we must separate them according to their qualities. This may be done (1) at the purchase from the manufacturer; (2) upon shipping to and their "reception" in a foreign country; and (3) in selling at retail.

We shall here first give some examples showing how the assorting is done in different countries.

CANADA.—Here they assort fish, first according to size into large, medium, and small;† they are likewise assorted according to quality

* See report of the proceedings in the discussion meeting in Bergen, October 27, 1880, pp. 29–32.

† These are exported in barrels

into merchantable fish (*morue marchande*); second quality (*morue inférieure*); and refuse (*morue refusée*). Among the last are placed all damaged fish (sunburned, salt-burned, injured by rain, &c.).

NEWFOUNDLAND.—The fish are assorted here into three kinds: Merchantable, which must measure at least about 22 English inches [56 centimeters] from the nape to the last dorsal vertebra; Madeira; and West Indies. The assorting is done by private sorters at the fixed charge (one penny) per quintal.

ICELAND.—Here the fish are assorted, upon their receipt from the fishermen, into two kinds, according to size, those which are over and those which are under 18 inches; also, according to quality, into first and second. At the exportation to Spain* the authorities appoint two sorters, who see that the fish are good, well dried, and well handled articles of the year's production, free from wet and spoiled fish, and not mixed with haddock, ling, pollock, and small fish. An affidavit to that effect is signed upon the bill of lading, which besides is certified to by the district judge or the town judge. In exporting to England and Denmark there is no assorting by public sorters, but the small fish and the seconds are shipped separately from the remaining fish.

SCOTLAND.—Here klip-fish are treated just like herring by the merchants. In purchasing green fish from the fishermen they distinguish between fish over 14 inches and those under 14. Only perfect fish, and fish over 14 inches, are exported; the remainder go to Ireland or to the inland markets. Fish intended for the colonies are dried more thoroughly than those for other markets.

FRANCE.†—Most of the fish at present shipped from here to Spain are caught south of Iceland. They are assorted for exportation into two kinds according to quality and into two kinds according to size. A fish weighing from 2 to 2½ kilograms is considered large; fish from ½ to 1½ kilograms are medium or small.

BARCELONA.—Here fish are separated, as well upon the receipt from the fishermen as in retailing, into three kinds: first kind, superior *meclado* (superior unassorted); second kind, *buen meclado* (good unassorted); and inferior fish. As inferior fish they classify brownish and somewhat *middet* fish. If it is very *middet* or dark, it is classed as refuse fish.

* From the north and east coast klip-fish has not hitherto been exported directly to Spain.

† The French sea fishery is aided by the Government with the following premiums: Every registered man, an owner, whose vessel goes to Iceland or to Newfoundland and dries fish there, obtains 50 francs [36 crowns]; if, on the contrary, the fish are dried in France, he obtains 30 francs [21.57 crowns]. Dogger Bank fishermen obtain half as much.

Also, in the exportation of klip-fish, he obtains when exported: To foreign transatlantic countries, 20 francs per metrical quintal [100 kilograms]; to French colonies or European countries, 16 francs; to Algiers and Sardinia, 12 francs; then for every metrical quintal of roe imported, which is the yield of a particular kind of fish, there is obtained 20 francs.

BILBOA.—Here fish are separated for retail into many sorts, which are here arranged with the addition, for the sake of comparison, of the prices according to a price-current received from one of the trading houses there, dated January 4, 1884.

Norwegian cod are divided into: large club-fish, *toston*, 224 reals per 50 kilograms;* small club-fish, *toston cito*, 210 reals per 50 kilograms; large fish, *crecido*, 220 reals first kind, 216 reals second kind, 208 reals third kind, (?) reals fourth kind; small fish, 200 reals; ling and cusk are divided into three kinds.

The cod klip-fish from Iceland, Shetland, and the Faroes are divided into:

Iceland: First kind, 202 reals; second kind, 194 reals; third kind, 186 reals; medium, 192 reals; small fish, 186 reals.

Newfoundland fish are divided into: large klip-fish, *truchuelon*, 194 reals; medium, *truchuelon*,† 194 reals.

Labrador, 164 reals.

French fish are divided into:

Iceland, first quality, 180 reals; second quality, 160 reals.

Newfoundland, first quality, 170 reals; second quality, 150 reals.

It will be seen from this price-current that even the fourth quality of Norwegian fish exceed in price the klip-fish from other countries.

ITALY.—Here fish are divided, according to size, into large, medium, and small; according to quality, into first, second, and refuse, following the same rules which are operative in Barcelona.

The assorting is thus based in most places upon both the size and the quality; and as a rule they are separated with regard to both into three kinds: by size, they are separated into large, medium, and small, or large and small; by quality, they are divided into first quality, second quality, and refuse. This assorting also is perfectly rational, and is therefore in our country in part the basis for assorting by the sorters.

Size plays an important rôle in the market, since in some places large fish are preferred, in other smaller fish. The difference in the size of the fish in our waters is, however, at present not so great that we feel in need of making a general sorting with reference to size in purchasing from producers.‡ As the manufacture of the yield of the daily coast fishing into klip-fish becomes more general and the bank fishing expands, the number of small fish will increase; and the time will therefore come when size will be so important a factor that it will have to be taken into consideration in the purchase of fish. For the present, however, as previously remarked, it has little importance; wherefore we omit it here.

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* One real equals 17.5 ore; 200 reals = 35 crowns = $9.38.

† Divided again into two qualities. Under this brand occur also the Norwegian fish. Translated, it means "small dried cod."

‡ The fact that the unusually small fish are rejected we will leave out of the calculation.

As regards quality (under which size and condition of flesh also belongs, strictly speaking, but which we do not consider here), fish are divided among us at the "reception" into only two kinds, unassorted and rejected, while the price in part has a division into three, depending upon whether in the agreement as to price attention is paid to the impression which is made by preliminary examination into the condition of the cargo. In this way the truly good, well-made fish do not get full justice, while less carefully manufactured fish, on the other hand, bring a price which they would not have reached had there been two sorters instead of one—unassorted. The present universal method of sale, therefore, rather encourages the manufacturers to produce a medium article than to attempt to make the most possible out of the raw product. The result of this, besides the direct loss which arises from not making the most out of what we have, will be increasing discredit in the world's markets, which again will cause the Norwegian klip-fish to be sold only when other better wares are not to be had. At present the result is not so evident with klip-fish as with herring; but if the system is continued the Norwegian klip-fish industry and those which are associated with it will in a longer or shorter time meet the same fate as every prodigal, disorderly economy, in which everything "*gaar paa Raus*," an expression which we may be allowed to use, although it is scarcely grammatical. We ask, what encouragement has one to purchase by preference fresh fish, or to pay for their dressing, or to wash them, or to use the means necessary that the drying may be as complete as possible, when no special attention is paid to these different factors, although they contain all the conditions for securing especially desirable products, or when they are not considered in their full bearing, but disappear, so to speak, into "chaos"?

We have in the foregoing shown how certain conditions, under which the greater portion of our fisheries are conducted, make the Norwegian products in many respects faulty and cause them to be surpassed by those of our competitors. But just herein is an invitation to keep pace with them, where the conditions are the same; while the present mode of sorting and of manufacture consequently thereby produces, by a similar principle, the opposite result. It brings the manufacture down instead of improving it. We cannot, therefore, sufficiently emphasize the necessity in the purchase from the producer of resuming the old method of sorting with its three classes: First quality, white, well-dried, perfect fish, and, if size is taken into consideration, large, plump fish; "*blodstuven*" ought to be rejected. Second quality, overworked, salt-burned, indifferently dried, yellow fish. Rejected, lacerated, damp, split, sunburned, dark, sour fish.

In the foregoing remarks we advised the producer to sort his fish at the salting and at the washing out, because we believe that he can thereby contribute to the accomplishment of the proposed reform. If he comes into the market with unassorted fish, he must sell the whole lot to one purchaser, and he will possibly find it difficult to make him agree to any more stringent assorting than the customary one. If, on the contrary, the fish are assorted beforehand, he will be likely, because of competition, to find different purchasers for each kind of fish, while dried first quality will always command a good price at the close of the season, in which we include the time from December to May.

The question of sorting is, we can readily say, a live issue for the Norwegian klip-fish trade, and is one of great importance in our national economy. It will be a source of gratification to the editor to place the Tidskrift at the disposition of authors for the continuation of this discussion which he has here only begun.

XVII.—PEARLS AND MOTHER-OF-PEARL AT TAHITI AND THE TUAMOTU ARCHIPELAGO.*

By G. Bouchon-Brandely,

Secretary of the College of France.

[Extracted from report to the Minister of Marine and the Colonies.]

In ancient times pearls came from the Indian Ocean, the Red Sea, and the Persian Gulf. After the discovery of America, the Gulf of Paria, the Isle of Margarita, Peru, the Gulf of Mexico, and the Gulf of California furnished the European market with the most famous pearls. The fisheries of Ceylon, of the Coromandel Coast, of Koudatschy, Manaar, and generally all the fisheries of the Indian Ocean, the Red Sea, and the Persian Gulf, date back to the most remote antiquity.

In modern times these fisheries have been worked by the Portuguese and English, and have always yielded very large profits, furnishing a large share of the trade of the coasts of India. At the present time England derives from these fisheries an annual revenue of several millions of francs; and the total annual yield in pearls and mother-of-pearl of the Asiatic fisheries amounts to 20,000,000 francs† [nearly $4,000,000].

Next to these fisheries, the most productive pearl fisheries of our times are those of the Sunda Isles, of Panama, of Colombia, all of which have been carried on for a long time. Of more recent date are those of the Tuamotu Islands, the Gambier Islands, and Australia. These last-mentioned stations furnish the beautiful pearls produced by the large pearl-oyster, called in science *Meleagrina margaritifera*, and by another smaller pearl-oyster, the *M. radiata*. We should also mention the fisheries in the fresh and brackish waters of the Hawaiian Islands, Saxony, Bavaria, Bohemia, Jutland, Scotland, Ireland, Norway, Sweden, Russia, and France. But only in exceptional cases are pearls of fine water and great value found. The pearls more commonly found are generally known under the name of "druggists' pearls," because from

* "*La Pêche et la Culture des Huitres Perlières à Tahiti: Pêcheries de l'Archipel Tuamotu.*" Extracts from the *Journal Officiel* of June 23, 25, 26, and 27, 1885. Also printed in pamphlet form. Paris, 1885. Translated from the French by Herman Jacobson.

For abstract of article by Bouchon-Brandely on a like subject, see F. C. Bulletin, 1885, p. 292.

†A franc is valued at 19.3 cents; a pound sterling at $4.86.

them the powder was obtained which in ancient therapeutics was used in certain astringent medicines, which are now no longer employed.

Formerly the markets of Constantinople, Venice, and Lisbon were celebrated for their sale of pearls; but now the trade in pearls has taken another direction, most of the pearls, which are found to some extent in all parts of the globe, being now sent to England, Germany, North America, and somewhat less to France.

Quality and value of pearls.—Pearls have formed the object of numerous classifications, according to their water, luster, transparency, color, form, weight, and dimensions. There are white, gray, black, lilac, rose-colored, blue, and yellow pearls. They are also distinguished as odd-shaped, pear-shaped, button-shaped (flat at one end), virgin or paragon pearls, the last being the most perfect as to form and the most highly esteemed.

Nothing varies so much as the value of pearls. It is entirely a matter of fashion and taste. Sometimes white pearls are most sought after, and sometimes gray ones. At present black pearls are those which are valued most highly. A beautiful pearl, valued, for instance, at 2,000 or 3,000 francs, would be worth 5,000 or 6,000 if a similar pearl could be found to match it; that is, the pair would be worth 10,000 or 12,000 francs to an amateur. Pearls are sold either by the weight or by the piece; by weight when they are of not more than ordinary beauty; by the piece when they are uncommonly beautiful. Even when sold by weight, the price is not fixed, and it may vary from one price to tenfold that sum, according to whether the pearl is round, azure, or black, or whether it weighs six grains or thirty grains. A pearl of ten grains, if shaped like a button, would be worth from 8 to 12 francs per grain; if, on the contrary, it is round, white, or rose-colored, 25 to 35 francs; and if black, 55 to 65 francs. A pearl weighing thirty grains might be bought by a dealer for 100 francs per grain. (There are four grains to a carat and nearly four carats to a gram.) The trade in pearls is counted by millions. It is difficult to make an exact valuation, for after they have been worked, the articles of jewelry and ornaments in which pearls are used are no longer valued at their intrinsic worth, but at their artistic or industrial value. The only information which we possess relative to the trade in pearls in France is found in the customs statistics. In 1883 France imported 94,000 grams of pearls, gross weight. Of these, 84,000 grams came from Germany, 5,000 from Colombia, 4,000 from the United States, and 1,000 from various other countries, representing a total value of 800,000 francs [$154,400]. But these figures do not represent the total quantity of pearls used in France. French jewelers use a much larger quantity of pearls, and receive them from sources not given in the statistics referred to above. Nor do these statistics mention the pearls which come from England, nor those which come direct from Tahiti. Both these countries furnish us with pearls valued at very large sums.

Origin of pearls.—The finest and most valuable pearls owe their origin to a small and very modest little shell-fish, occupying a very low grade in the animal kingdom, the pearl-oyster (*Meleagrina margaritifera*, and a smaller variety, *Meleagrina radiata*). Beds of pearls, properly speaking, do not exist. There are beds of shell-fish producing pearls, but pearls are not found on the sands of the sea, except in rare and accidental cases.

Fine pearls are not produced exclusively by the pearl-oyster; but they are also found in the shell-fish, commonly called "hog mussel"; in the "*mulette margaritifère*," common in fresh water, the valves of which are used by gilders in preparing their gilding; in the "*bénitiers*," a shell belonging to the conchiferous Acephala, in the *Haliotidæ*, &c. In the pearl-oyster, however, the finest and most highly valued pearls are generally found.

Formation of pearls.—The question as to what is the cause of the formation of pearls has frequently been discussed, and has been studied to some extent, but it has not yet been satisfactorily answered. The best work on the subject is that published by Möbius in 1858. Since then nothing has been said which is not already found in the work of this naturalist. Möbius does not solve the problem of the first origin. He says that the kernel or nucleus around which the pearl forms is formed by bodies foreign to the oyster; such as calcareous crystals, entozoa, anodonta, distoma, sometimes an egg lodged in a corner of the genital gland, organic, amorphous, brown, or yellowish *débris*, &c. But how these bodies found their way into the tissues where the pearl originates no investigation has as yet settled.

The further development of the pearl, and its structure, are better known. The pearl is formed like the mother-of-pearl layer of a scale. It is the product of a secretion of the tissues of the oyster round a nucleus; in other words, it is a shell reversed. In the center is the nucleus around which there is an epidermic layer; over this a layer of prisms (calcareous prisms with six sides, like the prisms of the enamel of the teeth), and finally a third layer, called by Möbius, the mother-of-pearl layer, to which are added several concentric layers secreted by the tissues, and which produce the continuous growth of the mother-of-pearl layer. As in the teeth, the structure of the pearl comprises an organic azotic cover and hard parts, the latter soluble in acids. The coloring and reflection is due to metallic salts.

Pearls may be found in nearly all parts of the oyster—in the genital gland, in and around the adductor muscle, and in the mantle. There may be fixed ones on the shell, or some, covered up by growth but originally external, in the shell itself. The pearls found on the body of the mollusk are considered the finest and purest. Their form approaches that of a perfect sphere. These are the ones which are called "virgin" or "paragon" pearls. They are nearly always found in the periphery of the gland and in the lower portion of the same. Held merely by the enveloping membrane, which finally breaks, either by too great a tension or from some other cause, they live a life of their own, as they do not seem to adhere at any point to the tissues among which they are found. When freed, the pearl falls in the folds of the mantle or in the cavity of the valves. In this latter case, if the animal does not succeed in ejecting it—which it generally tries to do—the pearl adheres after a few days to the shell, and by constant additions of new layers of mother-of-pearl to the entire inner side of the shell, it finally becomes wholly imbedded in it.

Pearls protruding from the shell are used in articles of jewelry or ornaments where a portion of the pearl can be hid. As regards those which are imbedded in the mother-of-pearl, a Paris jeweler (Mr. Daniel Léoboldti) has found a way to extract them without breaking them; after which, by a special process, they are made so perfect that these pearls, which are otherwise natural pearls, are currently sold under the name of Panama pearls, their primitive value being now restored.

Many pearls, also, are changed by a manual process before they are exposed in the jeweler's window. This is done sometimes with pearls whose luster is only veiled by some peripheric layers, which are removed; some, also, from being pear-shaped, are made round by being delicately worked; others are made black by soaking them in a bath of nitrate of silver. It can hardly be imagined what ingenious devices have been employed to give to pearls of little value the appearance of fine pearls. Means have been found to make them rose-colored, lilac, yellow, gray, &c.; but, on the other hand, ways have been found to discover these deceptions.

There are also pearls which are called fine pearls, but are not such in reality. These are caused by the perforation of the shells by the animals. They are hollow inside, and contain substances having no relation whatever to mother-of-pearl, and all of them have a large and distinctly marked stem. Besides pearls, the pearl-oyster also produces a mother-of-pearl protuberance, of irregular shape, which sometimes reaches the size of a pigeon-egg. These excrescences or swellings are due to the presence of foreign bodies in the oyster. It is not difficult to cause their formation; all that is required is to attach to the inside of the valve a piece of hard substance—stone, glass, or coral—which will soon be covered with glandular secretions, taking from the pearls their transparency and from the mother-of-pearl their iridescence. It is well known that the Chinese manufacture pearls by introducing between the valves of certain shells solid bodies on which secretions are soon deposited.

An experiment that I made at Tahiti in order to obtain internal protuberances of different kinds by artificial means was as follows: By the aid of a gimlet, holes were drilled in different parts of the shell of the pearl-oyster; and through these holes, measuring from one centimeter to a centimeter and a half in diameter [about half an inch], small glass or stone balls were introduced, held by a brass wire. A stopper of cork or burao wood, pierced by the wire and not protruding inside the valve, closed the opening hermetically. In this way the glass ball was the only foreign body protruding on the inside of the shell. After four weeks a thin layer of mother-of-pearl had formed round the ball, covering it almost entirely. The result was a very fine artificial pearl in course of development. I believe that this process might be developed into an important industry, and I am also convinced that by making the proper selection it will be possible to produce mother-of-pearl of various colors.

Pearl-oysters.—The genus *Avicula*, to which the pearl-oysters belong, comprises a great number of varieties, differing but little from each other, and which it would be useless to enumerate in this report.

In commerce two kinds of pearl-oysters are distinguished—the one the *Meleagrina radiata*, which is found in the Indian Ocean, the Persian Gulf, in the Chinese Seas, the Caribbean Sea, the Red Sea, and on the north of Australia inside the Great Reef; the other the *Meleagrina margaritifera*, also comes from the Indian Sea, south of the Comoro Islands, Zanzibar, the Australian coasts, the Sunda Isles, Gilbert Islands, Philippine Islands, New Guinea, and finally from the French Possessions in Oceanica, especially the Gambier Islands, and the Tuamotu Archipelago.

When fully developed, the first of these oysters rarely has a diameter exceeding 10 centimeters [nearly 4 inches]. The weight of both the valves combined rarely reaches 150 grams [about 5¼ ounces]. The second kind may reach a diameter of 30 centimeters, and a weight of 9 to 10 kilograms [about 20 to 22 pounds]. The first-mentioned kind furnishes inferior mother-of-pearl, as to quality and commercial value. The second produces the beautiful mother-of-pearl, so much sought for industrial purposes, on account of its solidity, consistence, iridescence, and beautiful whiteness.

Pearl fisheries.—The Tuamotu Archipelago contains the largest pearl fisheries in the world. Of the 80 islands composing this archipelago there are only 5 or 6 which do not produce pearls. These immense fisheries, however, are far from yielding the revenue which England derives from her pearl fisheries in India, nor is the manner in which they are managed the same. The English Government has taken possession of these fisheries, works them on its own account, or lets them them to different persons at a high rent.

The French Government, on the other hand, leaves the fisheries on the oyster-beds free, derives no revenue from the trade in pearls, and exercises no control. This apparent indifference would be inexplicable if we did not take into consideration the circumstance that we have been absolute masters of the Tuamotu Archipelago only since 1880, and that consequently during this short period we have not been able to work out a system according to which the fisheries should be suitably managed.

It is certain that the Tuamotu Islands are not as rich in pearls as the

India pearl fisheries. But, although there is no basis upon which to make an estimate, it must be supposed that they could every year furnish pearls to the value of several hundred thousand francs.

Whatever the traders may say about it, there are few of the natives who do not possess pearls. I have convinced myself of this by personal observation. Every time we landed at an island, the natives came almost immediately, and, in a shy manner, as if trying to hide them, offered us pearls for sale, drawing them from some fold in their belt in which they had been concealed. The quantity of pearls gathered ought to be in proportion to the quantity of mother-of-pearl fished. If we take, as an example, the fisheries of some parts of Australia which, according to official statistics, produce about 250 tons of mother-of-pearl per annum, and more than 300,000 francs' worth of pearls, the lagoons of Tuamotu, from which 600 tons of mother-of-pearl are drawn every year, should yield at least 600,000 francs' worth of pearls.* The mother-of-pearl obtained from the Australian waters resembles, except in its coloring, that of Tuamotu and Tahiti. Both in Australia and in the Tuamotu Islands it is furnished by the same pearl-oyster, the *Meleagrina margaritifera*.

It is true that in the French Possessions in Oceanica there are no longer found in the same abundance magnificent pearls of such large dimensions that Queen Pomare, of Tahiti, used them as billiard balls. Exhaustive fisheries have been carried on in these lagoons for half a century, and fine specimens of pearl-oysters have become scarce. But, in spite of all this, the Tuamotu Islands cannot be so poor in pearls as people pretend, to judge from the large number of persons who, in Tahiti alone, make a living by trading in pearls. Mention should be made in the first place of the special buyers, nearly all English, Germans, and Americans (with the exception of two Frenchmen sent to Tahiti by two French houses, a thing which had never occurred before); secondly, the captains of vessels plying in these waters, who make a living principally from pearls and mother-of-pearl; and finally the merchants of Papaete, who occasionally add the trade in pearls to that for which they pay a license, as the trade in pearls is exempt from all duties and control, and any one may engage in it.

Nearly all the pearls from Tahiti go to America, Germany, or England, to the great detriment of the French jewelry trade, which uses a very large portion of the beautiful pearls sold in the European markets. It will easily be understood that the French jewelry trade has to

* In Australia the yield of pearls in 1881 was estimated at $58,200, and in 1882 at $84,875. When I passed through Melbourne no data could as yet be furnished for 1883, but it was thought that the quantity of pearls was increasing, to judge from the much greater quantity of mother-of-pearl obtained during that year. In 1875 a pearl was found valued at $7,275; another, found at Nicol Bay, and weighing 234 grains, sold for $3,468. At the same place there was found in 1883 an extraordinary pearl, or rather a conglomeration of pearls, there being seven of them, of the size of peas, solidly soldered together, and forming a perfect cross. It was valued at an enormous sum.

obtain its supply of pearls through expensive intermediaries. This is all the more to be regretted, as the Tahiti pearls, of matchless beauty, are at present much sought after and valued very highly.

What measures could be taken to turn the trade in pearls to our profit, and to make French industry (at least as far as the Tahiti pearls are concerned) independent of foreigners? It was proposed to levy a high duty on all pearls destined to be sold to countries other than France, and to exempt from all duty those sent direct to the French markets; but it was recognized that this measure would not answer the purpose, considering the facility with which this precious article can be concealed. A large quantity of mother-of-pearl is smuggled, and the same would be done with pearls.

Mr. Mariot, an old resident of Tuamotu, has proposed a system which deserves to be mentioned. He says: "I think that pearls could be made to find their way to Paris by establishing at Tuamotu a branch of the Agricultural Bank of Tahiti, which would pay the owners of pearls one-fourth their estimated value; the remainder—less a certain small percentage for general expenses—to be paid as soon as their sale at Paris had been reported." I think that Mr. Mariot's plan deserves to be examined and carefully studied. Our large dealers in pearls and our great jewelry houses ought to form a syndicate and establish an office at Tuamotu for buying pearls. It is true that pearls have never been sold in Oceanica to greater advantage than at the present time; and even a medium pearl will fetch a higher price in Tuamotu than in Europe or America.

Mother-of-pearl.—The trade in mother-of-pearl is constantly increasing. England imports not less than 5,000 to 6,000 tons a year, and Germany from 1,200 to 1,500. France imports about 2,500 tons, representing a value of $1,351,000. French industry (fine furniture, inlaid work, fans, buttons, &c.) uses nearly all the mother-of-pearl imported into France, while England retains for industrial purposes only one-twentieth part of the mother-of-pearl she imports, and sells the rest to France, Austria, and North America. In fact, most of the articles into whose composition mother-of-pearl enters are manufactured in France. It is impossible to estimate the value of these articles, but it is certain that it reaches a very considerable sum. For some years Austria has become our rival in this respect, and it is estimated that the number of men employed in Austria in working in mother-of-pearl is 8,000, while their number in France probably does not exceed 4,000.

In 1883 France imported 2,235 tons of mother-of-pearl, as follows:

Whence imported.	Quantity.	Whence imported.	Quantity.
	Tons.		*Tons.*
Egypt	13	Mexico	85
Dutch East Indies	11	British Indies	92
Colombia	13	Australia	303
Germany	18	Various countries	37
Japan	19	England	1,553
Netherlands	63	Tahiti	28

Two of the above figures are particularly suggestive: the enormous quantity of 1,553 tons of mother-of-pearl which French industry is compelled to buy in England, and the small quantity of 28 tons representing all the mother-of-pearl obtained directly from the French Possessions in Oceanica.* The Gambier Islands and the Tuamotu Islands each produce about 600 tons of mother-of-pearl per annum; but this goes mostly to England or Germany.

The best mother-of-pearl comes, as we have already stated, from the large pearl-oyster. Other shells, among the rest the nautilus, and even the small pearl-oyster, produce mother-of-pearl of inferior quality, used in the manufacture of less expensive articles. In Australia, the Sunda Isles, Banda Sea, Torres Strait, on the coasts near Panama, and in Tahiti the richest beds of mother-of-pearl are found, and the most extensive fisheries are carried on.

In Australia these fisheries have, during the last few years, developed enormously owing to the discovery of new beds. Queensland alone in 1882 exported 250 tons of mother-of-pearl, representing a value of $121,250. The entire quantity yielded by the Australian fisheries in 1880 amounted to from 720 to 750 tons. The price of mother-of-pearl in this colony varies from $26.50 to $39 per hundredweight. In 1880 forty-four licensed vessels and fifty-five boats were engaged in these fisheries on the northwest coast of Australia.

†The mother-of-pearl from Port Darwin, Thursday Island, is somewhat yellowish on the outside, and when it attains to certain dimensions breaks in small leaves. It is worth from $630.50 to $679 per ton brought to London. The consignments comprise shells classed in trade according to their dimensions, as "bold," "chicken," and "medium."

The mother-of-pearl from Freemantle has a greater degree of consistency, is thicker and heavier, not so large, but generally of a whiter color than the preceding kind, and it is worth about $48.50 or more per ton. Seven or eight years ago its price rose exceptionally to $1,164 per ton. As there are no laws to regulate the Australian fisheries, shells of greatly varying dimensions are shipped from there.

The Macassar mother-of-pearl is the most expensive, and that which is sought after most. White, like that from Australia, but not so dense and hard, it is used in the manufacture of the most sumptuous furniture. On an average, 120 tons are exported per annum, selling—without regard to dimensions—at about $970 per ton.

* These figures, taken from the French customs statistics, do not agree with those furnished me by the large Paris dealers in mother-of-pearl, nor with those obtained at Papaete. According to the last-mentioned authority, about 70 tons of mother-of-pearl came to France directly from Tahiti.

†I am indebted to the Hon. Emanuel Sarassin, one of the great Paris dealers in mother-of-pearl, member of the syndicate of manufacturers of fine furniture, for the following information relative to the price and quality of mother-of-pearl of different origin which comes to the French market.

The Auckland mother-of-pearl is grayish and small, hardly ever exceeding 20 centimeters in diameter; it is worth from $388 to $485 per ton, according to the demand. The smallest shells exported measure 5 to 6 centimeters [about 2 inches] in diameter.

The Zanzibar mother-of-pearl is one of the smallest and also least expensive kinds. The diameter of the finest shells does not exceed 10 centimeters [nearly 4 inches], and does not sell for more than from $145 to $195 per ton. These shells, however, are pleasing to the eye, having azure and copper-colored edges. Only very few are found.

The Panama mother-of-pearl reaches a maximum diameter of 15 centimeters [nearly 6 inches]. The edge is somewhat yellowish, and the center rather white. It resembles the Mexican mother-of-pearl called "Mazatlan," except in the color of the border, which in the latter is bluish green. Panama mother-of-pearl is worth $242.50 per ton.

The mother-of-pearl called "Banda" is taken in the neighborhood of Manila, and in the Strait of Malacca. It has a deep gray color, is not very transparent, rarely reaches a diameter of 10 centimeters [6 inches], and is worth $194 per ton. It comes to Europe by way of the Netherlands or Marseilles.

The Sydney mother-of-pearl is gray, and somewhat resembles the Banda, only it is a little thicker, and is worth $242.50 per ton.

Liverpool, London, and Hamburg are the largest markets in Europe for the sale of mother-of-pearl. In these ports mother-of-pearl and other valuable shells arrive in considerable quantities from nearly all the fisheries in the world.

An English newspaper, bearing date of February 4, 1885, published the following price-list per hundredweight for mother-of-pearl during 1884 and 1885:

Fisheries.	1884.	1885.
Manila, bold	$48 50 to $49 71	$44 86 to $47 28
Bombay:		
Bold	23 64 to 26 67	23 02 to 27 87
Medium	22 23 to 24 25	19 40 to 21 82
Small	15 15 to 22 23	12 73 to 18 19
Egypt:		
Bold	21 82 to 25 46	21 82 to 23 64
Small and medium	16 97 to 23 64	10 91 to 21 82
Freemantle:		
Bold	36 37 to 41 22	38 80 to 41 22
Chicken	46 08 to 48 50	46 08 to 48 50
Sydney:		
Bold	38 19 to 45 47	37 59 to 42 34
Chicken	45 47 to 47 89	41 22 to 46 08
Panama	11 40 to 11 64	11 64 to 12 61
Tahiti, black-edged	18 19 to 33 95	18 19 to 31 52
Auckland	16 97 to 23 02	15 76 to 19 40
Banda	11 52 to 16 97	10 91 to 12 73

Mother-of-pearl is subject to the caprice of fashion and to the whim of the moment. During the last few years the black-edged Tahiti mother-of-pearl was preferred to the white. At present the latter, although more common, is the more expensive and more highly prized. Very beautiful in itself, the Tahiti mother-of-pearl is hard, homogeneous, transparent, iridescent, and of darker color along the edges. When held to the light, it shows fiery colors, combining all the colors of the prism; and these astonishing reflections unite in a glittering and delightful harmony. Should fashion take a fancy to prefer brown and azure mother-of-pearl, our oceanic fisheries can satisfy the demands of industry; for no mother-of-pearl can rival that of Tahiti, which, moreover, is a specialty of our possessions in the Pacific Ocean.

Decrease of mother-of-pearl.—In all parts of the globe where mother-of-pearl beds exist the fisheries are continually extending at such a rate that, unless proper measures for protection and propagation are taken, the time can be foreseen when the banks will be exhausted. As far as we are concerned, our fisheries in the Gambier and Tuamotu Islands already show unmistakable signs of exhaustion. The "bold" mother-of-pearl has become so rare in these waters that it is found only at a very great depth. And if the yield of the lagoons is not noticeably less than it was fifteen or twenty years ago, the reason is this, that the fishermen go to a greater depth, and that they gather as marketable mother-of-pearl the small shells, which in former times they would have despised when the Tuamotu fisheries were at their height.

Twenty or thirty years ago the trade in mother-of-pearl in the Tuamotu Islands was very profitable to those engaged in it. For a piece of cheap cloth, some handfuls of flour, or a few gallons of rum, the trader could get half a ton of mother-of-pearl, worth 1,000 or 2,000 francs, or beautiful pearls whose value the natives did not know. This archipelago was visited by vessels of different nationalities. Mother-of-pearl was abundant, and pearls were not so scarce as they are now. Since that time the number of vessels has increased; the natives, allured by the advantages of a trade which became more profitable as competition increased, commenced to fish with the most improvident ardor. Now, they find that the lagoons are less productive, that they are gradually being exhausted, and that even some of those which used to be the most productive show signs of approaching exhaustion.

Mother-of-pearl fisheries.—The natives of Tuamotu have no other industry but the fisheries. Their aptitude for this difficult and dangerous occupation is truly astonishing; and they all—men, women, and children—follow it for a living. They dive like fish and remain under the water several minutes, sometimes going to the depth of 25 fathoms and staying under the water for three minutes. In doing this they are exposed to the greatest dangers, for in the dark depths of the lagoons there are many sharks which roam about the fishing places in the hope of finding some prey. If, in spite of all possible vigilance and agility the diver does not succeed in avoiding the sharks, he has to meet them in an unequal and terrible combat.

Diving is not only a very dangerous occupation but also one of the most difficult known. In the beginning of the season the fishermen are obliged to take great precautions, the first and most essential being not to dive in the water too often in one day. To neglect this precaution exposes the fisherman to hemorrhages and congestions. After a while he becomes accustomed to diving; but to continue this practice to a certain age is apt to cause paralysis.

Thus far, very few natives of Tuamotu engage in fishing on their own account. Most of them do not possess the necessary funds or the requisite spirit of enterprise. Some work by the day on a fishing vessel, which is the more profitable way; but only those can do this who permanently reside in the islands near which these fisheries are carried on. Others hire themselves out for the entire season, or for part of it to business houses of Papaete, or to the captain of a fishing vessel. A diver working by the day gets about a dollar a day. The diver who hires himself out for the season makes a contract with the person or persons carrying on the fisheries, by the terms of which he has to give up all the products of the fisheries on conditions determined beforehand, and in return is furnished during the entire period of his engagement with food and other necessaries of life. In carrying out this contract the diver is sometimes badly imposed on.

An ordinary diver earns from about $23 to $29 per month, according to the condition of the sea and the productiveness of the oyster-beds. If he is fortunate enough to strike a bed which has not yet been subjected to excessive fishing he can earn very good wages. There are some who in one week have gathered about $40 worth of mother-of-pearl.

Diving begins in the morning. After the vessel reaches the fishing place the necessary preparations are made, and do not occupy much time. All the clothing of the divers consists in a piece of cloth round the loins, and all their tools in a pair of spectacles. Intended for examining, from the surface, the depths which the diver has to explore, these spectacles resemble those used by calkers. They are composed of four pieces about 16½ inches long and about 11 inches broad, forming a small chamber, one of whose ends is provided with a glass. The other end is open to admit the head of the diver. The glass side is held to the water so as to remove all blurs. As the waters of the lagoons of Tuamotu are remarkably clear and transparent, a skilled fisherman can, by means of this simple apparatus, discover oysters at a considerable depth. In most cases he will not dive into the depths until he has made this preliminary reconnaissance.

The Tuamotu divers may justly be considered the best in the world. The Hindoos employed in the pearl fisheries in the Gulf of Persia and on the shores of Ceylon, who are very properly considered expert divers, cannot be compared to them. The Hindoo diver descends in the water by means of a weight of 20 to 25 pounds attached to his feet. His belt contains also 7 or 8 pounds of ballast, serving to keep him in the depths after he has rid himself of the first weight. He stops up his nostrils and ears with cotton soaked in oil, and places a band over his mouth. Thus equipped he goes to a depth of 40 feet, remains 53 to 90 seconds under the water, and ascends by means of the rope which has accompanied him. The Tuamotu diver, on the other hand, does not use any of this apparatus or any of these precautions. All his preparation consists in vigorously exercising his lungs by inhaling and exhaling in an energetic manner a few moments before plunging into the water. After this, he takes a last and copious supply of air, and then, divested of every vestige of clothing, he lets himself drop into the water, feet foremost, without the slightest weight to accelerate his descent. He descends not merely 40 feet, but sometimes 25 to 30 fathoms, and remains under the water not 90 seconds, at most, but from 2 to 3 minutes; and having made his haul rises to the surface, without the aid of a rope, in an incredibly short time.

It has been said that the natives of the lower islands rub their bodies with oil to protect them against the burning rays of the sun and the corrosive action of the sea-water; but in no place was I able to observe anything of the kind. As far as the sun is concerned, the natives have nothing to fear from its rays; for, although the Tuamotu Islands are under the tropics, the heat of the sun is not unbearable because it is greatly moderated by the currents of air which prevail. Cases of sunstroke are unknown, and the temperature of the water in the lagoons rarely exceeds 25° centigrade [77° Fahr.]. Each plunge into great depths averages from one minute to a minute and a half, rarely two minutes, and only in exceptional cases three minutes.

Some business houses have endeavored, but without success, to introduce swimming-suits among the natives. They refuse to wear them, alleging, and with some apparent reason, that these suits would rapidly produce paralysis of the lower limbs. Three Europeans use swimming-suits, and consequently make rich hauls. They also maintain that these suits keep away the sharks. They rarely rise to the surface without bringing up several pieces of mother-of-pearl at a time; while the native fisherman must be content to detach them rapidly one by one, it being a very rare case that he brings up more than one piece at a time. His first care, when under the water, is to keep the valves of the oyster pressed closely together, for fear that the animal, roughly torn from the object to which it adhered, and feeling a pain caused by the tearing of some of the threads of its byssus, might, by the movement of its organs, eject the pearl which it contains. There are no external characteristic marks indicating the presence of pearls in the oyster. Nevertheless, the fishermen have been observed to dive for certain oysters in preference to others, guided by the looks, shape, and color of the shell. But all these indications are very indefinite; and only in exceptional cases have I seen the selection of the oysters, by the indications given above, realize the expectations of the fishermen.

After the work of the day is over the divers begin to open the oysters, using for this purpose a large knife, which they handle very skilfully. By the first cut the adductor is severed. Each shell and its contents are then examined with the greatest care, so that no pearl may escape. The masters never fail to assist in this operation; for, although divested of all clothing, the native of Tuamotu can quickly swallow a pearl the moment he has discovered it. The shells belonging to independent fishermen are, after they have been emptied, placed in moist sand till the day of sale, so that they may not lose any of their weight by evaporation.

Diving for pearl-oysters is going on from one end of the year to the other, but especially during the months of November, December, January, and February. In June, July, August, and September it takes place only in the afternoon, the water being too cold in the morning.

Exhaustion of the Tuamotu lagoons.—After my arrival in the Tuamotu Islands my first care was to make an investigation of the condition of the waters, in order to ascertain if what has been said regarding the gradual exhaustion of the lagoons was exaggerated: in other words, whether the Tuamotu Islands were threatened with approaching ruin. The danger is, I am sorry to say, only too real. The lagoons become poorer in oysters every day, and the time has come for taking energetic measures if their complete exhaustion is to be prevented. This state of affairs is not of recent date. M. de Bovis, in his work on the colony of Tahiti, urged as far back as 1863 that the fisheries in this archipelago should be protected, and expressed the fear that sooner or later the lagoons would become entirely exhausted. Later, Mr. Mariot called attention to the constantly-increasing gravity of the situation, and did not hesitate to predict that if no measures were taken to check the progress of the evil the pearl-oysters would soon become entirely exterminated.

The divers all agree that mother-of-pearl is constantly becoming more scarce; that large oysters are found only in exceptional cases, and that even oysters which are barely salable, namely, those measuring about 7 inches, are found only at a great depth, while formerly they were found even close to the shore. Those times have passed when vessels, carrying seventeen divers, could gather in less than a year, near the island of Tikahau, 120 tons of mother-of-pearl. Mother-of-pearl, as it has become scarcer, has also become dearer. According to Mr. Mariot the kilogram was worth, in 1873, from 30 to 60 centimes,* but about 1 franc in 1875. At the present time it sells at Tuamotu at 1 franc 75 centimes to 2 francs 25 centimes per kilogram.†

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* 100 centimes=1 franc=$0.193.

† This is the nominal value. By paying part in goods and part in Chilian dollars, these prices, both those of 1873 and 1875, and those of 1884, should be reduced one-third in order to be brought to their exact proportions.

Causes of exhaustion.—It will be sufficient to name the following principal causes of this depletion:

1. The abusive fishing which the Tuamotu fishermen have carried on for the last fifteen or twenty years, at the instance of ignorant merchants, and the taking of young oysters.
2. Absence of all supervision.
3. Insufficiency of the administrative measures intended to regulate the fisheries in the archipelago.
4. Absence of efficacious provisions for restocking the lagoons.

There is no supervision in the fishing places, and no officers to superintend the fisheries. Since France took possession of Tahiti the successive governors had their hands full in providing for the first necessities of establishing French rule in these islands. Since then the condition of our mother-of-pearl fisheries has remained the same as it was under the protectorate, and the fisheries have not been subject to any restrictions. At present this question is seriously occupying the minds of all men who have the future of this colony at heart. They know that if the mother-of-pearl was to disappear, the colony would at once lose a great portion of its commercial importance.

A plan for preventing the extermination of these oysters consists in working the lagoons in regular turns, subjecting to prohibitory measures those in which there has been indiscriminate fishing for a number of years. This prohibition is, in the language of the islands, called "rahui." The "rahui" may be ordered by a decree of the governor, for a period varying from two to five years, in any given island of the archipelago; either because, according to the rank it occupies among the islands, its turn has come to have fishing prohibited, or because the condition of the oyster-beds renders such a measure imperative. The decree ordering prohibition at the same time determines in which islands the fisheries shall be free.

The periods of prohibition and of free fishing may be calculated in such a manner, as to have fisheries going on in nearly the same number of islands every year. All this is very well understood, and the principle in itself is good. According to this system most of the fisheries in the Indian Ocean and the Persian Gulf are managed. But with due regard to the character of the Tuamotu lagoons, which really constitute inclosed fisheries, and in which oysters could easily be propagated, and also to the fact that the Tahiti pearl-oyster differs very much from the small pearl-oyster of Ceylon and the Persian Gulf, it may be presumed that the method applied to the open waters of the Indian Ocean will not be the one best suited to our oyster-cultural establishments.

Under the "rahui" system, when an administrative measure prohibits fishing in an island, the divers have left there only those oysters which are at too great a depth, or which have escaped their constant researches. The "rahui" is based on the principle of the hermaphrodism of the pearl-oyster. The persons who inaugurated this system thought that, in view of the fecundity of mollusks in general, a small number of pearl-oysters would be sufficient to restock in a few years the most exhausted waters. This way of reasoning, however, was based on an erroneous principle. The pearl-oyster is a uni-sexual mollusk, either entirely male or entirely female. In order to accomplish reproduction, it is necessary that within a certain limited space there should be oysters of both sexes, and this was not the case in the fishing grounds which had been ransacked more than once during several consecutive years. The oysters were too scarce and too isolated to let the generative elements meet often. This is the sole reason why the "rahui" has not produced the happy results which were expected from it. Nor should it be forgotten that by reason of the relative tranquillity of the waters of the lagoons, and also from anatomical reasons, the generative elements have very little chance of coming in contact with each other. I have often found that the spawn does not go far from the place where it was produced. Thus the branches of coral near conglomerations of oysters are sometimes so full of small oysters that they literally choke each other. This is a fortunate circumstance, owing to which it becomes easy to get the spawn of the pearl-oyster, and by its means to accomplish their production in the lagoons of Tuamotu.

NATURAL HISTORY.

Reproduction.—Although of a different kind, the pearl-oyster is not excelled in fecundity by the edible oysters raised in the oyster-parcs on the coast of France, and not even by the Portuguese oyster, which every year ejects several millions of eggs. The mode of reproduction of the pearl-oyster resembles that of the Portuguese oyster. The sexual products are, at the period of maturity, ejected from the genital glands, and meet in the water. I have never succeeded in finding spawn in the valves of the pearl-oyster, although I have opened them at every stage of the reproductive period.

Resembling the trees of this climate, which never cease to bear fruit from one end of the year to the other, the pearl-oysters seem capable of performing the generative functions at every season of the year. I have not been able to ascertain the number of times which the pearl-oyster spawned within the period of one year, but they certainly must be very numerous. It is very rare to find the sexual glands completely empty during several consecutive weeks, and it is probable that there are periods during which the emissions are more abundant than at other times. Spawning does not take place at one and the same time in all the islands of the archipelago, nor even in islands of one and the same neighborhood. About the middle of July of last year the oysters of Aratica were not in a fit condition for reproduction, while at this very time the oysters of Fakarava ejected their eggs, and it should be remembered that the islands of Fakarava and Aratica are not very distant from each other. The climatic conditions are the same, and the density and temperature of the water resemble each other. As it appears that the glands accomplish their germinative evolution in a few weeks, the ejection of the elements of reproduction should be accomplished in a comparatively short time. The observations in the next two paragraphs are given in support of this theory:

The spawning oysters gathered and brought by us from Fakarava as far as Papaete, had all, eight days after their arrival in the last-mentioned place, discharged the sexual products. Towards the middle of the month of July we noticed in the island of Aratica, that the oysters of the lagoon did not present any appearance of the near approach of generative activity. Five weeks later the oysters of this same lagoon spawned.

I have made similar observations at Tahiti and Moorea, all proving the constant activity of the organs of reproduction. The fishermen of whom I made inquiries assured me that the oyster propagates its species every year, at least at Tahiti, Moorea, and in the Tuamotu Islands. It is possible that in the Gambier Islands, which at certain periods are much colder, spawning takes place only at certain fixed seasons. The fishermen also think that the oysters become fertile at every full moon. I have not been able to verify the truth of this assertion, as far as the pearl-oysters are concerned, but it appears to be generally admitted that this is a fact as regards the edible oysters, which are very common in the Society Islands (a kind of *Ostrea plicatula*), and as regards some other kinds of shell-fish. The emission of the sexual products generally took place at the waning of the full moon. The mother-of-pearl oyster begins to spawn from the year following that of its birth.

During my stay in the colony of Tahiti I made a certain number of experiments with the reproduction and raising of pearl-oysters, which were accompanied by the best results. I proceeded in the following manner:

At the very outset I found that it would be impossible to create in these waters oyster-parcs like those existing on the shores of France for edible oysters. In the first place, the pearl-oyster cannot live an independent life like the edible oyster. Once detached from its original collector, it immediately needs another collector, as without this it cannot exist. It does not matter what may be the nature of this collector (wood, iron, stone, or brick), the oyster will at once adhere to it, provided it is a body which has the power of resistance, and which is brought in close proximity to the threads of the byssus. It would be a grave mistake to scatter pearl-oysters on any kind of sea-bottom, and expect that they would develop there like edible oysters, as the result would most certainly be a failure. If such an oyster falls on the sand, it is irrevocably doomed. Pearl-oysters are not provided with organs of locomotion enabling them to change their place. And how could the oysters be found again among the net-work of coral which covers the bottom of the sea in this archipelago? How could they be taken care of? An army of divers would not suffice to take care of one parc; moreover the tide at Tahiti is too weak to leave dry any places capable of being converted into oyster-parcs. I therefore at once abandoned the idea of raising oysters in parcs, and I would advise those who intend to engage in oyster culture in Tahiti to do the same if they wish to be spared many disappointments. Some years ago there were seized on the island of Anaa a certain number of small oysters. Under the pretext of planting them again, orders were given to scatter them at a place in the lagoon where the bottom was exclusively composed of sand. Not a single one of these oysters was again found alive, all having been buried under the sediment and thus perished. Similar experiments made in other islands met with the same result.

The system of raising oysters in boxes, which has proved successful at several stations in the ocean, and even in the Mediterranean, seemed to me to be the most appropriate under the circumstance.

Oyster-boxes, containing a certain number of oysters, were submerged in various localities at Tahiti at various depths, varying from 3 to 25 feet. After a month or five weeks the oysters had increased in size, those measuring about 7 inches by about half an inch, and the small ones by almost ¾ of an inch. Only one had died, but then it should be stated that it had been hurt in a particular experiment.

I renewed these operations in the port of Papetoaï, in the island of Moorea, and under entirely unfavorable conditions. The oysters, before being placed in the box, had been deprived of the horny part round the edge of the valves by means of sharp pinchers and a scraper. Each oyster was numbered, and the outline of the shell traced on a sheet of paper. In some of them I had bored holes in several parts of the shell, to favor the formation of mother-of-pearl protuberances. After a month or five weeks the mutilated oysters had recovered, the edge of their shell had reformed, and all had increased in size about half an inch. With a few exceptions they had attached themselves to stones or pieces of coral placed in the box, or to the sides of the box. Those whose byssus had not found any object to which to adhere, had not increased in size. The fixing of oysters, taken from their natural collector, to resisting bodies, was therefore an accomplished fact. It had been asserted that once torn from their original collector, they would not adhere to another, and would soon perish. Later I observed that a single thread of the byssus was sufficient to insure fixation. The new fixation took place in from one to three days after the oysters had been placed in the box.

The first oyster-boxes of a model resembling those used in French oyster-cultural establishments, did not altogether suit the pearl-oyster. Accordingly, other boxes were made, which were better adapted to the purpose. These new boxes measured from 4 to 5 feet in length, 27 to 31 inches in breadth, and 10 to 12 inches in depth. They rested on four feet, making the space between the box and the ground about 10 inches. On the inside there was a row of slats running parallel with the broad sides, and slightly inclined like the slats of a shutter, each slat being provided on the lower side with a bracket with a round hole, each intended to receive one oyster. In this way the oyster was placed almost vertically, its valves were in the air, and its byssus was brought in contact with the wood. Arranged systematically between the slats, the oysters could not become mixed, or become displaced by the action of the current. The bottom and the cover of the apparatus were composed of open slats, and the sides were perforated. In this way the water could enter the boxes and circulate freely.

The submersion of these oyster-boxes presented no difficulties. Four ropes attached to the four feet of the apparatus, were tied in a knot at the height of a yard above it. To this knot a rope was attached, which was lengthened in proportion as the apparatus weighted with stones sunk deeper into the water. A float attached to the upper end of the rope showed the place where the box was submerged. The operation of submerging and hauling up the oyster-box would be very much simplified, and be accomplished in a very short time, if there was a float with a system of winches and pulleys.

On September 3, 1884, a box like those described above, having its full supply of oysters, was deposited in the water of the harbor of Papaete, near the little island of Mutu-Uta. When drawn up three days afterwards all the oysters had become fixed to the wood of the slats, each in its own hole, forming in a certain way one body with the apparatus. It will be seen from this how advantageous the method of raising oysters in boxes might prove at Tahiti. If this method was employed not a single oyster would perish; their exact number would be known, and moreover each one might be numbered. The care which these young oysters need could easily be given them.

At no place on the French coasts is oyster culture carried on under such conditions of convenience and economy as are found at Tahiti. The absence of the tide, leaving the shore dry, is, in my opinion, an advantage to the oyster cultivator, who is thus enabled to carry on his operations at any time. Instead of having to send numerous relays of workmen to the parcs to use the short intervals when the water allows them to work, a small number of laborers will suffice to keep up the establishment, as they can work at any time. And if the trade in mother-of-pearl is languishing and prices are not remunerative, the cultivator can afford to wait for better times. The oysters are simply left in the parcs, where they will continue to grow and increase in value; and when better times come he would be prepared to meet the demands of the merchants, and would obtain good prices.

On nearly all the oyster-boxes containing mother oysters, deposited at Aratica at the entrance to the lagoon, spawn was obtained. Other important results were reached near Papaete. Some of the oysters had been removed from the box sunk in this place in order to verify their growth. After three weeks the shells of these oysters were covered with spawn, measuring from .06 to .08 inch. On one valve as many as 300 eggs were counted. It is therefore beyond doubt that by placing collectors near the oyster-boxes an abundant supply of spawn could be secured.

Vitality of the pearl-oyster.—The pearl-oyster is endowed with a high degree of vitality. Changes of temperature and the density of the water may have some influence on its development, but they are not necessarily injurious to it. Thus, oysters placed, by way of experiment, back of the arsenal of Fare-Ute, although submerged in very brackish water, having a specific weight of 38½ grains, had hardly increased less in size than those placed at the same time in the harbor of Papaete, where the water weighs 44 grains, and were fully as vigorous as these. This does not mean that there are no places more favorable than others for the cultivation of the pearl-oyster, for in the Tuamotu Archipelago there are islands, especially Takapota, where the oysters always remain small; and the temperature, the density of the water, the nature of the bottom, and the currents, exercise a considerable influence on the growth of the pearl-oyster; but it is not very exacting in its demands, and may easily be preserved.

Transportation of oysters.—The transportation of the pearl-oyster is not connected with any serious difficulties. This is a most fortunate circumstance, for it thus becomes possible to furnish young oysters to parcs at a distance from the place where they were produced. Returning from Tuamotu to Papaete on July 13, 1884, we carried on board the Volage several hundred oysters destined for experiments which had been begun at Tahiti. These oysters were kept in cans whose water was renewed every three or four hours; and during this trip lasting forty hours we lost but very few. Some weeks later, employing the same method, I transported from Papaete to Tautira, on board the Aoraï, one hundred oysters; and not a single one perished during the three days which this trip lasted. I am convinced that none would have been lost on the trip between Tuamotu and Tahiti, if there had been on board the vessel an apparatus constantly distributing aerated water in cans containing the oysters. Barrels furnished with faucets would fully answer this purpose.

Enemies of the oyster.—Like the edible oyster, the pearl-oyster has its enemies and parasites. Among the former there are two fish: the one, called "*Tahereta*" by the natives, is a flat fish bearing a strong resemblance to the fish so much dreaded by our oyster cultivators, on account of the ravages which it makes in the parcs; the other, called "*Oiri*" or "*Kotohe*," is a long fish with powerful jaws. It seems that these fish do much harm; they attack the oysters, break them open, and devour them. Other enemies of the oyster are two shell-fish, namely, a *Murex*, and a *Pholas*. These attack the shell of the oyster. The first pierces it in several places, compelling the animal by a constant work of secretion to close up the numerous holes which have been bored in the shell; the second confines itself to lodging in the thick part of the shell, just as similar shell-fish on the coast of France lodge in stones or rocks. These animals are aided in their work of perforation by marine worms, one of which (called the "needle-worm," the most injurious of all) bores numerous holes and small galleries between the outer layer of the shell and the mother-of-pearl part, causing it to resemble a piece of wood attacked by xylophagous animals. Mother-of-pearl thus deteriorated loses all commercial value, and is called perforated or worm-eaten mother-of-pearl. A small parasitic sponge works similar injury. Even the malicious crab thinks that it has a special claim on the pearl-oyster, and attacks especially the young ones. I must finally mention the polyps, the ascidians, and the *Serpula*, which are dangerous parasites; also a small crab called "*pinnothère*," similar to the one found in France in non-cultivated mussels, which lodges in side the shell and lives at the expense of the oyster. Oyster culture based on the system of raising the oysters in boxes, provides protection for the young oysters against the many different enemies, of which I have enumerated only a few.

It has been noticed that the edible oysters raised in oyster-boxes were those whose shell was the finest, the healthiest, and the most transparent. The reason of it is this, that the apparatus in which they are inclosed, rests on feet, keeping them 8 to 12 inches above the ground. In this way the oysters are no longer in contact with the sand on the bottom of the sea where those animals live which it is important for them to avoid. Moreover it is one of the rules of oyster culture not to give the parasites contained in the sediments which engender them the time to develop and become fixed.

Coloring of mother-of-pearl.—White mother-of-pearl is at present most expensive and most sought after. How does it come that mollusks of the same kind sometimes have a white shell, like the Macassar mother-of-pearl, and sometimes a shell with a black border like the Tahiti mother-of-pearl? Is it a question of breed, or must these differences of color be attributed to more or less local influences, orginating from the nature of the water and the bottom? I am inclined to the latter opinion. It has been observed in France that the element in which shell-fish live exercises an influence on their quality and their color. If, for instance, an Arcachon oyster, one year old, is transported to the parcs in the river Bélon in the Department of Finistère, it will be noticed that after a while that part of the shell which has grown in the new place will differ in color, hardness, and transparency from the original part of the same shell. Oyster cultivators have daily occasion to observe facts of this kind. White mother-of-pearl is not entirely unknown in Tahiti. From time to time specimens of this kind are found in the lagoons of the Gambier Islands.

As this question is a very important one from a commercial standpoint, experiments should be made with a view to ascertain whether by special methods of culture it would be possible to cultivate white mother-of-pearl at Tahiti. These experiments are not the only ones which should be made. There remain a large number of questions whose solution would be profitable, such as, to determine the normal development of the oysters; the influence of waters, currents, temperature, and bottom; the choice of the best collectors for gathering the spawn; the selection of the most suitable places for raising oysters, ascertaining the time when spawn is ejected, &c. A year at least should be devoted to the study of these different questions, with the view to get at some practical data.

From what has been said it follows:

1. That the pearl-oyster is susceptible of being raised just like the edible oyster, and that its spawn can be gathered.

2. That at Tahiti oyster-cultural establishments may be founded with every chance of success.

3. That it is possible not only to check the gradual exhaustion of the Tuamotu lagoons, but to restock them, and make them as flourishing and productive as ever.

Organization of the fisheries.—The first thing to be done is to organize a special service of oyster culture analogous to that which the English have established in India, and the Dutch in their possessions in Asia. This service should include a strict supervision of the fishing places; this, in fact, is the most important point. It would cause the regulations to be properly respected, would prevent frauds and smuggling, would cause the contracts between masters and divers to be rigidly observed; it would keep the governor constantly acquainted with the condition of the fisheries, so that he would know which could be worked, and those which should be subjected to prohibitory measures ("rahui"); it would aid in determining the localities where new centers of reproduction should be established, and would assist in properly keeping up these hatcheries. The chief of the service of oyster culture should have at his disposal a steamer of 120 to 150 tons, built so that it could easily enter the lagoons and resist the bad weather which often prevails at Tuamotu. This vessel should be commanded by some experienced naval officer, having under him a crew of seven or eight men, who would act as fisheries police and see to it that the regulations were not violated. The vessel should be a rapid sailer, so that it could promptly and unexpectedly go from one island to the other. Some of the crew might, in certain cases, be detailed to guard the fishing places for a longer or shorter period. From the day when a proper and effective service of supervision has been established, the work of renewing the stock of oysters in the lagoons may be commenced with a well-assured hope of success.

This is, in my opinion, the method which should be pursued. At first only two or three islands should be subjected to the new regulations;

the others might meanwhile merely be subjected to some proper prohibitory measures. We have the choice between the islands of Aratica, Takaroa, Manihi, and Takapota, which can easily be superintended, owing to their small size. The fisheries in these islands should be declared free at all times; but the fishermen should be compelled to deposit in oyster-boxes and in specially selected places all the young oysters which they capture, and which have not yet reached the regulation size. These oysters should remain their property, and as soon as they had reached a marketable size they could dispose of them as they pleased. The centers of reproduction should be kept constantly supplied with oysters and propagate them all the time. Generative elements ejected by oysters placed in these reservations would be found there at all times, and it may be presumed that nearly all the eggs ejected by the mother oysters and susceptible of impregnation would there receive the fecundating fluid which they require. As the pearl-oyster is exceptionally productive, numberless young oysters would escape from these reservations, and would by the current be carried into the lagoons, which they would fill with a new generation of oysters; and by placing suitable collectors here and there, a rich harvest of spawn might be gathered.

There would be no serious difficulties in the way of putting this system into operation. The natives of Tuamotu are docile and understand their interests. From what I have stated in my report on the condition of the fisheries in this archipelago, it will appear that the fishermen are entirely disposed to obey the instructions given them, and to become, in short, co-workers in this enterprise, which is undertaken for their own benefit as well as for that of the entire colony.

If we desire to bring to an end a condition of affairs which, as I have said, grows graver from day to day, threatening the natives with absolute ruin; if we desire to save from total destruction our oceanic fisheries; if we wish the Tahiti colony to flourish, it is of the utmost importance that we should make some sacrifices at once, and adopt some measures of immediate practical value.

Our Tuamotu fisheries are peculiar, and combine all the requisite conditions for becoming centers of a most productive and remunerative mother-of-pearl cultivation. If we were to cultivate these fisheries more than we have done, we might have a monopoly which no country could seriously dispute; especially as in a very short time, owing to exhaustive oyster-fisheries, mother-of-pearl is going to become a very rare article. I sincerely believe that if these fisheries were properly managed, the annual yield, which is now about a million of francs, would soon reach eight or ten millions.

However well disposed the natives may be, it will be necessary in the beginning to aid and encourage them. I would, therefore, propose to give premiums to those who, by their labors, had obtained the best results. The expense would not be very great, and the colony would doubtless provide the necessary funds.

I would also propose to send a thousand oyster-boxes from France to the governor of Tahiti, and have them properly distributed among the natives, to whom we shall have to look for establishing the first centers of reproduction. These boxes would also serve as models; and those of the natives of Tuamotu who are skilled in carpentering, could hardly fail to construct similar boxes. The *Miki-miki* wood, common in Tahiti, is very hard and resists the action of the water, and, like the wood of the cocoanut tree, it would be admirably adapted to this purpose.

The introduction of the industry of oyster culture in Tuamotu would be accompanied by very happy results. In the first place it would furnish steady work to the natives, something which they have needed for a long time, and to which they are well adapted; it would relieve them from the cupidity of unscrupulous merchants; it would develop among the natives of Tuamoto a feeling of family, economy, love of property, and of country; it would cause the Tuamotu native to abandon the vagabond life which necessity at present compels him to lead, roaming from one island of the archipelago to the other, in following the precarious trade of a diver, which shortens his life, and would gradually raise him morally and intellectually. And all this would benefit the entire colony, making business of every kind more prosperous.

Ownership of the lagoons.—The introduction of oyster culture in our oceanic establishments would bring about the solution of a question which has been pending for a long time, namely, the ownership of the lagoons. As long as this question has not been definitely settled, it will be impossible to do anything. It is very evident that neither the natives nor the French oyster cultivators who might feel inclined to introduce their industry in these remote countries will set to work in earnest until regular grants of these waters have been made to them and they feel that they are secure in their possession.

Some people in Tahiti have, from reasons which I cannot understand, constituted themselves the defenders of ancient and superannuated privileges, which the native population would never dream of claiming, and which are absolutely at variance with the laws in force in all countries of the globe. These officious people seek to convince the natives that these lagoons belong to them, and that they are communal or private property, just like ground. They say that the portion of the sea extending from the edge of the reef to the center of the lagoon is only the natural extension of the ground. Our law, on the other hand, proclaims that the domain of the sea belongs to the state, and is inalienable. Would it, therefore, be proper to make an exception in the case of the Tuamotu Archipelago? If this was the case, navigation in the lagoons would be a matter of sufferance.

In the course of my voyage through the Tuamotu Archipelago I made inquiries of the natives relative to the claims above referred to, which they are said to make, and in all cases I was informed that nothing approaching to such a claim had ever been made. They have always considered the lagoons as free waters, and belonging to the state. They have all assured me that they have not authorized any one to make such statements. All they desire is, that some preference shall be shown to them, when grants are made, and that no grants should be made to foreigners. The above statements have been entered on the minutes of a meeting held at Takaroa, attended by the district superintendents of the different islands, and by a large number of fishermen.

On the other hand, the Tahiti courts have, on two different occasions, pronounced in favor of the principle contained in the French laws, namely, that the portions of the sea comprised between the reef and the shore are the property of the state. Under the rule of the ancient sovereigns of Tahiti, however, the owner of the shore was also the owner of the corresponding portion of the sea between the reef and the shore; but the fact of these islands having become annexed to France has changed this. And does it not follow, as a matter of course, that the Tuamotu lagoons are subject to the same laws as the Tahiti waters, as the annexation of the archipelago took place at the same time and on the same conditions as that of the Society Islands?

Although the rights of the state to the Tuamotu lagoons, and to the arms of the sea comprised between the reef and the shore are incontestable, it will be necessary to state this authoritatively. This will be the only way to avoid the lawsuits in which the people of these islands are inclined to engage on the slightest pretext.

Localities for stations.—Thus far only the Tuamotu Archipelago has come into question; and I have not yet stated whether at Tahiti and at Moorea there are favorable localities for establishing oyster-parcs, and under what conditions oyster culture could be carried on there. These two islands would be the very ones in which emigrants would prefer to settle, on account of their greater and more manifold resources. It is impossible for me to furnish any detailed information as regards each one of the localities adapted to oyster culture, and to enumerate all of them. These localities are far too numerous. In the Island of Moorea there are the Cook Bay and the Bay of Oponuhu, well adapted to the purpose by nature, where oyster culture could be conducted on a large scale; likewise the greater portion of the water inside the reef, whose depth is sufficient for submerging oyster-boxes. Pearl-oysters thrive there naturally. Moorea is 12 or 13 miles from Papaete; the climate is healthy, and the means of existence are the same as at Tahiti. It is a most delightful island, one of the most interesting of the oceanic islands; and there is no lack of arable soil of the utmost fertility.

At Tahiti there are also numerous places suitable for the cultivation of pearl-oysters. I will mention among the rest the Papaete Roads, the neighborhood of Faaa, the bays of Matavai, Tautira, Taravao, Port Phaeton, the portions of the sea situated in the districts of Hitiaa, Tiarei, &c. There are enough places to satisfy the whole world, and large establishments could flourish here. Sheltered from the open sea and the winds, and easy to supervise, these different locations are all inside the reef which at a distance from the coast, varying from about half a mile to 1½ miles, extends for about 93 miles. Nearly everywhere fine and valuable mother-of-pearl is found. It would be necessary to establish at Tahiti, as at Tuamotu, reservations for the reproduction of oysters and the gathering of young oysters. In case a measure of this kind should meet with difficulties and not be followed by the expected results, spawn could always be obtained from Tuamotu. It is said that mother-of-pearl is not at all scarce in the Tubuai Islands; but no important fisheries are carried on there. It is also stated that there are in these islands places which are exceedingly well adapted to the organization of oyster-pares. These islands have greater resources than the Tuamotu Islands, and the climate is more favorable. Emigrants would therefore probably prefer them to the former.

Market in France for mother-of-pearl.—It remains to be stated briefly by what means the French merchants of Tahiti think Tahiti mother-of-pearl could be brought into our markets. It is well known that we buy from England nearly two-thirds of the mother-of-pearl which our industry consumes. At London a market is held every six weeks. In Liverpool the markets are held according to the arrivals of mother-of-pearl. It is sold by public auction. The business men of Papaete, from whom I obtained information, are of the opinion that if a similar market was created in one of our ports, all, or at least a great portion, of the mother-of-pearl from our oceanic colonies would go there, provided that all the vessels coming directly from Tahiti were exempt from the duty of 40 francs per ton levied on mother-of-pearl by the colony.

PARIS, FRANCE, *May* 28, 1885.

APPENDIX C.

OYSTER CULTURE.

XVIII.—AN EXPOSITION OF THE PRINCIPLES OF A RATIONAL SYSTEM OF OYSTER CULTURE, TOGETHER WITH AN ACCOUNT OF A NEW AND PRACTICAL METHOD OF OBTAINING OYSTER SPAT ON A SCALE OF COMMERCIAL IMPORTANCE.

By John A. Ryder.

Introductory.

The developments made within the last six years show that the solution of the most important problems in oyster culture, by means of artificial methods, starting with the egg, is possible. The question of questions in oyster culture is, "*In what way is it possible to certainly secure an abundance of spat under conditions which can be controlled, and within such an area and at such a cost as will render it possible for persons possessing the proper knowledge to undertake spat culture or the actual propagation of the oyster as a business?*"

This may seem an extravagantly sanguine view to take of the matter. Nevertheless it is true that it is actually possible to begin at once, with the knowledge now in our possession, and not only be successful, but also be so to a degree which must completely revolutionize the business of the bed culture of this mollusk in open waters.

I.—Historical.

My own connection with the oyster question dates from 1880, and during the years intervening between the latter and 1885 the writer has devised and had constructed no less than twenty forms of incubating apparatus in which it was hoped to obtain spat from artificially fertilized eggs, such apparatus ranging in size from less than a cubic foot to large ponds four feet deep and several hundred square yards in area. The basic idea in all of these except three was the use of filters with a continuous or an interrupted tidal flow of water through the apparatus; the function of the filters was to confine the fry in the inclosures.* In none of this apparatus, except in one form of it, I am obliged to admit, was it found that results of startling economic importance were obtained,

* The trouble with filters, of any form whatsoever, is that they soon clog and become useless. They can therefore never be successfully used in any practical system of propagation.

and while this is true, it is also a fact that observations and results were obtained which indicate that there is a feasible method of almost unlimited productiveness; all that is needed being the proper combination of conditions which it is now proposed to describe on the basis of well-known facts which may be verified by any one who will take the trouble to do so.

Besides devising the various forms of incubating apparatus, during the interval of time mentioned, the writer, in conjunction with others, used in his experiments no less than eighteen forms of collectors or cultch in coves, ponds, and in the incubating apparatus, for the purpose of affording the free-swimming fry surfaces to which it could affix itself. Some of these forms of collectors were previously used in France, Holland, England, Portugal, and Italy, to obtain the spat of *Ostrea edulis*, and long before any one had thought of introducing them into our own country; indeed, the use of cultch or collectors of various kinds has been in vogue for a long period, in fact, if historical records are to be trusted, since the days of the Cæsars. The practice of strewing oyster shells upon the sea bottom as cultch, to which some of the many billions of fry diffused through the water could become affixed, seems to have been inaugurated by the French Government about 1851, under the direction of Professor Coste, the distinguished embryologist of the Collége de France. This practice seems since then to have fallen into disrepute or partial neglect abroad, but has been practiced with such magnificent results in this country that the method is now applied in Long Island Sound, in the deeper water, on a scale which is without an approach or parallel in any other part of the world. The principal inaugurator of this system seems to have been Mr. H. C. Rowe, of New Haven, Conn., who, about twelve years ago, began sowing shells in deep water. Ridiculed at first, Mr. Rowe has finally made such a splendid success of his system that he sows as many as 100,000 bushels of shells annually upon what is now probably the most colossal oyster-farm in the world, embracing as it does about 15,000 acres of the bottom of the sound, off the city and vicinity of New Haven.

While this system is eminently successful, it is also attended with considerable risk, great quantities of shells being sometimes wasted in consequence of the fact that in some seasons no set of spat whatever becomes attached over large areas, owing to adverse conditions of weather, currents, or the inroads of sediment, which coats the surfaces of the shells and asphyxiates the minute embryos which have recently become adherent to this kind of cultch. The same objection holds in reference to all the other kinds of collectors hitherto used. Strewing shells on the bottom renders only their upper surfaces available, so that the amount of spatting surface is meager to begin with. The under convex surface of the shells is partly in contact with the bottom, and is largely useless, while the upper or smooth side soon becomes coated with sediment, unless the currents are quite strong over the bottom. Other collectors, such as brush, tiles, slates, in their various modes of utilization, are too expensive and give a too inconsiderable surface of attachment to justify the outlay incurred in their construction as practiced in Europe. The methods which make tiles available abroad are not the methods which will justify their use in America. In Europe labor is cheap, and oysters are so valuable that they are a luxury to be enjoyed only by the wealthier classes. Not so in the United States, where the middle classes along our eastern seaboard can consume the luscious *Ostrea virginica* as part of their every-day fare without feeling that they are living extravagantly.

Other investigators besides the writer have sought to develop some method of artificial culture for the American oyster. Foremost amongst these must be mentioned Prof. W. K. Brooks, of Johns Hopkins University, who, in 1878 and 1879, for the first time investigated the development of our American species, using artificially fertilized eggs for the purpose. Later, Lieut. Francis Winslow, U. S. N., associated himself with Professor Brooks at Fort Wool, and actually operated two different devices with that object in view. Another pupil of Brooks, the late Henry J. Rice, also devised some apparatus for the purpose, and is, I believe, the investigator who has maintained artificially fertilized embryos of the oyster alive for a longer time than any one else. None of these efforts have, however, so far as I can learn at this writing, yielded results which were of direct practical application, or have been of sufficient promise, when applied on a large scale, to justify their continuance in their original forms.

About the same time, or during the period intervening between 1880 and 1884, investigators were busying themselves with a study of the large diœcious Portuguese oyster, *Ostrea angulata* of Europe. The first published account of the artificial fertilization of this species was by an American, Lieutenant Winslow, who in 1880, while with an American man-of-war lying off Cadiz, Spain, obtained successful results with the method of artificial fertilization first used by Brooks. Subsequently M. Bouchon-Brandely, of the *Collége de France*, took up the subject and carried on further investigations, and in his efforts to attain practical results reported very remarkable success in obtaining spat on a moderately large scale. He, however, adopted a system which had been previously used on a small scale by the writer. Subsequently, and unaware of what American investigators were doing, this experimenter used the closed-circuit system devised by McDonald, but which the French experimenter operated in a different manner.

Out of this grew the system of operating inclosed ponds with the help of the tides during the years 1882 to 1885. But in consequence of a radical misapprehension of the essentials of a rational method, I am forced to admit that no results of great practical value were the immediate outcome of any of these experiments. While the work has been immediately fruitless, mediately it has *not* been so, for the light gained as the result of all the work of others, as well as my own, now enables me to state with certainty *why* we have failed.

Failure is a harsh word, and it is a humiliating one as well; but it will soon be seen that we have been cultivating a lot of fallacies and erroneous conclusions which led to it. In a word, we have neglected to think about what we have observed, so as to elaborate a practical theory of spat culture.

II.—Fallacies and elementary principles.

1. Where fixation occurs.—The fact that artificially fertilized oyster fry would rise at a certain stage of development to the top of a tumbler or beaker filled with sea-water, when allowed to remain undisturbed for a time, has been supposed to have some bearing upon the question as to how collectors should be disposed in the water; that is, whether at the surface or the bottom. It is now known that such a habit on the part of the young fry when in perfectly still water does not indicate that the collectors should be placed at the surface. On the contrary, numerous facts can be cited to show that the fry will affix itself and become spat at any level in the water. This was indicated by the results of the closed circuit experiment conducted by Colonel McDonald and myself in 1882, when in a small apparatus, covering not over a square yard, we succeeded in getting fry 24 hours old to affix itself to the sides of the glass vessels and old oyster-shells contained therein. In the course of this experiment not less than 100,000 young oysters were adherent at one time to the available surfaces inside this apparatus. No greater success in obtaining adherent oyster fry from artificially fertilized eggs has ever been recorded either in Europe or America.

Another set of facts, observed in 1883 at Cohasset, Mass., indicates that fry will adhere in the open water in the same way. Pole buoys were there found thickly covered with very young spat as far as they were immersed. On some parts of these poles as many as 100 young oysters might have been counted upon a single square inch of surface. At other places in the same vicinity oyster and clam shells lying on the bottom were thickly covered with spat, so that as many as 150 were actually counted on a single valve.

The conclusion, therefore, is that fixation occurs at all levels, and that cultch 1 foot below the surface stands as good a chance of having a set of spat adhere to it as others at a depth of 30 feet. In other words, *spat can be obtained in the whole range of all three of the dimensions of any given body of water.* This is the first principle in a rational theory of oyster culture.

2. The surfaces of collectors.—Another fallacious belief is that the fry will adhere most readily to a rough surface. This conclusion was shown to be erroneous in the experiments with the closed circuit apparatus at Saint Jerome's Creek in 1882, as well as by all the facts observed at Cohasset and Stockton in 1883. Anything, no matter how smooth it is, will serve as a spat-collector; in fact, the greatest number of spat ever observed by the writer per square inch has been found on the smoothest possible surfaces. The fundamentally important prerequisite in oyster culture, however, is that *all spatting surfaces shall remain clean for a long enough time to allow the spat to become well established* This, I would say, is the second great and important principle, which is never to be lost sight of in practical oyster culture.

3. **Artificial fertilization.**—A third erroneous conclusion is, that artificial fertilization is impracticable, and can yield no valuable results. Large bodies of water may be artificially charged in all three dimensions with embryos as effectually as a small body of water used in the closed-circuit experiments. It has also been found that pumping sea-water which is charged with embryos through a steam-pump will not injure the oyster fry. Spat was obtained from water into which oysters had spawned and which had passed through the steam-pump employed to fill the supply tanks with the sea-water used in incubating fish ova at Cherrystone in 1881. Several young oysters were found in the tanks at the end of our season's operations, and doubtless many more would have been found had a large supply of cultch been put into the tanks when our work began.

It is, therefore, obvious that, no matter in what way the water is charged with embryos or fry, provided plenty of cultch is used, spat will be obtained. This has been illustrated by the abundant set of spat obtained from artificially fertilized eggs on the cultch used in the closed-circuit experiments of 1882, and in the results of the pond system, in which filters were used, from 1882 to 1885; and by the spat obtained by us from native embryos at Cherrystone in 1881, and by Mr. Mather in 1885. Of the nature of the experiments of Brooks and Winslow in 1882 I am uncertain, but they also, I believe, obtained attached embryos on shells laid in troughs, through which water charged with embryos was allowed to flow. The embryos employed by them were, I believe, obtained by artificial fertilization.

The remarkable set of spat observed at Cohasset, Mass., in 1883 may be contrasted with the number of artificially fertilized embryos found fixed to the sides of the jars and to the cultch contained in the closed-circuit apparatus used in 1882, for I believe it may be affirmed without overstating the case, that a greater proportion of artificially fertilized embryos were found to be adherent in the last instance than naturally fertilized ones in the first. The third principle determining success in oyster culture will, therefore, *consist in having the water used in spat-collecting well charged either with native or with artificially fertilized embryos, or with both.*

4. **Condition of collecting surfaces.**—It is well known that *the cultch, in order to be available or to afford an eligible surface for the existence of the adhering fry, must be clean.* This, I repeat, may be considered to be a cardinal principle in practical oyster culture. If the cultch becomes

thickly coated with vegetable life, such as filamentous algæ, or diatoms, or with incrusting animal life, such as bryozoa barnacles and ascidians, ooze or sediment, the chances for the survival of the adherent fry and its capability of growing into spat is greatly diminished or rendered quite impossible. Diatoms will very often increase on such surfaces with prodigious rapidity, and form a thick coating which will greatly interfere with the life of the very first adherent stages of the oyster. In fact, the latter are asphyxiated in prodigious numbers from such causes.

5. **Why oyster fry adheres to the lower side of collectors.**—Another fallacious belief which has gained some currency is that the fry will adhere to the under surface of collectors or cultch more freely and in greater numbers than to the upper surface. This is apparently but not actually true. The reason that more spat is found on the under side of the collectors is simply because the sediment deposited on the cultch from the water by the action of gravity will fall only on the upper and not on the under surface of the collectors. In this way it happens that the fry which adheres to the upper surface of the cultch is soon smothered, while that on the lower survives. It will be readily understood that it is a very easy thing to smother an organism which is sedentary like the diminutive young oyster, since it at first measures only $\frac{1}{500}$th of an inch in diameter.

6. **Light.**—This brings us to the question of light and the part it plays in the life of the infant oyster. Light seems to be of subordinate importance, for it has been found that the fry which adheres to the under and shaded side of the cultch, if the conditions are otherwise favorable, will grow just as rapidly as that found on the upper side in the direct light. Indirect light, therefore, seems sufficient for the purposes of the health of the animal.

7. **Density of water.**—The density of the water is also to be considered in relation to the hygiene of the oyster. It has been found that it can exist in water barely more than perceptibly saline, or in water having a density nearly equal to that of the ocean. While it may be said that its favorite abode is in bays, inlets, and the mouths of rivers adjoining the sea, and in which the density, as measured by the hydrometer, would range from 1.003 up to 1.0235, the writer has himself found oysters living in this great range of densities, or in water little more than brackish on up to that which is not far from as saline as that found in the open ocean.

It appears also to be a fact, though I give it as such with some hesitancy, that the greatest amount of spat falls in water having a density ranging from 1.014 to about 1.022.

8. **Bathymetric distribution.**—The bathymetric distribution of the animal ranges from the shore line to a depth of probably ten or twelve fathoms. Deep-water culture is now becoming a prominent and profitable feature of the oyster industry in Long Island Sound, since its feasi-

bility has been so thoroughly tested by Mr. Rowe. Where the tide rises and recedes from natural banks, thousands of the animals are often exposed for several hours during low tide without apparent injury. The animals, under such circumstances, when the tide recedes apparently retain sufficient sea-water between their valves to meet the demands of respiration during the time they are uncovered.

9. **Horizontal distribution.**—Their range of distribution along the eastern coast of the United States is from Damariscotta Bay in Maine south to Florida and the Gulf of Mexico. The most important beds industrially are those of Long Island Sound, Chincoteague, Delaware, and Chesapeake Bays, and their tributaries. The States of Maryland and Virginia possess the greatest area of natural beds, though the importance of the still more southern beds is probably not yet fully appreciated.

10. **Influence of temperature.**—The temperature of the water in which the oyster ordinarily exists throughout the year ranges from something under 32° to 90° Fahrenheit. On the exposed banks in shallow water many are frozen during the winter, and it appears that if they thaw out slowly, freezing does not usually injure them.

In summer, or during the spawning season, the temperature of the water ranges from about 60° Fahrenheit to 90° Fahrenheit. The usual temperature, however, is from 60° to 81° Fahrenheit. When the temperature falls below 65° Fahrenheit the development of the embryos is greatly impeded, in fact, it almost ceases; whereas, at a temperature ranging from 74° Fahrenheit to 80° Fahrenheit it is very rapid, so that in three to ten hours from the time of the fertilization of the eggs they have advanced as far as the swimming or veliger stage, and have acquired a larval shell. Cold rains frequently kill a great deal of fry during the summer. Other meteorological disturbances, such as violent thunder-storms, have also been found to be injurious or fatal to young oyster embryos. The fifth principle to be borne in mind in successful oyster culture is, therefore, the following: *That the prevalent temperature of the water during the spawning season shall range from about* 68° *to* 80° *Fahrenheit.*

11. **Food of the fry and spat.**—The *food* of the fry, spat, and adult stages of the oyster is also an important matter. That of the fry consists of the most minute organic life to be found in sea-water, such as *Bacteria* and *Monads.* Many of the food balls found in the intestine of the recently attached spat will measure under $\frac{1}{10000}$th of an inch in diameter. The cavity of the little creature's stomach measures only $\frac{1}{2500}$th of an inch. Yet in this minute digestive cavity the food is actually found rotating in the form of minute rounded and oval bodies, which are kept in motion by the action of the cilia which line the stomach. That these bodies must have been of about the size noted when they were originally swallowed and as seen rotating in the stomach, is

evident from the fact that the young oysters, like the adults, are wholly without teeth or triturating organs of any kind.

This minute kind of vegetable and animal food is found more or less abundantly in all sea-water, and is especially abundant during the spawning season, when the decomposition and disintegration of all kinds of minute organic *débris* floating about in the water is in rapid progress, owing to the prevalent high temperature of the air and water. It is therefore probable that very few otherwise suitable locations exist where it is not possible to find an abundance of the proper sort of food for the oyster during its very earliest stages of growth.

12. **Food of the adults.**—The food of the slightly more advanced spat and the adults is found to consist of diatoms, rhizopods, infusoria of all kinds, monads, spores of algæ, pollen grains blown from trees and plants on shore, their own larvæ or fry, as well as that of many other mollusks, of bryozoa and minute embryos of polyps and worms, together with other fragments of animal or vegetable origin, and sometimes even minute crustaceans. In variety of food, the oyster therefore has a wide range of choice. There are also few locations otherwise well adapted which will not supply an abundance of food for the animal, which, it is to be remembered, captures and hoards millions of these minute plants and creatures in its stomach, where they are digested and incorporated into its own organization. It therefore follows that when we eat an oyster we are consuming what it required millions of the minutest organisms in the world to nourish. The oyster is consequently a sort of living storehouse for the incorporation and appropriation of the minute life of the sea, which could never be rendered tributary to the food-supply of mankind in any other way except through the action, growth, and organization of this mollusk.

13. **The value of coves.**—It is true that partially land-locked coves or inlets with narrow mouths are favorable to the production of the minute life upon which the oyster feeds, and it is in such locations that some of the finest oysters are grown. But oysters of excellent quality are also grown in deep water, as the experience of Mr. Rowe has shown.

14. **Greening.**—I formerly supposed that green-fleshed oysters were confined to beds which were located in narrow coves or inlets; in fact, there seems to be a predisposition to develop the green-fleshed condition when oysters are cultivated in ponds or *claires*. Recently I find that my original conclusion must be modified, as I have found that green-fleshed oysters are found in open water and at a depth of 4 to 5 fathoms. As already stated elsewhere, this condition is now well-known to arise from the absorption of the coloring matters in certain kinds of food which is consumed by the animal, and that the latter is in no way impaired or rendered hurtful as food. (See note X, in Appendix.)

15. **Effects of currents.**—The effects of currents of water are also to be taken into account. When a current sweeps around a gravelly, shelly

point of the shore, and if, under these circumstances, the water be well charged with floating fry from adult oysters in the vicinity, the set of spat will often be very abundant. This is especially the case where the tidal currents are strong enough to make such points act as jetties and keep the sediment and *débris* from lodging on the cultch so as to cover it up. Such natural conditions are presented by projecting gravelly points along the shore and on the buoys in the channel near Cohasset, Mass. So constantly has it been found that oyster-spat catches or falls in abundance on the gravel at that place that oystermen were formerly in the habit of going there to obtain the gravel after it was covered with spat for seeding purposes. We actually behold here in operation, under natural conditions, processes which can be imitated on a large scale by artificial means, with such success as to make us wonder why some such method as the one presently to be proposed was never applied before.

16. **Effect of currents on fixation.**—It may be asked, however, will the young fry attach itself to a fixed collecting apparatus where the current of water is running rapidly through the latter? It might be supposed that where a rapid current was sweeping over the cultch it would have no chance to become affixed, but this is a mistake, for I have found that spat will become affixed to a stationary object just as abundantly in a current running several miles an hour as when the water is comparatively quiescent. This was also verified in the closed-circuit experiments made in 1882, when the artificially fertilized embryos were kept in constant motion. Similar results were, I believe, obtained by Brooks and Winslow in another apparatus, in which the water charged with embryos was kept continually moving. All of the facts, therefore, which have been observed both under natural and under artificial conditions, indicate that rapid movement of the water which is charged with embryos does actually in no way interfere with the fixation of the fry; on the contrary, it rather seems to favor fixation.

Currents of comparative rapidity and force do not detach the quite recently affixed fry, as has been shown by me as the result of other direct experiments and observations.

17. **Utility of artificial fertilization.**—The artificial fertilization of the eggs may also be expeditiously accomplished with certainty to the number of billions at a time, so that, besides the chances for obtaining spat from water charged with embryos by natural means, we are enabled to add greatly in favorable weather to the number already in the water. The chances to obtain spat may thus be doubled or even quadrupled by the aid of artificial methods.

18. **Causes destructive of embryos.**—Great losses of embryos are doubtless sustained under natural conditions from the circumstance that millions of billions of eggs and embryos either sink into the mud to be irrecoverably lost, or many ova are never even impregnated. Under artificial conditions these embryos may be reared to the swimming stage and

brought so far along as to diffuse themselves through large bodies of water. That such diffusion actually does take place is shown by the fact that the oysters lying at the bottom of the water at Cohasset threw off embryos which swam up through 2 fathoms of water so as to reach and adhere to the pole buoys as far as they were immersed.

19. **Conditions at Fortress Monroe.**—At Fortress Monroe the oysters which are attached so thickly to the walls of the moat are wholly derived from floating fry, and it is instructive to observe that on the muddy bottom of the moat there are neither old nor young oysters, because the conditions for their existence are not present there. Here the walls of the moat form a natural collecting surface, and as the tide ebbs and flows the conditions favorable to their existence are present, just as on natural banks the old oysters form natural cultch upon which year after year spat falls; then as the bank becomes higher and higher the tides sweep the surfaces of the shells clean and afford the spat a chance to survive, but at the expense of the life of the old oysters beneath, which are finally covered and smothered by the young growth.

20. **Nuclei of natural banks.**—As far as I have been able to discover, the nucleus of a natural bank is always some mass of cultch which existed naturally on the bottom or has been placed there intentionally or unintentionally by man. This may be illustrated by several sets of facts which have either fallen under my own observation or have been communicated to me by reliable persons. In one case a heap of shells thrown down on the bottom in Cherrystone River became the nucleus of a well-defined bank or reef in two years. In another case a dense cordon of pine brush stuck down into the bottom in Mobjack Bay became the nucleus of an oyster bank or reef. In the vicinity of New Haven brush stuck down into the river bottom, forming a dense sort of *chevaux-de-frise*, has been found a profitable type of collector.

21. **Position of natural banks.**—Natural beds or oyster reefs tend to have their long axes extend across the channel, as I have noticed in several places, and such banks also become longer and greater in area if properly worked. They tend also to become higher, so that eventually at low tide the oysters are left by the tide for several hours at a time; this is due of course to the fact that the last generation becomes the cultch for the next one. Such banks also doubtless arise upon ridges of gravel on the bottom, or are developed on gravelly shoals running out from the shore. This seems to have been the history of several which I have examined. In all, the one same set of favorable conditions seems to have been present.

22. **A firm bottom necessary.**—A fixed bottom or basis of attachment must exist where oysters are expected to thrive or develop spat. Shifting deposits of sand, mud, or ooze are always fatal if the deposit reaches any considerable thickness. A firm or hard bottom is therefore a prime condition in oyster culture. If cultch is thrown on a soft, muddy bottom, it would have been far better had the oyster culturist

allowed it to remain on shore, where it would at least not have been altogether useless. In many cases it is necessary before planting that the bottom be prepared by dumping gravelly, firm loam over it before attempting to plant either oysters or shells on it, so that it may be firm enough for the purpose. In other cases dredging might be resorted to with advantage, but that would depend upon circumstances; whether, in fact, it could be done at a justifiable cost.

23. **Spatting in narrow channels.**—Another remarkable combination of conditions under which a fall of spat occurs may be here cited in partial illustration of the system of spat-culture to be developed in the sequel. At Wood's Holl, Mass., Mr. J. S. Fay some years ago planted some oysters in almost land-locked ponds owned by him, and in which the density of the water ranges from 1.012 to 1.020. An outlet from these ponds consists of a little water-course which is not much over a foot in width and 6 to 8 inches deep at any part of its extent. In the bottom of this water-course there are a great many loose stones and pebbles, and upon these oyster fry has adhered in considerable numbers. In this case what would at first appear to be very unfavorable conditions for the adhesion and development of oyster fry are, on the contrary, found to be quite favorable.

24. **Critical periods during the spawning season.**—There are critical periods or crises during the spawning period when the larger proportion of the spatting of one season occurs. Somewhat prolonged observation indicates, as far as my personal experience goes, that these crises occur during the latter part of July and early part of August. According to the observations of Brooks and Winslow the critical period when the greatest amount of spat falls is somewhat earlier farther south, perhaps a week or ten days. In order to get the best results from the use of collectors of any form, it is therefore desirable that the cultch should be exposed to the fry at about or just before the time mentioned, otherwise the best portion of the season will be lost to the propagator. Another reason why the cultch should be put down during or immediately preceding these critical periods is that the accumulation of slime, diatoms, and sediment on the cultch is avoided during the most important part of the spatting period.

The accumulations of diatoms on the collectors are especially noxious and hurtful to the recently fixed fry, since, together with the hordes of microscopical, boat-shaped organisms known as diatoms, there rapidly develops a slimy, transparent pellicle on recently submerged objects which soon reaches a thickness of at least one-sixteenth of an inch. This pellicle is sometimes quite clear and transparent, like the white of an egg, and contains besides vast numbers of frustules of diatoms innumerable multitudes of still more minute organisms resembling *Bacteria*. The accumulation of this pellicle is usually only a matter of a few days, and is probably more hurtful to the very early stages of the oyster than all of its other enemies combined.

I believe, in fact, that under ordinary conditions a hundred or a thousand times more fry actually adheres than can ever reach even the condition of spat, on account of the asphyxiating effect of this coating or pellicle which rapidly develops over the surfaces to which spat is adhering.

25. **Summary.**—The foregoing statements of notices, principles, and of observations made, where human agency had and where it had not affected the results, must now be depended upon to yield us an answer to the question whether spat-culture will be feasible and profitable or not. I think we will be able to show that all of the methods hitherto applied were founded on a partial or total misapprehension of the essential principles which should have controlled the choice of the plans upon which the work was to proceed. Following in the wake of the French, we adopted an inefficient system of collectors, because these were too scattered to attain results of the greatest possible value, or if not too much scattered, they soon became too thickly coated with sediment in most situations to be of service as collectors. In order to remedy both of these defects, it is proposed to break away entirely from the effete and antiquated methods of Europe. The American system of sowing shells appears to be profitable, but, as already stated, the planter is not getting the benefit of the whole surface of the shells sown, besides running the risk of having them covered with sediment. *To obviate all of these difficulties, and to actually come into competition with the system of shell-sowing in deep water, we must proceed to abandon all old methods, condense our cultch so as to have the greatest possible quantity over the smallest possible area, and finally, have that so arranged that, the currents developed by the tides in consequence of the peculiar construction of a system of spawning ponds and canals will keep the cultch washed clean automatically.* Unless this can be done, all systems of pond or cove culture for the purpose of obtaining spat must unhesitatingly be pronounced failures.

The foregoing is the present status of the whole question, and, after stating as fully as I have at the outset what are the conditions, we are now ready to present the plans proposed to carry them out. In doing this we have plain, simple facts and principles to guide us, provided that we always have an abundance of floating fry and that we provide means which will direct it against or upon our cultch at the critical moment of its existence, or when it is ready to affix itself. The greatest source of loss in the culture of the oyster arises through our inability to give the billions of larval oysters which are annually wafted about by the waves resting-places where they may become manageable spat.

III.—The new methods of spat-culture.

(*A*) *The method as adapted to canals or sluices in which the cultch is placed in masses, with jetties at intervals.*

The first form in which I propose to inaugurate the new system of spat-culture which has grown out of the principles already developed, consists, essentially, in condensing the cultch or collecting apparatus in such a way as to expose the maximum amount of collecting surface for the spat to adhere to within the least possible area. This may be achieved in the following manner: A pond, *X*, as shown in plan and elevation in Plate I, is constructed with a long zigzag channel, *s*, connecting it with the open water. The pond ought to be, say, 40 to 60 feet square; the channel, *s*, may be, say, 3 feet 3 inches wide, as shown in the diagram. The vertical banks, *z*, between the zigzag canals running to the open water might be 3 feet in width. The sides of the canals ought to be nearly or quite vertical, and the earth held in place with piles and rough slabs or planks. The direct inlet to the pond at I, might be provided with a gate, and the outlet of the canal, where the latter connects with the open water at *o*, might be provided with a filter of moderately fine galvanized-wire netting and a gate—the first answering to keep out large fish and débris, and the latter to close under certain circumstances, or when violent storms develop strong breakers. The accompanying plan and sectional elevation, as shown in Plate I, will render the construction of such a pond and system of collecting canals clear.

Into the pond, *X*, I would put an abundance of spawning oysters, say 100 bushels, if the pond were 40 feet square, and 200 bushels if it were 60 feet square. But instead of throwing the oysters directly upon the bottom, I would suggest that a platform, *P*, of strong slats, be placed over the bottom of the pond at a distance of 8 to 10 inches from the earth below, upon which the oysters should be evenly distributed. This arrangement will prevent the adult oysters from being killed by sediment, and also afford a collector in the form of a layer of shells to be spread over the platform, and give the fry a better chance to escape without immediately sinking into the ooze below.

The mean depth of water in the pond and canals ought not to be less than 3½ feet, and the bottom of the pond and canals should be cut to the same level, with a view to get the full benefit of the tides.

The method of operating such a system will now be explained. The pond *X* is supplied with the above specified quantity of good spawning oysters, which at a low estimate ought at the rate of fifty females per bushel, to yield from one hundred to two hundred billions of fry during the time the cultch may be in position in the canals. If, however, the oysters were very large selected ones, fully twice as much fry ought to be thrown out by them, or fully two to four hundred billions.

This enormous quantity of embryos must, unless it finds some objects to which to attach itself, be irrecoverably lost. In order, therefore, to provide it with a nidus for the purpose of fixation, an extensive system of collectors is provided in the channel *s*. These are figured in detail on Plate II, the first being an end and the second a side view, and the third a plan. These are essentially flat baskets with wooden ends, and with the bottoms and sides formed of a very coarse kind of galvanized-iron wire netting, with 1 to 1½ inch mesh. At the top they are open, and on either side a strong strip or scantling is secured and projects out past the ends of the box or receptacle to afford a means of supporting the whole upon scantling or ledges secured near the tops of the sides of the canals *s*. These projections of the strips are also intended to afford handles by which two men may lift and move the apparatus about. The uprights at the ends and the horizontal cross-bars are intended to enable the culturist to vibrate the box and its contents in the water of the canal without lifting it out and in such a way as to wash off any injurious accumulation of sediment not swept away by the action of the jetties presently to be described.

These baskets or receptacles are open at the top and are intended to be filled with clean oyster or clam shells as cultch for the spat. They are each to hold about 3 bushels of shells, a quantity as large as can be conveniently handled by two men. One hundred of these will therefore contain 300 bushels of cultch; though I actually believe that four hundred such boxes, or 1,200 bushels of cultch through which sea-water charged with fry thrown off by 100 bushels of spawning oysters would pass would not afford too great an amount of spatting surface, because we have shown on the basis of actual observation, that a body of water adapted to oyster culture is capable of yielding spat throughout all of its three dimensions.

These boxes or frames, after they are filled with the cultch, are suspended in the canals, the cross-section of which they should nearly fill at low tide. They are placed with their widest dimension across the canal, so that during the rise and fall of the tide the water has to rush through them no less than four times daily, and as the water is thoroughly charged with embryos, the greatest possible opportunity is afforded the young fry to affix itself.

In order to still further guard against the accumulation of sediment it is proposed to place jetties across the canals, as shown in the ground plan at the points *j*. These may consist of boards, forming a frame, which may slide into or be secured by vertical ledges fastened to the sides of the canal. These jetties may have one or two wide vertical slots in them, through which the tide will be compelled to flow with augmented velocity, and thus scour the sediment off of the cultch contained in the suspended boxes or frames on either side of them. Such jetties may be placed at intervals along the canal, and they might be made movable so as to be changed in order to affect other sets of boxes of cultch at other points along the sluice.

The system of canals as shown in the plans should hold about 400 receptacles filled with shells, or at least 1,200 bushels of cultch. In practice I think it probable that even a longer system of canals will be found available, but it must always be borne in mind that the area of the pond must not very greatly exceed the total area of the system of canals, or else so much more water will run out of the pond at every ebb of the tide that a great many embryos will be carried past the system of collectors in the canals into the open water and be entirely lost. There is, consequently, a very good reason for having the areas of the two nearly equal.

The preceding system of culture, it will be obvious, is only an application of principles well established and based upon the observation of the actual behavior of oysters under natural conditions, as observed at Fortress Monroe, Saint Jerome's Creek, Wood's Holl, Cohasset, and Long Island Sound.

The spawning ponds after the season is over may be used for fattening choice oysters for market, as they will actually hold about the quantity stated at the outset of this chapter. They may also be used in connection with another modification of the method of using cultch much crowded together or condensed, to be described later on.

The cultch may, without harm to the spat, be allowed to remain in the suspended receptacles in the canals until the first or middle of October, when it should be taken out and spread upon the bottom on the open beds where it is to grow larger. The reason for allowing the cultch to remain so long in the boxes is because spatting under favorable conditions continues for not less than ninety days, or from July 1 to October 1, so that all of this plant should be in working order by the first of July.

This system is especially well adapted for the work along the Chesapeake, and I know of no better location for the construction of these new devices for spat-culture than the United States Fish Commission station at Saint Jerome's Creek, in Saint Mary's County, Maryland. At that place the equipment and conditions already in part exist for its realization at far less cost than in any other place which could be occupied by the Commission for the work at present.

(*B*) *The new method of condensed spat-culture as conducted in a series of tanks filled with cultch.*

In this modification, the sea-water, charged with an abundance of free-swimming fry, is pumped through a series of troughs filled with cultch, the method being founded on the accidental results obtained in 1881 at Cherrystone, Md.

The water from the spawning ponds, or from vats charged with artificially fertilized fry, is pumped by means of a steam-pump or a pump operated by a wind-mill, into an inclined tank, shown in elevation and in plan in Plate III. Such a tank inclined at an angle of about 15° may be 45 feet long, ten feet wide, and 1 foot deep, and may be subdivided into fifteen compartments transversely, each of which would be about 3 feet in width. The transverse subdivisions within the tank should be two or three inches lower than the sides so as to allow the water to run from the highest to the next lower one in succession, and finally into the lowest compartment, from which the water would run back into the spawning ponds, or the vats containing the embryonized water. Each of the successive compartments is filled to the water-level with cultch, preferably oyster-shells, upon which the spat will adhere. Such an apparatus, containing 180 to 200 bushels of cultch, would be as efficient as the same amount in the system of canals in connection with spawning ponds, with only the disadvantage of having to use some kind of power in order to pump the embryonized water through it instead of depending upon the tides to operate the plant automatically. It might also cost relatively somewhat more to keep in repair than the system of ponds and canals.

Taps or plugs might be arranged in the bottom of each of the compartments to draw off any accumulations of sediment which would collect in them.

Another system of tanks through which a continuous flow of embryonized water might be kept running is also submitted in elevation and in plan, in Plate IV. This consists of a series of ten troughs, *a* to *k*, which, as in the preceding system, are supported on a framework of tressels. The embryonized water, from the spawning ponds or vats, is pumped into the highest trough, *a*, and runs into a narrow compartment at one end of the tank, as shown in section in the sectional elevation. This narrow compartment opens below into a space covered by a sloping perforated partition or bottom. The cultch is placed in the trough so as to cover the perforated false bottom, and is to fill the trough evenly within half an inch of the water-level, which is determined by the height of the board at the other or outflow end of the trough where the water pours over a chute into the next trough below. The object of the perforated bottom is to cause the embryos to be distributed and be brought into contact with the under side of the shells or cultch. After the water, charged with free-swimming embryos, has passed through this chain of troughs it is returned to the spawning pond connected with a canal system, or back into the ponds or vats in which artificially fertilized embryos have been poured.

Each of the troughs of this system measures 12 feet long, 6 to 8 feet wide, and 1 foot deep. It is undesirable to make them deeper for the present, as it is doubtful if sufficient light would penetrate through a very much deeper layer of cultch. Their aggregate capacity would be from 100 to 150 bushels of cultch, or very much less than could be accommodated in the system of canals. I believe, however, that there would be more complete control. This system could be operated with great expediency at Wood's Holl, where the experiments of this year have very conclusively shown that oysters will live, thrive, and increase, some individuals from Long Island Sound having made a new growth of a quarter of an inch in the short space of a month. It is especially desirable to conduct the work of spat-culture at Wood's Holl, in the lower floors of the new laboratory and residence, where the facilities for obtaining an abundance of sea-water are unsurpassed. This is all the more easily done now that our experiments in transplanting oysters to that place have been so successful, but where they have never heretofore been to any extent indigenous.

It is also very important that the tanks or troughs be operated on an extensive scale at Saint Jerome's Creek station, in connection with the system of spawning ponds and canals containing the new system of collectors. The efforts which are to be made now, after we have so far worked out the details and principles, are simply those of routine, and it is to be hoped that no pains will be spared to push the construction of the necessary plant to completion at both places as rapidly as possible, and in abundant time for the beginning of the spawning season on the 1st of July, 1886.

The method of pumping embryonized water, or water containing oyster embryos, through shells, was resorted to by Brooks and Winslow in 1882, the apparatus used by them being still in existence among the stores of the Fish Commission at Wood's Holl. The same year McDonald's apparatus was operated, and in that adherent fry was obtained, to our delight and astonishment, 24 hours after its fertilization. In that apparatus the same body of water was constantly kept circulating by hand. In Bouchon-Brandely's apparatus the water charged with embryos was operated by means of a pump, and I think about the same time. These details are given as matters of history, in case there should be any disputes in the future as to who was the first to use such methods. Each one of these experimenters devised his apparatus independently of the other, and in ignorance of how any one of the others was working, so that there could have been no unrightful appropriation of ideas on the part of any of them.

But all of these experiments, I am now satisfied, were conducted on too meager or limited a scale to be very decisive in character, but they have served to indicate what are the proper methods to be adopted. Large quantities of cultch and large and continuous supplies of fry from large quantities of oysters were never used in any of these experiments such as it is now proposed to use in the further prosecution of the work. Whatever results we see accomplished under favorable conditions in nature can be just as readily accomplished under conditions which may be supplied by the ingenuity of the cultivator, if he is guided by the proper preliminary knowledge. If any one were to inform me that I could not produce even more satisfactory results in collecting spat than are to be seen occurring naturally in the moat at Fortress Monroe, I would simply tell that person that he knew nothing of the conditions determining the nature of the problem which he pretended to regard as incapable of solution.

What we must do to-day is to adapt such means to the solution of the oyster problem as will render them applicable in practice. The American cultivator does not get the price obtained by the French or Dutch oyster farmer, nor can he for a long time to come expect to, for the reason that the aggregate area upon which the American oyster is cultivated or indigenous exceeds by many times that upon which the European species is either native or cultivated. The European methods of using cultch, such as tiles, slates, brush, fagots, &c., are too expensive, too elaborate, for our practical people. We must reap in quantity what they reap out of the high price of their product. Under the circumstances there is no possible way of solving the greatest question which now exercises the oyster-growers of this country, but to put into their hands a method by the aid of which they can get all the spat they want on their *own* lands and from the spawn of their *own* oysters.

This we propose to accomplish with the apparatus described above. The cost of the entire plant requisite is a mere trifle compared with the results to be gained by its use. In order to show that the method is practical, I will state some of the results of previous experiments with collectors at Saint Jerome's Creek in 1880. I arrived there on the 19th day of July in that year, and on the 22d of the same month had some collectors in place in the open water and coves. I continued to put out collectors until towards the middle of September, but in nearly every case it was impossible to direct the water charged with embryos directly upon the collectors as it is proposed to do by the help of the new method, yet in almost every case I obtained a set of spat on these collectors, some of the young oysters on the latter by the first of November measured nearly two inches in length. It was then that I first noticed the disposition of the spat to adhere to the under or clean side of the cultch and also to surfaces which were vertical and their indisposition to adhere to the dirty upper surfaces of the slates, &c., which were used.

Enough spat was obtained that season to prove that it could be profitably collected in that way provided we had a sufficiency of such within a limited area so as to condense our cultch and get more spat on a smaller area. Many of our collectors during that season soon became heavily coated above with sediment (as much as an inch in depth being deposited in two months), so that such surfaces were rendered valueless for our purpose. Had we instead been able to expose one hundred times as much collecting surface within one-tenth the space covered by the apparatus used that season, the oyster question would have been settled that year. The subsequent experiences which were obtained there and at other places, however, have served to indicate that still other supplemental conditions were necessary, viz, (1) such that would enable us to direct the water charged with embryos direct upon the cultch, and (2) such a utilization of the tide and construction of the receptacles for the cultch as would enable us to keep the latter clean.

In order to realize the spat-yielding capabilities of any given body of water to its fullest extent, and throughout its three dimensions of length, breadth, and depth, the cultch must be distributed as evenly throughout those same three dimensions as possible. This implies the concentration or condensation of the cultch or collecting apparatus to an extent never before attempted. The new method here proposed will then mark the third period or stage of the development of oyster culture. The first one is the *laissez-faire* stage of the industry, now largely prevalent in this country. The second stage is the ordinary method of shell-sowing.

The advantages of the method of using the cultch in concentrated bodies, giving an enormous amount of surface for the spat to adhere to, are, that it can be conducted on the land owned by the culturist himself, and with the spawn thrown off by the oysters belonging to him. He is therefore not bound by any arbitrary oyster laws now existing to conform to what are, generally speaking, very inefficient and often absurd conditions. The new method puts it in the power of the culturist to rear his own seed for planting, and if he is so disposed he may put down an excess of cultch, which he can sell after it is covered with spat to the owners of the open beds in his vicinity. It involves comparatively little outlay to put down a plant which will accommodate 5,000 bushels of cultch, or enough to seed from 20 to 30 acres for the first year. Such a system would be of great practical utility in the region of the Chesapeake Bay, where there are very extensive areas upon which, with very inexpensive excavation, the plant for conducting this method of culture could be organized.

At places like Wood's Holl it would also be possible to organize the system of using the cultch in concentrated form, so that if the locality did not actually afford the means of extensive bed-culture for market, it would in many instances become available for the purpose of rearing spat to be planted in available localities near by.

IV.—THE FUNCTION OF ARTIFICIAL FERTILIZATION.

As stated in the introductory portion of this paper, the utility of artificial fertilization of the eggs of the oyster is unquestionable, but I would not give it either the principal, nor yet a subordinate place in my system of spat-culture. We know, for example, that 100 bushels of good oysters ought to yield at least 100 billions of fry. While we cannot possibly prevent a very large percentage of this astounding yield of embryos from being lost, it would be very poor economy indeed not to avail ourselves of such a convenient and constant source from which to obtain embryos under natural conditions. So I propose that we use the natural yield thrown off by the adult oysters, but in addition call in the aid of artificial fertilization to supplement the supply of fry yielded naturally.

Into the spawning ponds and system of canals, in which the cultch is suspended, the tide will ebb twice and flow twice every day. In other words, the water charged with embryos is changed over the collectors four times in every twenty-four hours. During ninety days, or as long as the spatting season lasts, the water surrounding the collectors will have been changed or shifted about 360 times. During the ebb tide the fry will be carried out of the pond into the canal, and thrown into contact with the collectors twice daily. When the flood tide again returns the water to the pond from the open bay a large part of the fry will be carried back into the pond again, and away from the cultch or collectors. It is during the flood-tide that I would therefore commend the practice of putting artificially-fertilized embryos in the swimming stage of development into the outlet of the canal to be swept back amongst the collectors toward the spawning pond.

The artificially-fertilized embryos should be taken from the adults by gentle pressure with a pipette and dropped into a dish of clean sea-water so as to discover by means of the "drop test," when male and female products were obtained so as to make sure of artificial fertilization. In a favorable temperature and suitable weather they will reach the swimming stage in three or four hours, when they may be poured into the canal system, or into the spawning vats or ponds used in connection with the troughs filled with cultch through which embryonized water is being pumped. This is an important point, as the chances for the adhesion and survival of the fry after it reaches the swimming stage are very greatly increased.

Another way of providing fry in the canal at all times would be to place a half-dozen good spawning oysters in every receptacle for cultch so that an abundance of embryos would be constantly wafted back and forth in the canal. Even then I think it would be advisable to use artificially-fertilized spawn as supplementary to that thrown off in addition from the oysters contained in the receptacles filled with cultch. This would render the operator trebly sure of results. The importance of artificial fertilization is shown by the facts established as a result of the experiments with ponds, into which and out of which the water passed through filters of sand, at Stockton in 1883, and at Saint Jerome's Creek in 1884 and 1885. As the spat obtained in these ponds was entirely derived from fry which had been artificially fertilized, there can be no doubt of the efficiency of artificial fertilization.

V.—Coating the cultch with a detachable covering of lime or cement.

Coating the cultch with a layer of lime and sand, or lime, cement, and sand, cement alone, or cement in combination with various other substances, such as ox-blood, as proposed by Dr. Kemmerer, may serve an excellent purpose, and might even be necessary where the spat became so thickly crowded together as to be killed as a consequence of overcrowding. Under ordinary circumstances, however, where only one or two young oysters adhere to a single shell, there would be no need for any such detachable coating, as there would be no danger from overcrowding. Nevertheless, where as many as fifty or one hundred spat become attached to a single shell such a coating would probably be found necessary, as under such circumstances it would simply be impossible for any but a small proportion of the entire set to survive beyond a month or so. In case such overcrowding should occur on the cultch used in the collectors employed in the canals or troughs, it would probably be best to use a coating of some kind on the shells.

Such a coating should consist of a very thin mixture of very fine sand, lime, and a little cement in such proportions as will cause the coating to set firmly and not wash off readily, but be easily flaked off with a little effort, so as to free the crowded spat. Into such a mixture the shells used as cultch might be dipped very rapidly by means of a basket of wire netting, so that half a bushel could be coated at one operation, the surplus mixture shaken off, and the shells thrown into a heap to allow the coating to set preparatory to being thrown into the troughs or the receptacles used in the canal system. For filling the latter a wooden hopper provided to fit over the top of the receptacle, and removable so as to be used in filling collectors successively, would be useful, as the mouth or open top is rather narrow to admit of a shovelful of shells being conveniently thrown into it.

In handling the spat which has been flaked off of the cultch when overcrowded, wider and more capacious receptacles, made of finer galvanized wire netting, and constructed upon the same general plan as those used to hold the cultch in the canals, might be made to receive the detached spat. These could then be suspended in the canals and allowed to remain there until a year old, when they could be scattered upon a firm, clean bottom to grow larger. In this way the canal system could be kept in use a great part of the year, or until the next spatting season.

VI.—Collectors.

In handling tile and slate it must always be coated with a detachable covering of lime and sand, or something of the kind, in order that it may be possible to remove the adherent spat. After that the individual tiles and slates must be supported by some sort of framework, or fastened together in some sort of a bundle to make them most effective. The result is that the first cost of such collectors is too great, because both the tiles and slates must be bought as manufactured articles, whereas the shells can be got for the trouble of hauling them away, in the region of the Chesapeake at least. Moreover, the cost of the contrivances for supporting the slates and tiles, together with the latter, is almost as great in the long run as that of the receptacles in which the cultch is suspended in my system. These receptacles, being for the most part constructed of galvanized wire-netting, will last for at least three or four years, during which time each one of them should have produced at least 9 to 12 bushels of spat suitable for seeding purposes. The new apparatus can be used repeatedly, whereas the other, if it is used again, must be recoated, and if made of several tiles or slates must be reconstructed every year. All of these disadvantages render the older European methods so cumbersome and expensive that they are of very little service in this country, where it is desired to get the largest possible return for the least possible outlay both in labor and money.

I would therefore unhesitatingly give the preference to oyster-shells as cultch, especially since they can still be obtained far more cheaply than either tiles or slates. The time may come, however, when these may become so valuable as cultch that it may be necessary to find some substitute. In that event potsherds might be manufactured on a large scale to answer the purpose equally well. Pottery—such as is used to make clay pigeons for sportsmen—would be very serviceable as a collector. Clay pigeons, in fact, either entire or broken up, would make an excellent kind of cultch.

A curious property of oyster-shells, manifested where they are simply sown on the bottom, and which has fallen under my observation, is of considerable interest in connection with oyster culture. It is found that if the dead valves of the oyster are thrown into water they will almost invariably fall to the bottom with the smooth inner or concave face upward, and the rough convex face downward. The best side is therefore, in the practice of shell-sowing, the least efficient for the purpose of collecting spat. Upon investigation this is found to be actually so not only when oyster-shells are sown as cultch, but also when those of the clam and scallop are used for the same purpose. Upon examining the shells used as cultch by the Long Island planters it will be found that the most of the spat has adhered to the convex or undermost side of the shells, and that comparatively little spat has fastened itself to the upper side.

When the oysters are planted in the water from a boat, they also, as a rule, fall upon the bottom with the left or most convex and colorless valve downward, while the colored and flattest or right valve is uppermost. Upon examining old oysters which have been lying flat on the bottom the spat will be found for the most part fast to the lower valve, just as we found it upon examining the cultch of shells.

These data seem to me to indicate most conclusively that the sediment which is deposited from the overlying water has rendered the upper surfaces of both the cultch and the oysters unfit for the adhesion of young fry. That it does adhere to the upper surface very often we have evidence enough, but we also have abundant evidence to prove that it adheres there far less commonly than to the lower side. So we actually find that the experience with slate and tile collectors in shallow water tallies completely with what is observed in relation to the cultch used in deep water, namely, that the lower side is always the most efficient for the purpose of collecting spat. This leads to the obvious conclusion that in suspending our masses of cultch above the bottom we are doing the very best possible thing to facilitate the adhesion of the fry and prevent its subsequent asphyxiation by the accumulation of sediment.

This sediment needs some discussion, so as to point out to the reader something in regard to its origin. Observation has taught the writer that it is largely of organic origin; that it in fact is largely composed of seaweed, in sounds and along shore, which has been torn loose and ground into fragments by the action of the breakers and undertow, as it is always increased in quantity during storms. Wherever there are coves or inlets this fine *débris* is carried into them by the flood-tides, and during slack-water it is slowly deposited by the action of gravity. I know of localities where deposits of ooze exist which owe their origin entirely to such a slow deposition of sediment, and where it is now all of 10 feet in thickness. Such a bottom is, of course, quite unfit for purposes of oyster-culture, and is just as totally useless if it is intended to sow cultch. If the cultch is suspended or supported above the bottom, then it is possible to obtain spat in such situations, as the writer has found by actual experience.

Other materials, such as gravel, under some circumstances, might be advantageously used as cultch, but ordinarily I suspect that unless it was sown on very firm or hard bottom, after being taken from the suspended collectors in the canal system, many of the young oysters would be smothered. It would also present less collecting surface in proportion to its weight than shells.

Hard-wood chips made by the wood-cutter's ax, after becoming water-logged, might serve as cultch if placed in the suspended collectors, but as the slow decomposition of the wood is unfavorable, I doubt if anything would be gained by its use which would not be just as effectually achieved with the use of shells.

In fact, after considering all the readily available materials, I do not think there is anything which can be compared for suitableness and efficiency with oyster, clam, or scallop shells as cultch. There is certainly no form of collector in use in Europe which will as cheaply afford the same great amount of spatting surface as can be obtained in suspended receptacles filled with shells such as are used in the canal system here proposed.

It appears to me that stringing shells upon wire is also impracticable in this country. That involves taking each shell singly and perforating it before it is strung. Such a proceeding might answer very well where labor costs one-third of what it does in the United States. If we can suspend the shells just as effectively and at far less cost without handling them singly in order to perforate them, it would indeed seem to be a waste of time and labor to resort to such an expensive method to effect what can be done far more easily and on a larger scale in another way.

VII.—The possibilities of the new method in the hands of the oystermen.

I know perfectly well how this paper will be greeted by the conservative oystermen. I find, indeed, that even those who pretend to be scientific are ready to cavil at the attacks here made upon the present systems and the apparently extravagant claims to which I have given expression. After five years of careful and often laborious observation and study, during which time I have personally instituted a large number of experiments in the field, and have studied the problem in all its aspects, I am ready to own that I have misapprehended the very elements of the question at issue. I have taken it for granted that the methods in vogue in Europe were somehow applicable here. So they are, but not until so modified as to have lost almost all original semblance of themselves. I have *not* dealt with *probabilities*, but with *actual possibilities*, in this paper, as founded upon *personally observed facts.* I have proposed no cunningly-devised hypotheses to entrap the unwary novice, but at every step in the development of my system I have checked what I had to say upon a given point by something within the bounds of experience. This is my final contribution to the *theory of oyster culture*, a thing which it has never possessed before in the way in which it is presented here.

In no part of this paper has there been any direct reference to the anatomy or development of the animal. The practical man has no time to waste upon that part of the subject. What he wants to know is not how the egg of the oyster segments and develops, but what the habits of the minute creature are when it is first let loose in what must seem to it, if conscious, a truly vast universe of water. Moving about in its element with the help of the fine cilia encircling its velum, it swims until it finally meets with a nidus to which it can glue itself fast with the margin of the left lobe of its tiny mantle. Once fixed, its wandering existence is forever at an end. It is now ready, by slow stages of growth, to become more and more like its parent. Its shell, before and some time after fixation, is perfectly symmetrical, like that of the hard clam, and remains so until it attains the still diminutive size of one-ninetieth of an inch across. It is this symmetrical phase of its infant or embryonic career which constitutes the most critical stage of the creature's life. The losses prior to fixation are very great, and all we can possibly do to diminish them, in the present state of our knowledge, is to so enormously increase the proportional amount of cultch, to which fixation is possible, that for any given bed such losses will be reduced to their possible minimum. Scattered cultch, such as tiles, slates, &c., have been as unphilosophically and unscientifically applied hitherto as the cultch used on the bottom in only two dimensions of space. For the present mode of use of the latter, however, there are assignable reasons when such cultch is applied in open water. The use of cultch where the adult oysters are much scattered, so that the embryos are diffused through such enormous bodies of water that the greatest possible results are not obtained, is likewise unscientific. What has been needed is a study of the habits of the animal, and then to *create* the necessary favorable conditions by artificial means. I have sought to point out the way in which these conditions are to be created, and, in the hope that they may soon be extensively taken advantage of, I will turn for a moment to a consideration of the possibilities of the new method.

With the new method it is possible to provide and expose not less than fifty times the amount of spatting surface per acre that can be exposed if shells are simply thrown down upon the bottom. The yield of spat or seed oysters per acre can therefore be augmented in just the proportion in which the quantity of cultch over a given area is increased. If it is objected that the great increase in the number of oysters would rob the water of its lime in the form of its carbonates, I can reply, it seems to me, with considerable confidence, that the vast amount of oyster-shells used as cultch in the collectors would supply all that is needed in the most available form, for these shells are being constantly eroded by the solvent action of the water, so that an abundance of calcic carbonate would be supplied in solution in the water for the purpose of building the shells of the young spat. We therefore have, in these circumstances, a very strong argument in favor of the use of oyster-shells as cultch, though it may be said that coating the cultch with lime or cement would supply the shelly matter perhaps equally well.

In the next place, the culturist of limited means, if possessed of low land adjoining the shore, can organize and equip a small plant adapted for collecting the spat from a few hundred bushels of oysters at a small cost. He can not only in that way obtain the seed needed for planting upon his own beds, but also supply his neighbors at a fixed rate per bushel, with spat for planting upon their beds.

For large operations the plant would have to be proportionally extensive and costly. For a plant which would accommodate fifty to one hundred thousand bushels of shells annually, the original outlay would be very considerable.

For such operations joint-stock companies could be organized, with an assurance that great profits could be reaped from the enterprise.

In all of this work, especially where the fry from coves is utilized, we would simply be saving what is now an almost total loss to the planters over a large part of the ground at present cultivated in the old way. We would simply be saving the brood from our own beds from being swept out by the tides and irrecoverably lost.

Localities exist all along the Chesapeake Bay where this method could be utilized very successfully. The range of its applicability extends, in fact, from some distance north of the mouth of the Potomac, south, almost to Norfolk, Va. There are localities in which it is doubtful if the tides rise high enough, but wherever a tidal rise and fall of 12 inches exists, it would seem that the method could be rendered available. Tides of at least 10 to 12 inches are necessary in order to waft the fry back and forth in the canals, and to render the operation of the jetties in the canals effective.

VIII.—MODIFICATIONS OF THE NEW SYSTEM WHERE NATURAL COVES OR PONDS EXIST.

The plan of the small establishment given in the preceding pages is to be regarded as typical. In the use of the system with crowded or condensed cultch in different localities, modifications of the typical plan may often be advantageously employed. For example, an oyster planter may have a large pond of two or three acres thickly planted with spawning oysters and connected with the open water by way of a narrow canal. The pond, if it has a firm bottom over its whole extent, may, if not already used for the purpose, be planted throughout with good seed or "plants," which, in the course of two years, will be mostly well grown, marketable oysters. In such a case several systems of canals could be fed from the single large inclosure, that is to say, instead of having only a single canal, several zigzag canal systems, each 3 feet in width, might be made to carry the water flowing in and out of the large inclosure instead of the original channel, which might then be filled up and closed. Or, if it were practicable, the channel connecting the natural pond with the open water might be utilized for the same purpose as artificially constructed canals, provided the cost of modifying it for the purpose were not too great. In some cases, by digging, filling, and dredging, as might be indicated in the course of such a natural channel, it could be prepared for the reception of cultch. Where such a channel were wide enough a system of parallel rows of light piles, the rows being 3 feet 3 inches apart, and running lengthwise throughout the course of the channel, might be used to support the receptacles for the cultch, the latter being of the form used in the design of the typical system, and supported as in the latter, upon ledges or scantling spiked horizontally to the rows of piles just below the level of low tide.

In other cases where there existed narrow points in the course of such a canal these might be used as jetties, still further narrowed in some cases, perhaps by filling in the sides, after which a system of parallel rows of piles with their horizontal supports of scantling might be constructed between the jetties, and upon which the receptacles filled with cultch could be supported. In this way the fry now discharged by spawning oysters from coves through their outlets, sometimes by the thousands of billions annually, can be caught upon cultch and permitted to develop into available spat.

In many cases the cost of digging out the proper channels or canals to be used in the system of applying the cultch in concentrated form, would be greatly diminished by the nature of the ground upon which the canals were dug out. If the level of the earth is not much above that of high water, so much the better, for then the labor to be expended in making the necessary excavations will be proportionally diminished, and no assistance from a skilled engineer will be required.

Whether the spawning pond is excavated or not, the principle upon which the system is constructed and operated remains the same, namely, that the area of the canal systems and the ponds be about the same. In order that the fry may not be carried past the collectors, the area of the pond should not much exceed the total area of the canals. In order that the fry may be wafted to the outermost collectors, the area of the canal system ought not to greatly exceed that of the pond or ponds.

Canals constructed between a series of spawning ponds may also be utilized; in fact a great many other modifications of the system are available, which would become apparent only after a study of a given location. The plans for carrying out this system would in fact have to conform to the demands of the location, so that it may be said that each establishment would have to be designed in conformity with local conditions.

IX.—Convenience and accessibility of the system at all stages of the work.

No system of spat collecting with which I am acquainted can be so conveniently conducted as this one. The cultch at every stage of its exposure is completely under control. The cultch, with its catch or set of spat, can be watched and conveniently overhauled without the use of boats, dredges, tongs, or rakes. If no set of spat should happen to fall upon a part of the cultch, that portion is not out of reach, as a great part of it would be were it simply strewn upon the bottom. In the latter case, if the cultch is wanted, or if it is desired to make it again available somewhere else, it must be fished up. In my system every 3 bushels of cultch is completely independent of all the rest, and can be removed from the canal and examined at any stage of its exposure to the floating fry.

The filled receptacles can be wheeled with barrows to the canals, where they can be rapidly put in position, where they are to remain for ninety days. If all of the shells should not have spat attached at the end of that time, those which have no set upon them can be thrown aside to be used over again, and the others taken in wheelbarrows to the boats, from which they are at once scattered upon new beds as seed.

Should any collector full of cultch get out of order, it can be readily examined, removed, and repaired. There is no need of getting into an unsteady boat to go out to lift an unwieldy collector out of the water. Filling, emptying, and caring for the collectors is entirely conducted on shore in the use of the new system. Operating and handling them is in like manner done while the manipulator stands on the banks and on a sure footing, such as he sadly feels the want of while handling the heavy old-fashioned collectors from a cranky boat.

X.—Size, form, position, and method of handling the receptacles for cultch.

The size of the suspended receptacles for the cultch should not be much over the dimensions now to be given. If the vertical end pieces are 6 feet long and 6 inches wide, and secured together about the middle and parallel by broad side strips and one at top, as shown in the figures, so as to be 3 feet apart, with the wire screen inclosing the space between the end pieces or strips and below the parallel horizontal bars, a flat basket or crate is formed. This basket or receptacle is filled to the lower edge of the horizontal strips with clean oyster-shells. The contents of one of these receptacles would then be equal to 3 bushels and nearly a peck of shells, or a quantity which will be found to be about as heavy as two men can readily lift about. The receptacle when made of the size given will hold 6,936 cubic inches. There are 2,150 cubic inches in a bushel.

The galvanized-wire netting should be fastened to the sides and edges and lower ends of the vertical strips and horizontal cross-bars, with small barbed galvanized-iron staples used as nails. If, upon filling this wire basket with shells, there should be any tendency of the wire netting to "bag" or bulge outward in the middle, that trouble may be remedied by securing the central part of one side to that of the other by a galvanized wire running across the interval between them. The total cost of each one of these baskets should not be over 50 to 70 cents when made in quantity. In ordinary spatting seasons the receptacles should pay for themselves within fifteen months; that is, they should yield a sufficient quantity of spat or seed oysters at a fair market value, in that space of time, to pay for the cost of the rearing apparatus. The galvanized netting will last for fully four seasons. The wooden ends will be attacked more or less by the *teredo* or ship-worm, though it is believed that under ordinary conditions this will not be so serious an enemy to the durability of the apparatus as might at first be supposed. Copper paint might be applied as a protection against this enemy. The outside dimensions of the immersed portions of the collectors or receptacles will therefore be about 3 feet by 3 feet, with a thickness of 6 inches. This will make it necessary for the ditch to be about 2 or 3 inches wider than the receptacles below the ends of the horizontal strips. The ledge or sill on the tops of the piles, along the sides of the canal, would make the latter a foot wider at its upper than at its lower portion for about 12 to 16 inches from the top. This ledge is the simplest arrangement which can be devised to support the receptacle.

The receptacles filled with cultch are then placed with their widest dimensions across the canal, so that at every ebb and flood tide the floating oyster fry carried out and in, or from and to the spawning pond, will be driven through these masses of cultch; it is therefore desirable that just as little unused or free space in the canals be left for the water to ebb and flow through as possible.

It is not advisable to make the receptacles much thicker than 6 inches through their least diameters, lest the light necessary for the development of the spat be shut out too completely, or so as to interfere with the growth of the infant oysters. In order that the light may penetrate from above and down between the receptacles for the cultch, they should be placed 6 inches apart in the canals.

It follows from what has just been said that every running foot of the canal will accommodate three bushels of cultch. For 1,000 bushels of cultch it would, therefore, require a canal about 335 feet in length, covering a total area of only 2,010 square feet of surface, including the banks between the canals. The spawning pond to feed such a canal would be about 45 feet square, so that the whole plant would cover a total area of 4,035 square feet, including the system of canals, or not quite one-tenth of an acre. At this rate it is possible to accommodate 10,000 bushels of cultch per acre by the adoption of the new system. Fifteen hundred bushels of shells per acre would quite effectually cover the bottom, so that the ground would be concealed by them, but even that is probably a quantity which would be very wastefully applied if merely strewn on the bottom as cultch.

The care of the cultch in the receptacles is a very important matter during the spatting season. The empty space left between the receptacles, allowing 1 foot of the horizontal extent of the canal to each one, would be about 6 inches. This space, besides admitting the light, will enable the attendants to vibrate or rock the receptacles back and forth on the projecting ends of the horizontal strips, by means of the cross-bar at the top of the device. By rocking the receptacle back and forth vigorously a few times every two or three days, or even every day, the shells will be kept free from sediment, and the asphyxiation of the recently affixed fry prevented to an extent which is altogether impracticable in any other system now in vogue. This is one of the most important and distinctive features of my system, and one which will commend the latter to the favorable consideration of any one who has ever seriously considered the oyster question.

In filling the receptacles with cultch I have previously recommended the use of a removable hopper, in order to facilitate and expedite that part of the work. There is another point in the use of these contrivances which I have not touched upon, however, and it may be well to say a few words as to *how* the shells are to be placed in the receptacles.

As stated in the preceding pages, oyster-shells, if thrown into the water, will almost invariably fall with the rough convex side down, and the smooth concave side upward. This happens even when they are allowed to drop from a height into water only 6 inches deep. It also follows that if old shells are used as collectors, as proposed in my new system, there will be a tendency for the spat to catch all over both surfaces instead of only on the lower surface when simply strewn over the bottom. It will also be found that when the shells with adherent spat are taken from the receptacles used in my system and strewn over the bottom when planted, that they will tend to fall with the convex side down and the concave side up. It is obvious, therefore, that the collectors should be filled in such a way as to cause the shells to drop into them in the position which they would naturally tend to assume when sown as cultch. Otherwise it will readily be seen that in planting or sowing, the cultch covered with spat, which we have taken so much pains to rear in the receptacles, will fall on the bottom in such a way as to bury many of the young oysters. In order to avoid this as far as possible, I would recommend that the wire receptacles be placed in the water in their proper position and then be slowly filled with the shells. If this is carefully done the shells will fall to the bottom of the wire basket and assume just the same position, in relation to their surroundings as if thrown into the open water and allowed to fall to the bottom, namely, with the concave side upward and the convex one downward. The shells may now be said to have assumed their normal position in the receptacle. The latter is now ready to be placed in position in the canal.

One word about the way in which the receptacles freighted with cultch may be expeditiously handled. It will probably be found that a small, portable tripod so arranged as to straddle the canals would greatly lighten the labor of handling the receptacles. This, if supplemented by a system of pulleys over which a rope was passed, or a "block and fall," and the whole hitched to the apex of the tripod, would greatly facilitate lifting the wire receptacles in and out of the canal. Four short chains or ropes with hooks to catch under the edges of the horizontal strips would be the most convenient tackle with which to lift the receptacles and raise them out of and lower them into the canal.

XI.—Conclusion.

If cultch in the form of shells is the best (for which conclusion we have assigned reasons), it follows that such material should be so utilized as to obtain the largest possible return for the least possible outlay. In other words, if shell-cultch is to be used at all, let it be expeditiously and economically, and not wastefully and unscientifically, employed. It has been found that even the sowing of shells is profitable, as has been conclusively demonstrated, and in one type of culture, namely, that which is practiced in deep water, it is probable that it is the only practicable method which will be devised for a long time to come. While it is to a great extent wasteful and at times uncertain, for the present, at least, there seems to be no other which can be as economically and successfully operated over large open navigable areas. Large areas operated by one individual or corporation cannot always be commanded, or only exceptionally, under the existing laws of the States of Maryland and Virginia. In those States, however, where it is possible to command the right to natural areas of water which are more or less nearly land-locked, the system of merely sowing shells would be positively wasteful and not in conformity with the results attainable under the guidance of the proper knowledge. It is found in the practice of shell-sowing that extensive areas will sometimes fail to produce any spat. This is apparently due to the presence of currents which have swept the fry off the beds, or to the presence of sediment, which has put an end to the first stages of its fixed career. Even after the spat is caught, great destruction may occur through the inroads of star-fishes, or a too rapid multiplication of worm-tubes over the cultch and spat. The latter is sometimes smothered in vast numbers from the last-mentioned cause, as has been recently discovered by Mr. Rowe. Such casualties are rendered either impossible or readily observable during their early stages by the method of inclosing the cultch in suspended receptacles, as suggested in this paper. The netting will effectually protect the young spat against the attacks of large star-fishes, and no growth of barnacles or tunicates, worm-tubes or sponges, would be rapid enough during the spatting period, judging from an experience extending through several seasons, to seriously impair the spatting capacity of the cultch used in the suspended receptacles. Any of the larger carnivorous mollusks, fishes, or crustaceans which could prey on the young oysters can also be barred out and kept from committing serious depredations by means of the netting around the cultch, as well as by means of screens placed at the mouth of the canal.

The maximum efficiency of the cultch is not realized in any of the old forms of collectors, for the reason that the cultch cannot be kept clean; secondly, because both sides of the cultch cannot be exposed to the passing fry; thirdly, because the fry cannot be compelled to pass over and amongst the cultch repeatedly; fourthly, because the cultch is scattered over too great an area and throughout only two dimensions of a body of water, namely, its horizontal extent, whereas it is possible, as I have shown above, to do all this and more—that is, to avail ourselves of the possibility of obtaining spat throughout the three dimensions of a body of water charged with embryo oysters in their veliger condition. These are good and sufficient reasons for my assertion that cultch has hitherto been wastefully and unscientifically applied. With this I must conclude this exposition of the principles of a rational theory of oyster culture, a subject which has received the attention of many investigators, none of whom have, however, struck at the root of the question and allowed themselves to be guided by readily-verifiable facts. In the hope that I have made both the theory and practice of my new method clear to the reader, who, if he should happen to be an oysterman, will, I hope, at least give me the credit of being honest and sincere in my intentions, and, whether he feels inclined to ridicule or to adopt my conclusions, I feel very certain that what I have formulated in the preceding pages will become the recognized doctrine of the future.

WOOD'S HOLL, MASS., *September* 20, 1885.

APPENDIX.

I. Since the preceding paper was written, Prof. W. K. Brooks has discussed the feasibility of using a cultch of shells in mass or quantity,* as contemplated in the system devised by me and described above. I take the liberty of reproducing Professor Brooks's note entire, as follows:

"Without expressing any opinion as to the value of the process of 'fattening' oysters by placing them for a few days in cars floating in fresh water, I wish to point out that there is no similarity between this process and the process of propagation which is here described.

"My attention was first called to the value of floating cars in oyster culture by Mr. William Armstrong, of Hampton, Va., who informed me, in 1884, that 'seed' oysters which he had placed in floating cars in the mouth of Hampton Creek grew more rapidly and were of better shape and more marketable than those which grew from seed planted on the bottom in the usual way.

"One of the results of my study in 1879 of the development of the oyster was the discovery that there is a period of several hours, immediately after the embryo acquires its locomotor cilia, when it swims at the surface, and this is the period when it is swept into contact with collectors. As soon as the shell appears, the larva is dragged down by its weight, and either settles to the bottom and dies, or swims for a time near the bottom. The tendency to swim at the surface is an adaptation for securing wide distribution by means of the winds and currents which sweep the young oysters against solid bodies which may serve for attachment. The greatest danger to which the oyster is exposed at any part of its life is that it may not, at the swimming stage, find a clean, hard surface for attachment.

"As it is microscopic and only about half as thick as a sheet of thin paper, it may be smothered by a deposit of sediment or mud so slight as to be invisible, and most of the failures to get a good 'set of spat' are due to the formation of a coat of sediment upon the collectors before the young oysters come into contact with them.

"It occurred to me this summer that this danger could be entirely avoided by the use of floating collectors, for little sediment can fall on a body which is close to the surface of the water, and most of this will

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*On the artificial propagation and cultivation of oysters in floats. Johns Hopkins University Circulars, Vol. V, No. 43, p. 10, October 21, 1885.

be swept away by currents, which will, at the same time, sweep the swimming embryos down into the collector, and thus insure an early, abundant, and successful 'set.'

"I accordingly constructed a floating car, made so as to permit the free circulation of the water. This was filled with clean oyster-shells and moored in the channel in front of the laboratory at Beaufort, N. C., on July 4. As all the oysters in the vicinity were in very shallow water, they were nearly through spawning, and the conditions were therefore very unfavorable; but notwithstanding this, I immediately secured a good 'set,' and the young oysters grew with remarkable rapidity, on account of the abundant supply of food and fresh water which gained ready access to all of them, and the uniform temperature which was secured by the constant change of water.

"This method of oyster culture may be applied in many ways, of which the most obvious is the production of seed oysters for planting.

"The seed which is used for planting in Maryland and Virginia, as well as in Delaware and farther north, is now procured from the natural beds of our waters by tonging or dredging, and as the demand for oysters for this purpose is certainly one of the elements which have led to the depletion of our beds, there is a wide-spread feeling that the exportation of seed should be prohibited.

"By a small investment of capital in floating collectors any one on tide-water could easily raise large quantities of much better, cleaner seed than that which is now procured from the natural beds, and if the laws permitted the sale and transportation of this seed without restriction at the season when the demand exists, it could be sold at a profit for less than the cost of tonging.

"Northern planters could also raise seed for themselves by constructing floating collectors in the warm water of the sounds of Virginia and North Carolina, where the length of the summer would permit several collections to be made in one season. The oysters thus reared are large enough for planting in five or six weeks, and in the latitude of Beaufort there is an abundance of spat from the middle of April to the first of July, and it can be collected until September.

"The method may also be used by planters for collecting their own seed, especially in regions remote from a natural supply. If there are no oysters near to furnish the eggs, a few spawning oysters may be placed among the shells in the collector, after the French method, to supply the 'set.'

"It can also be used for the direct production of marketable oysters, especially over muddy bottoms and in regions where public sentiment does not permit any private ownership of the bottom.

"As food for the oyster is most abundant at the mouths of muddy creeks, where the bottom is too soft for oyster culture by planting or by shelling, this method will have especial advantage in such places, for there will be no danger of sanding or of smothering by mud at the surface, and there is no limit to the number of oysters which can thus be grown on a given area, for the free current of water will bring food to them all.

"The very rapid growth will more than compensate for the cost of the floats, and Mr. Armstrong's experiment shows that, in addition to all these advantages, the oysters are of a better shape, with better shells and more marketable, than those grown at the same place on the bottom.

"Finally, this method will do away with the necessity for a title to the bottom, and will thus enable a few enterprising men to set the example of oyster culture, and, by the education of the community, to hasten the time when wiser laws will render our natural advantages available for the benefit of our people.

"The most economical method of constructing floats must, of course, be determined by practical experiments, but a float constructed by connecting two old ship masts together by string-pieces, with a bottom of coarse galvanized-iron netting, would have sufficient buoyancy and enough resistance to water to support a large quantity of submerged shells and oysters for two or more seasons, and a coating of copper paint each year would protect the timbers from worms.

"The floats should be open at the ends to permit free circulation, and they should be moored in such a way as to swing with the current.

"Engagement in business projects is no part of the office of a university, and I feel that the experiments of the past summer have brought the subject of oyster culture to a point where its further development should be left to the people who are most interested."

It is hardly necessary for me to comment on the preceding further than to say that the results recorded by Professor Brooks prove in the most conclusive manner that the system of spat-culture proposed by me is feasible, and that we are henceforth in a position to guarantee success in the business of oyster culture if rational methods are pursued.

II. Under the title of *Successful Oyster Culture*, Mr. Fred Mather, in the issue of Forest and Stream for October 1, 1885, writes as follows:

"This summer, by direction of Mr. E. G. Blackford, member of the Board of the Commissioners of Fisheries of New York, and in special charge of the oyster investigation, I began some experiments in the artificial propagation of oysters at the hatchery under my charge at Cold Spring Harbor, L. I. The trial was made under two different conditions, and was successful in each.

"One experiment was made in a wooden tank, 12 feet long, 6 feet wide, and 3 feet deep. This was made of 2-inch pine plank, coated with coal-tar, and supplied with sea-water through three half-inch rubber tubes from a reservoir upon the hill, where it is pumped by a hot-air engine. The bottom of the tank was covered with shells and gravel, and shells were suspended on strings across the tank. On the latter there was no 'set,' but on the shells and gravel on the bottom many were caught. The temperature in the tank ranged, from July 8 to August 31, from 69° to 73° Fahr., standing most of the time about 71°, the density of the water being from 1.017 to 1.020, and standing steadily at the latter figure from July 18 to the close of the season named. At that time, September 1, it was necessary to remove the pipes, clean and tar them for the coming work with cod eggs, and the young oysters were removed from the great pond mentioned below. They were then one-fourth of an inch in diameter.

"The other trial was made in our large salt-water pond, which has a large flood-gate to hold the water at low tide, and from which we pump. This pond is some 280 feet long, 125 feet wide, and about 4 feet deep. Ten bushels of scallop (*Pecten*) shells were spread on the bottom and hung on strings. The swimming spat was put in at the flood-gate while the tide was flowing in, and thus scattered over the pond. On September 19 the pond was drawn down and a splendid 'set' was visible, both on the bottom shells and also on those suspended. On the latter there was a set as high as three feet from the bottom, but the lower ones showed more specimens. The following is from the journal kept by my foreman, Mr. F. A. Walters:

"'*July* 1.—Received first lot of oysters; opened 1 bushel; found 17 ripe females and 1 ripe male; took spawn from these. After 9 hours, as there was no sign of life, considered not good.

"'*July* 4.—From one-half bushel, 9 females and 3 males; milt not active; no sign of life after 10 hours.

"'*July* 5.—From one-half bushel, 11 females, 1 male. Three hours after taking spawn young were swimming; put in tank.

"'*July* 9.—Put in tank 3 pans of spawn.

"'*July* 10.—From 200 oysters, 175 were ripe females, 18 not spawning, and 7 partly ripe males; had to lose all.

"'*July* 11.—From 80 oysters, 60 ripe females, 4 unripe males, and 16 not spawning.

"'*July* 14.—Cleaned tank.

"'*July* 16.—Ground gate of salt pond had to be taken out, owing to a leak. Poor tides followed; pond did not fill for five days; could not pump, and consequently no circulation in tank for that time.

"'*July* 20.—Opened 70 oysters; found 20 ripe males, 30 females, and 20 not spawning. Took 2 pans of spawn at 10.20 a. m.; swimming at 2 p. m.; put in salt pond.

"'*July* 22.—Put spawn from 200 in salt pond.

"'*July* 26.—Cleaned tank; could find no set.

"'*July* 28.—Put in pond 4 pans of spawn in good order.

"'*July* 31.—Put in tank 4 pans of spawn, the best lot taken.

"'*August* 11.—Cleaned tank, and put in spawn from 1 bushel of oysters.

"'*August* 20.—Discovered set in tank.

"'*September* 8.—Cleaned tank; found a number of shells and about a peck of gravel with sets on, but all dead. There were no sets on the hanging shells. The reason for this, I think, is owing to lack of current, which should be quite strong; there is more danger of getting too little than too much. Lowered salt pond.

"'*September* 19.—Found a good set; the hanging shells had sets 3 feet from the bottom, but the shells on the bottom did the best.'"

I need not comment upon the preceding paper by Mr. Mather further than to point out that, taken together with the results reported in the preceding paper by Brooks, the first principle of the theory of spat-culture proposed by me is experimentally demonstrated. That principle as first published by the writer in a preliminary account of his new system of spat-culture in Forest and Stream, October 22, 1885, p. 249, is as follows:

"Oyster embryos, under ordinary conditions in open water, diffuse and affix themselves throughout the three dimensions of such a body of sea-water. This is a well-known and readily verifiable fact."

III. I also stated in the paper cited that "The spat of the oyster will grow and thrive with comparatively little light." In further proof of this statement I will take the liberty of relating a very remarkable observation made by Mr. E. G. Blackford, of New York. During the past season he found that the pipe through which the salt water was pumped from the sound to the reservoir on the hill at Cold Spring Harbor, L. I., was stopped up. Upon investigation it was discovered that the occlusion of the pipe was due to young oysters which had affixed themselves to the inside of the pipe, where they had grown until they had closed it up. In the narrow space inside the pipe, where only a very small amount of light could possibly have had access, it hardly seems conceivable that oysters could have thriven; yet, under the very unfavorable conditions above described, the fixation and growth of young oysters actually occurred. This observation has an important practical bearing on the use of cultch in solid masses, as proposed in the body of the foregoing paper.

IV. Very encouraging success has been reported for the season of 1885 from Saint Jerome's Creek. This season, at my suggestion, the suspension of shells and brood oysters a little distance above the bottom was tried there, galvanized-iron wire netting being used, which was suspended upon stringers supported a few inches above the bottom, upon short piles or stakes. On this the shells were spread. This was intended to overcome the difficulties encountered in the utilization of an oozy or muddy bottom, and enable the operators to shake the netting from the surface or from a boat with a boat-hook, in order to shake off any sediment which might gather on the shells used as collectors. Mr. Ravenel, the superintendent, has reported that "sets" have been obtained on all the different kinds of collectors used this season. He also reports that since a freer circulation has been established through the ponds much better success has been had in obtaining a good set of spat.

V. At Wood's Holl a very interesting observation was made this season, demonstrating the ability of the oyster to affix itself to a foreign body the second time, or long after the animal has passed the ordinary spat or first fixed stage of the first year. While the writer was engaged in artificially fertilizing eggs, the small oysters and shells left over were thrown back into the ponds, in which a large series of wooden collectors made of lath was placed near the bottom, resting upon stringers, and weighted down with bricks. One of the small oysters which had been thrown into the pond as described fell upon one of the bricks edgewise. As this oyster grew very rapidly afterwards, and was in a favorable position for fixation, as the margin of the lower or left valve was extended, it for the second time glued itself firmly to the surface of the brick. This is the first instance of the kind which has fallen under my observation. If similar observations have been made by others I am not aware of any published accounts of them. It is therefore deemed very important that this observation should be recorded, inasmuch as it has recently been questioned whether the oyster fixes itself by the left valve at all.

VI. In a late number of Nature, October 22, 1885, p. 597, Mr. J. T. Cunningham, under the caption of "The resting position of oysters," makes the extraordinary announcement that Woodward, Jeffrey, and Huxley were wrong in asserting that the oyster rests on and affixes itself by the left valve. I am now in a position to state with positive certainty that it is invariably the left valve of the fry of the oyster which becomes affixed to a foreign object. I have examined thousands of very young adherent spat, ranging in size from one-ninetieth of an inch to 2 inches in diameter, and have never found an exception to this rule. Besides the positive statements to the same effect made by Huxley and others, I would refer the reader to a brief paper by myself, entitled "On the mode of fixation of the fry of the oyster" (Bull. U. S. Fish Commission, Vol. II, 1882, pp. 383–387); but I must caution the reader that Figs. 3 to 8 were reversed through an unfortunate oversight, as the apices of the umbones of all the larval shells figured on page 387 should be directed to the left instead of to the right side. Otherwise these figures are accurate. This blunder of the artist is pointed out in the explanation to Plate LXXV, where the figures from the above-cited notice are reproduced in my paper entitled "A sketch of the life-history of the oyster," which forms Appendix II to "A review of the fossil ostreidæ of North America,"* by Charles A. White, M. D., and Prof. Angelo Heilprin. In another paper of mine, "The metamorphosis and post-larval stages of the oyster" (Report U. S. Fish Commissioner, Part X, 1882, p. 784), Fig. 2 shows the larval shell L of the young spat in nor-

*Published as part of the Fourth Annual Report of the Director of the U. S. Geological Survey for 1882–'83, 4to, pp. 275–430, and including Plates XXXIV–LXXXII. Washington, 1884.

mal position with the umbo directed to the left. This figure may be advantageously compared, in respect to the points raised here, with the figure of the external anatomy of the adult on Plate LXXIII in my "Sketch of the life-history of the oyster," already cited. Such a comparison will at once demonstrate that the curvature of the umbones of both the larval shell and of the adult is toward the left. This I find to be uniformly the case with the adults, and in the specimen which had affixed itself to the brick for the second time I also find that the rule holds.

Mr. Cunningham's inference that the left valve, usually regarded as the lower one, is really the upper, because he finds worm-tubes and hydroids most abundant on the convex or left valve, is founded upon an imperfect acquaintance with the habits of the oyster; for if living oysters are thrown into the water, they will invariably fall upon the bottom with the left valve downward. If dead oyster-shells (loose valves) be similarly thrown into the water, they will invariably fall with the hollow side up and the convex one down. And, furthermore, both living and dead oysters remain in just the position in which they fall. Dead shells sown as cultch or collectors fall in such a position and most of the spat is caught on the exposed parts of the under surface only of such shells, whereas little is found to grow on the upper surface. The reason for this is, that the sediment which is deposited on the upper surfaces asphyxiates the very young oyster-spat and other larvæ which affix themselves before they can become established and strong enough to resist its effects. The affixed organisms on the exposed, inclined under surfaces of the shells are, on the other hand, protected from the accumulation of sediment.

It is also well known that the right valve of the oyster is always the most deeply pigmented, while the lower or left one is paler. This is always the case when oysters lie almost flat on the bottom. When crowded together on the natural banks on a vertical position there is less difference between the colors of the valves. This difference is obviously due to some influence exerted by the position of the aspects of the body of the animal in respect to the light, the same as in land and aquatic animals generally. I would conclude, for this last reason alone, that the right valve of the oyster is normally always uppermost, were it not for the fact that I have observed all of the stages of transition from the spat to the adult condition in confirmation of such a conclusion. It is true that many young oysters have the right valve looking down when allowed to grow upon cultch or shells which have been sown upon the bottom to favor the collection of the spat; but that circumstance by no means invalidates, as supposed rather hastily by Mr. Cunningham, the observations and conclusions of such cautious and careful investigators as Brooks, Woodward, Jeffrey, Huxley, Horst, and others.

VII. The annual set of spat on the natural banks is remarkably large. In fact, upon a natural bank the number annually removed is very great; yet, if not deprived too entirely of its original stock, it will again be thickly covered with a natural growth in the course of twelve to twenty months. The conditions on the natural banks for spatting are those of the very crowded collectors contemplated in the plan proposed in the preceding pages. Often as many as thirty to forty oysters will be found crowded upon a single square foot of surface. Upon almost every one of these, young spat will be found adherent towards autumn, so that it is not surprising that the bank is so soon regenerated, appearing a year afterward as if it had never been disturbed, as it bristles with its multitudes of densely-crowded oysters, all of which have the hinge end down, and the free ends of the valves directed upward. The luxuriance of the young growth which adheres to the valves of the parent oysters is fatal to many of the latter, inasmuch as they are finally smothered and killed in great numbers by the rapidity of the growth of their progeny immediately above them.

VIII. Where brush of a suitable kind is abundant, it is not improbable that a very efficient and inexpensive system of collectors could be arranged in the system of zigzag canals described above. Such brush should be dry or stripped of its leaves, and consist of bushes tall enough to reach up to low-water level, and with stems long enough below the branches to be thrust firmly and securely into the bottom of the canal in a vertical position. The bottom of the canal might in this way be thickly studded with vertical brush collectors instead of the more elaborate system of baskets. Or the latter might be combined with a system of brush collectors. The wire receptacles might, in fact, be used to supply the spawn to the canal by filling a number of them partly with dead shells upon which living spawners were laid, and the receptacles then placed at intervals of a few feet apart in the canal, with a dense system of brush collectors arranged in the latter as proposed.

With this modification of the system jetties might also be used, as suggested in the body of the foregoing paper.

IX. In the use of the wire receptacles in the canal system, it will be found that the shells with their adherent spat cannot be left in the apparatus with advantage over ninety days. By that time many of the young oysters will have grown to the size of 2 inches across. They will, in fact, range from that size down to a fourth of an inch across. Figures of spat of *Ostrea virginica* of known age were first published by me, indicating the above-noted rate of growth in 1881. Lieutenant Winslow's results were similar, as based on experiments with collectors the season before.

If the young oysters are left too long in the wire baskets, disadvantageous adhesions will be formed with adjacent shells, so that the young spat may suffer injury and be broken when the shells are separated or poured out of the receptacles. A new and permanent place should therefore be provided for the young spat immediately after it is removed from the collecting apparatus. To that end, it would be best to at once plant the cultch, with its adherent spat, upon a good bottom, where it may be allowed to remain until fully grown. Two hundred bushels of shells, covered with a good set of spat, is an abundance of seed for one acre, as the spat will gain at least thirty to sixty times its own bulk in the course of the next four years, at the end of which time it becomes marketable.

X. Professor Lankester has recently published* some investigations upon the subject of green oysters, and has singularly enough overlooked some of the most important contributions to the subject previously published by others; in fact, he has been, in the main, anticipated by the writer by at least four years, as may be learned by reference to the papers cited below.†

He also seems to have been unaware of the researches of MM. Puységur and Decaisne, published five years ago, the first-named of whom, contrary to the assertion of Professor Lankester, published colored figures illustrating the pigment of *Navicula ostrearia* in 1880, in a memoir, of which I give the title in full below.‡

The second point which Professor Lankester claims to have first demonstrated, viz, the occurrence of *Navicula ostrearia* in the intestine of green oysters, was also previously determined by M. Puységur, as may be seen by reference to the paper cited above, or to a translation of the same in the report of the United States Commissioner of Fisheries for 1882, p. 800, as well as a notice of it published in Nature, XXII, 1880, pp. 549–50.

The third conclusion arrived at by Professor Lankester in the summary of his results given at the close of his paper is not borne out by an examination of sections of the gills of the oyster and clam prepared from specimens affected with the peculiar viridity so well known to European epicures; and, moreover, it does not seem probable that cells which are clearly epithelial should wander back into the circulation and collect together in large cysts in the mantle and also lodge in the ventricle of the heart to the number of many thousands, as I have often observed in green oysters; nor does it seem possible to explain the fact of the whole animal becoming green, with the exception of the adductor muscles, as sometimes occurs on Professor Lankester's hypothesis. There is

* On Green Oysters. By E. Ray Lankester, M. A., LL. D., F. R. S. Quarterly Jour. Mic. Science, Nov., 1885, new series, No. CI, pp. 71–94, pl. VII.

† 1. Notes on the breeding, food, and green color of the oyster. Bull. U. S. Fish Commission, I, 1881, pp. 403–419. (This paper also appeared previously in Forest and Stream.)

2. Supplementary note on the coloration of the blood corpuscles of the oyster. Report of the U. S. Commissioner of Fish and Fisheries for 1882, pp. 801-805.

3. On the green color of the oyster. Am. Naturalist, 1883, pp. 87–88.

4. On the green coloration of the gills and palps of the clam (*Mya arenaria*). Bull. U. S. Fish Commission, V, 1885, pp. 181–185.

‡ Notice sur la cause du verdissement des huîtres. Par M. Puységur, sous-commissaire de la marine, Chevalier de la Légion d'Honneur. (Extracted from Rev. Maritime et Coloniale.) Pp. 11, 1 pl. Paris, Berger-Levrault et Cie., 1880.

no objection to naming the coloring principle absorbed by the oyster *marennin;* and, so far as the writer can discover, this is Professor Lankester's principal contribution to the subject, aside from the claim made for the existence of "secretion cells" in the epithelium of the gills and palps. The existence of cells with the function ascribed to them in his paper is, however, rendered even more doubtful by the fact that sometimes a uniform deep, bluish-green tint becomes apparent not only in the epithelium of the gills, but also in the mantle, throughout which the color may be nearly uniform or irregularly distributed in patches, which shade off imperceptibly into areas not affected.

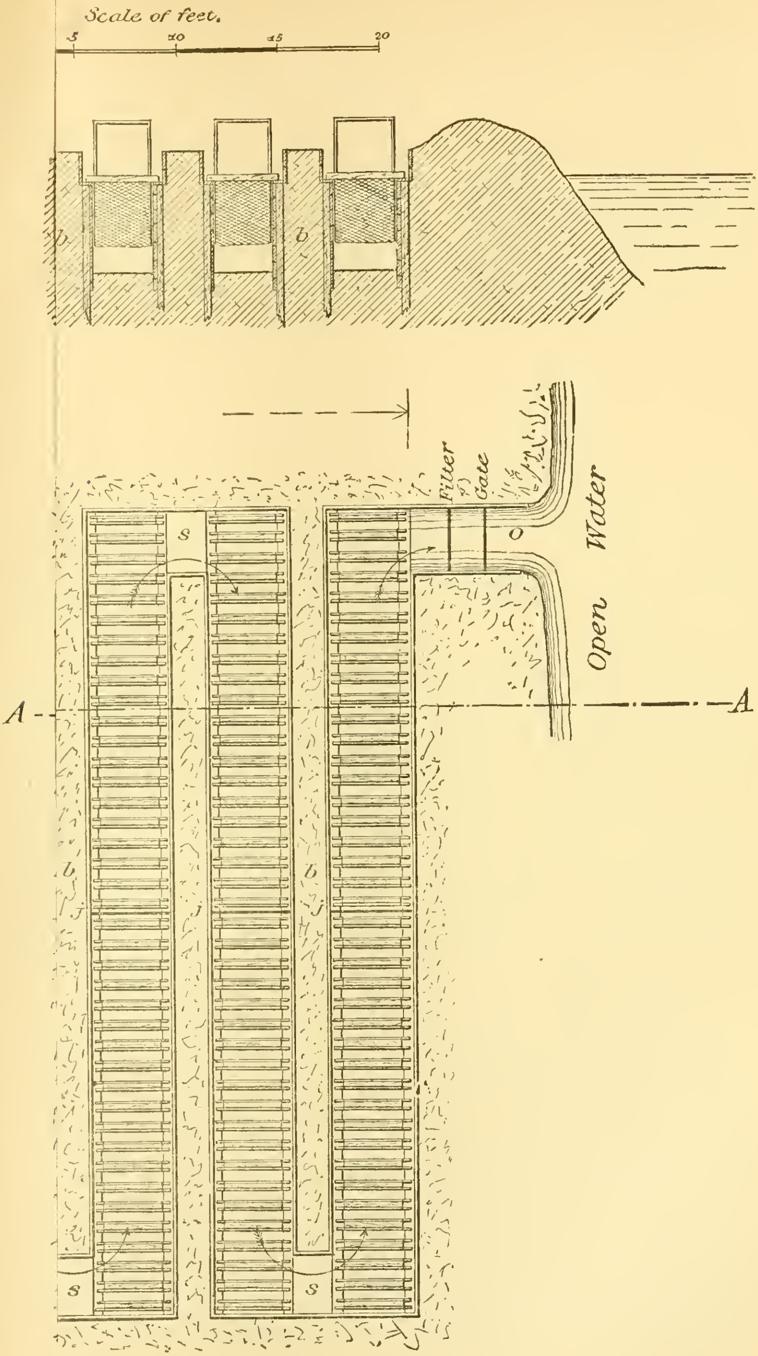
The fact that the green cells found by me in the ventricle are blood-cells admits of no doubt, as I was careful to compare them with the colorless blood-cells of uncolored individuals. That they are quite free is also unquestionable, as they would immediately separate when the cysts or the heart in which they were contained was opened. The view which I have published in my fourth paper on the clam has therefore not been in the least weakened by what Professor Lankester has published; and, while it anticipates him by several months, it likewise, I think, gives a far more probable explanation of the phenomenon.

I might also add that Professor Lankester's spectroscopic investigations brought him to about the same results as were reached by me with a microspectroscope in 1881.

Finally, I must not forget to mention the crucial tests made by MM. Puységur and Decaisne, as they showed that the coloration could be imparted to oysters at will by simply feeding them with *Navicula ostrearia.* They also proved that when oysters colored in that way were deprived of the kind of food whence the color was derived, in a short time they again became white-fleshed.

Ke

PLATE I.


Scale of feet.
5
10
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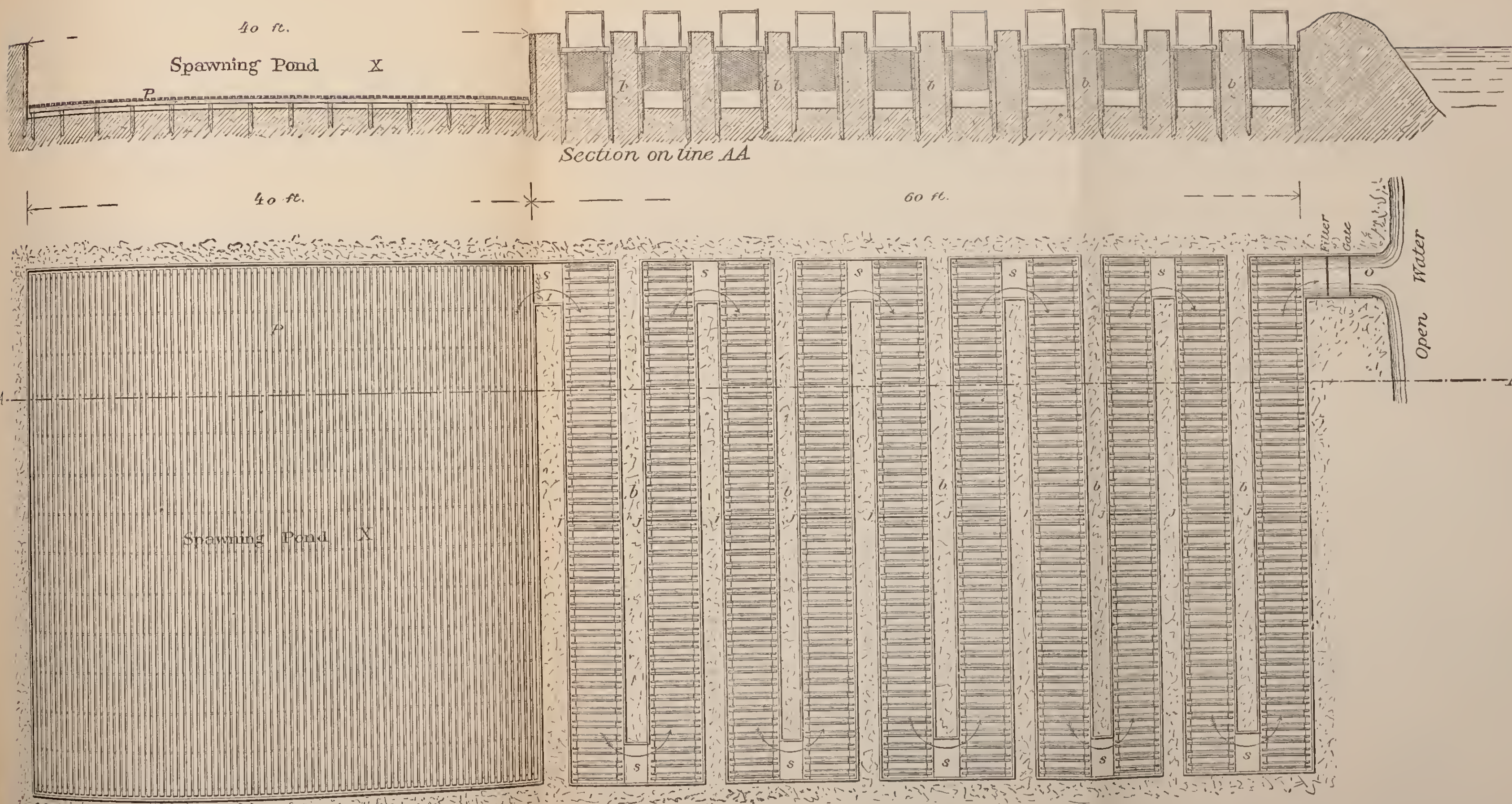
PLAN OF SPAWNING POND AND CANAL SYSTEM

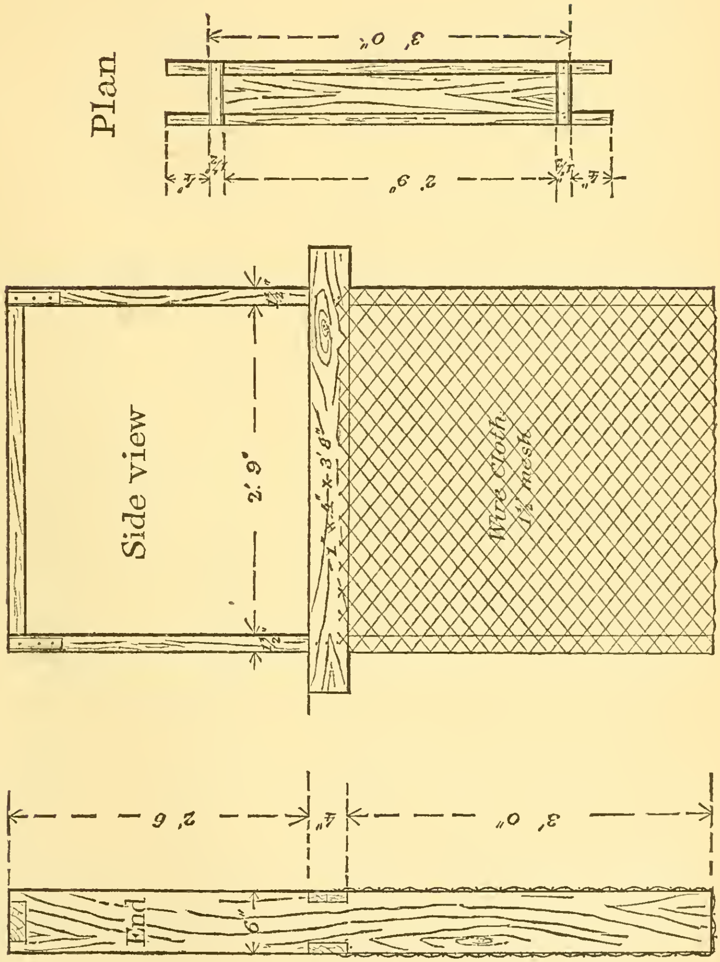
CAPACITY 400 COLLECTORS AND 1200 BUSHELS OF CULTCH.

Designed by John A. Ryder

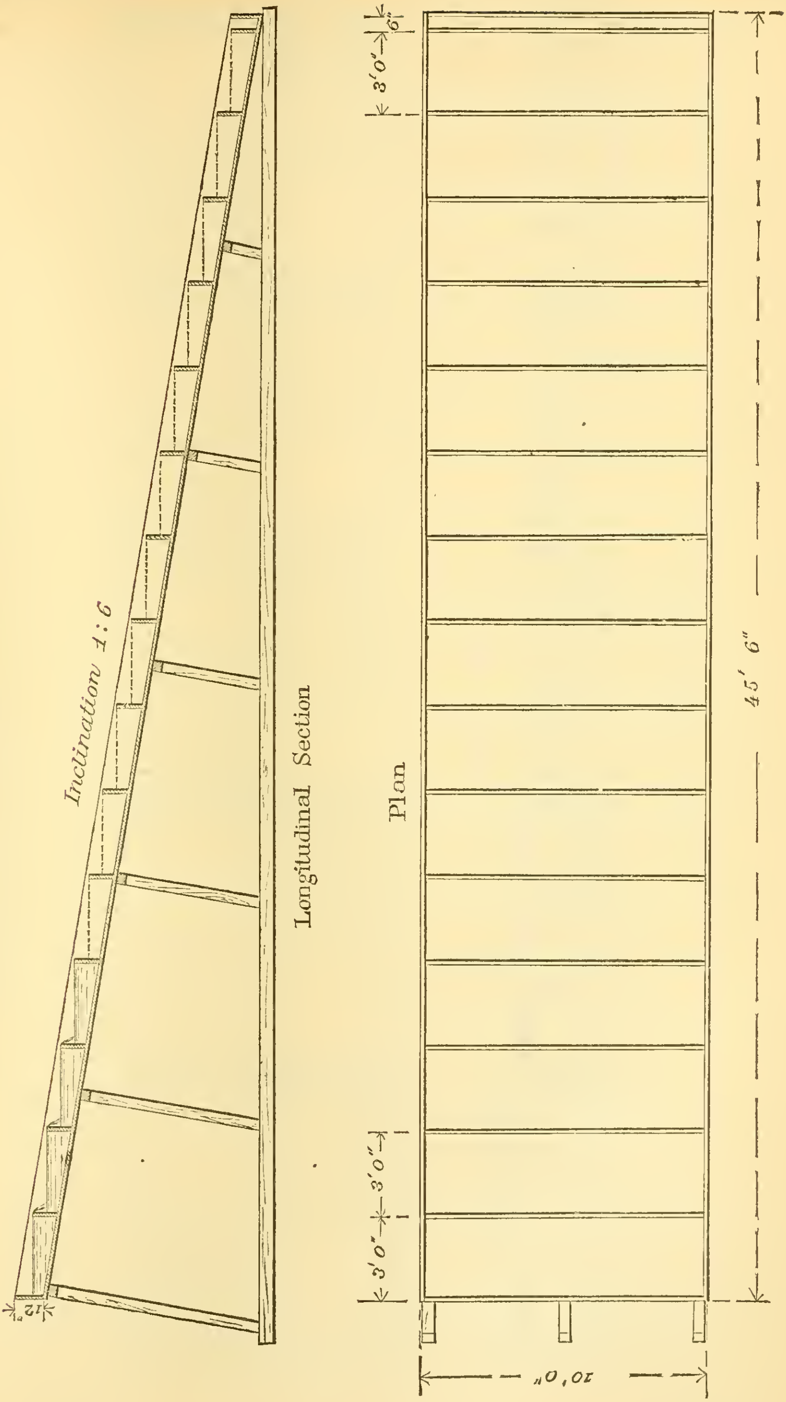
Scale of feet.

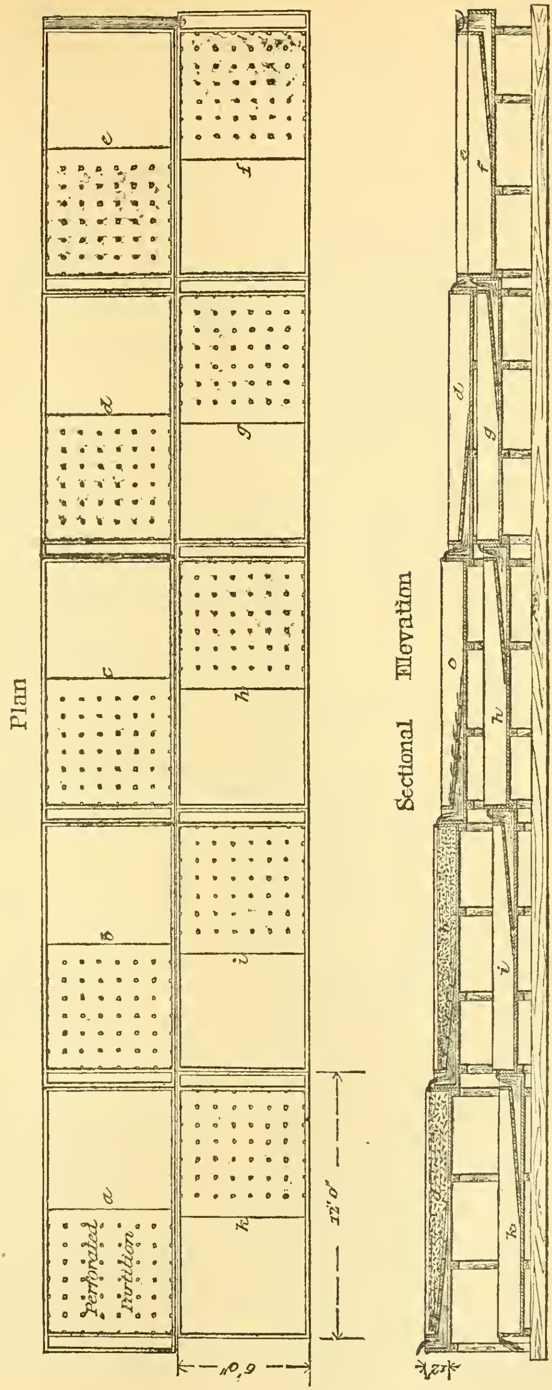


RECEPTACLE FOR CULTCH



INCLINED COLLECTING TROUGH





SERIES OF COLLECTING TROUGHS.

INDEX.

[NOTE.—The references are to page-figures in brackets.]

APPENDIX D.

SCIENTIFIC INVESTIGATIONS.

XIX.—ON THE DEVELOPMENT OF THE CETACEA, TOGETHER WITH A CONSIDERATION OF THE PROBABLE HOMOLOGIES OF THE FLUKES OF CETACEANS AND SIRENIANS.*

By John A. Ryder.

TABLE OF CONTENTS.

INTRODUCTORY.

The acquisition of materials for the prosecution of the study of Cetacean development is attended with difficulties, and the student who is fortunate enough to have access to a rare series of even pretty well advanced embryos, measuring from 1 inch up to 5½ inches long, may well consider how precious and important such materials are at this time, when the study of the development of living forms has taken such a high place as a part of the proper scientific method to be applied by the naturalist to the resolution of questions of affinity and the genesis of extreme structural modifications.

The following notes, interspersed as they will be with reflections

*A very brief and imperfect sketch of the contents of this paper has appeared under the following title: "On the probable origin, homologies, and development of the flukes of Cetaceans and Sirenians." (Am. Naturalist, May, 1885, pp. 515–519.) The development of the mammary glands has also been more fully discussed by me elsewhere, viz, in a paper entitled, "On the development of the mammary glands and genitalia of the Cetacea." (Bull. United States Fish Commission, Vol. V, 1885.)

upon the significance of this or that peculiarity of the external or internal conformation of the different parts of these creatures, as compared with similar or homologous parts in normal mammalia, and in the aquatic *Sirenia* and amphibious *Pinnipedia*, it is hoped may help us to better understand the question of the affinities of these organisms, and perhaps afford us a slightly clearer insight into the method of phylogeny, as its obscure lines converging backwards in time, are here and there brought out a little more distinctly, by some of the conclusions which may be drawn from anatomical and ontogenetic investigations. If the view here advocated, that the flukes are probably the degenerate homologues of hind feet (not the homologues of the whole hind limb, as was held by Gray and even earlier authors) at first seems improbable, such a view may, I venture to think, impress the fair-minded student as being a little nearer the truth than the comparatively modern assumption universally sustained up to the present year by the most eminent of living morphologists, amongst whom must be named Huxley, Flower, Claus, Owen, and Parker, that the hind limbs of *Cetacea* have been totally suppressed or atrophied outwardly, thus leading to the avowed or tacitly admitted conclusion that *the flukes, like the dorsal fin, are appendages which have been secondarily acquired or added to the morphological combination presented by the Cetacean organization*, and are not to be considered as representing, as seems to me far more probable, the last degenerate vestiges of the distal portions of primordially functional hind limbs.

What has led me to the preceding conclusions are the general laws which seem to preside over limb development within the limits of the *Vertebrata*, together with the results of a consideration of the effects of certain degenerative tendencies accompanied by functional changes and adaptations manifested in definite directions, as seen in all Cetaceans, Sirenians, and *Pinnipedia*.

These views have been reached quite independently of any which have been previously expressed to the same or similar effect by other authors, and it was not until I had fully thought over the problem, with such evidence as was then in my possession, that I ventured to express my conclusions to my friend, Professor Gill, who at once agreed with me in the main, and who then stated that he had actually published an opinion upon the subject in a lecture* delivered in the winter of 1882. Professor Gill has also been kind enough to write down for me the following statement of his views: "These characteristic structures are in my opinion derived from greatly hypertrophied integuments of hind limbs analogous to such as are developed, for instance, to the hind limbs of the eared seals, while the osseous elements have been inversely atrophied, pulled forward, and reduced to supports for muscles connected with the organs of generation."

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* Scientific and Popular Views of Nature Contrasted, a lecture delivered in the National Museum, March 11, 1882, pp. 10–11. Washington, 1882, Judd & Detweiler.

It now remains for me to present the data and the conclusions to be drawn therefrom in support of the hypothesis stated at the outset, and in order to render the evidence as conclusive as possible it will be necessary to consider the subject under discussion, first, in relation to the organization of the adult whales, compared with that of the Pinnipedia; secondly, in relation to the modes of development of the marine and land mammals, entering into the discussion of special sets of structures and their bearings upon the questions involved.

I.—The contrasts between the marine, amphibious, and terrestrial mammalia.

(1) *External form.*—As remarked by Huxley, in the *Cetacea* "the form of the body is still more fish-like than in the Sirenia." This is a trait especially well marked in the existing genera *Physalus* and *Leucorhamphus*, in which the caudal peduncle is vertically expanded as in fishes, with high carina on the dorsal and ventral aspects. This fish-like physiognomy is intensified by the development of the median dorsal integument into a rigid fin-like integumentary fold, filled up with tough non-contractile connective tissue, and with adipose cells filling in the meshes between the fibers. There is a superficial layer of very tough fibers just under the integument, which runs parallel with the anterior sloping border of the fin. The medullary fibers are for the most part disposed horizontally and constitute the bulk of its middle or central substance. Blood-vessels, and probably nerves, enter the base of the fin, and transverse its medulla in the plane of the vertical median line of the body, not being evident superficially.

Beyond their outward resemblance they have no morphological likeness to the mobile dorsal fins of fishes, which are actuated by paired muscles derived from the embryonic metameres.

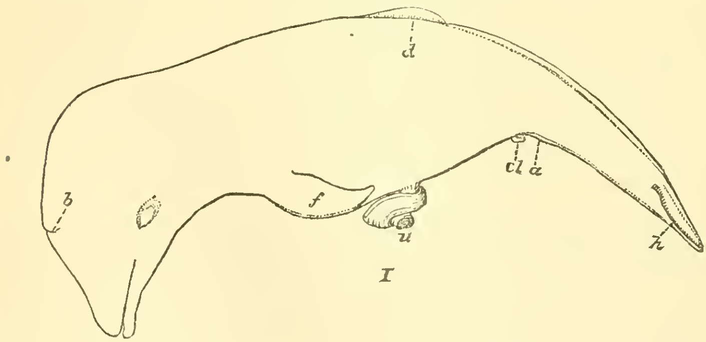
This fin is also of less morphological importance in the organization of the *Cetacea* than the flukes, for, while the latter are never wanting in any known form, the dorsal fin is absent in *Balæna*, *Rhachianectes*, *Agaphelus*, *Neomeris*, *Beluga* and in all Sirenians; rudimentary, or only present as a ridge or as a hump, as in *Megaptera*, *Physeter*, *Inia*, *Leucorhamphus*, *Platanista;* and moderately developed in *Berardius*, *Orcella*, *Kogia*, *Physalus*, and *Sibbaldius*. These facts indicate that the dorsal fin is physiologically of subordinate importance in comparison with the flukes.

It also begins to develop in the embryo only after the flukes are considerably advanced, thus showing that it is an organ which has been acquired after the latter. In some forms there is a carina extending forwards in the embryo as far as the front of the permanent dorsal fin. It is probably by hypertrophy of the anterior part of this carina, which is really a mere integumentary fold, that the dorsal fin of adult cetaceans has been developed.

The fusiform, head, body, and tail combined, is obviously the result of extensive modifications of the original type from which the existing cetaceans have descended. It will be observed that the central axis of the head, trunk, and tail in adult cetaceans, as in fishes, are continuations of each other, that is, the head is not bent downward on the neck, and the latter thrown upwards at an angle to the trunk, and the tail bent downward as in other Mammalia; that this was not the original form of the cetacean body seems to be supported by considerable embryological evidence.

(2) *Affinities of Cetaceans.*—Huxley, with his usual insight into the probable relationship existing between living forms, holds to the opinion that the *Phocodontia* (*Zeuglodon*, &c.), constitute the connecting link between the existing *Cetacea* and the aquatic *Carnivora*, their cervical vertebræ being free and unanchlylosed. The nasal bones, though abbreviated, are longer than those of any other Cetacean; consequently the external nareal opening was more nearly terminal and normal in position than in existing forms. "The scapula appears to have had a spine and acromion like that of manatee." "The humerus is compressed from the side, and has true articular faces upon its distal end, although they are of small size." It is, consequently, to be inferred that there was greater freedom of motion of the antebrachium upon the brachium, and that the flexor and extensor muscles of the forearm were better developed than in the existing species. Others are inclined to doubt the fact that the elbow-joint of *Phocodontia* possessed greater mobility than that of the existing whales. The molar teeth of the *Zeuglodontia* or *Phocodontia* also resemble those of certain Pinnipeds more than they do the posterior portion of the series in any existing Cetaceans.

The embryological evidence is quite as conclusive as the paleontological in favor of the idea that the extremely specialized existing whales and porpoises have descended from at least amphibious, if not terrestrial four-footed carnivorous mammals. As in the embryo of the walrus, nearly 3 inches long, Fig. III, the young porpoise, Figs. I and II, its



I


II

FIG. I.—Female fœtus of some Delphinoid form, from the side, natural size. (N. M. coll. 68-73. Locality not known.

FIG. II.—Tail of the same seen from above.

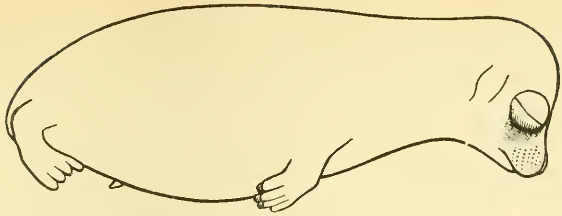


FIG. III.—Fœtal walrus from the side, natural size. After Allen, Proc. Acad. Nat. Sci., Phila., 1880, p. 38. From a specimen obtained by Dr. I. I. Hayes.

head bent downward at an angle with the trunk, and there is a perceptible neck or cervical constriction, indicating, as it seems to me, the affiliation of the two types with each other by descent from a common stem-form in which the head was differentiated from the body by a neck. This conclusion is still further supported by the pronounced fusiform shape of the neck, trunk, and tail combined, as seen in both types of embryos.

The external genitalia are far in advance of the insertion of the hind limb in the embryo walrus when compared with other embryo mammals, as, for example, with the cat, Fig. 14, Plate I, where the external genitalia are visible between the hind limbs instead of in front of them on the median line. It would thus appear that the acquisition of the fusiform or fish-like body so characteristic of *Cetacea* and *Pinnipedia* has entailed a number of changes or alterations in the morphological relations of contiguous parts.

This is shown very forcibly in the development of the tail, which has actually been hypertrophied in the *Cetacea* if the hypothesis that they have had a four-footed ancestry is correct. The tail of some of the existing Cetaceans contains about the same number of vertebræ as that of the sea-otter, *Enhydris*, but the extent to which its vertebræ and muscles have been hypertrophied in the former is nowhere approached within the limits of the *Mammalia*. None of the seals appear to have as many caudal vertebræ as the otters or *Cetacea*, and in the living *Pinnipedia* there is some evidence of caudal degeneracy which has been accompanied by another process, namely, the inclusion of more than half of the caudal segments of the spinal column by the adjacent parts and the integument, so that only the very short extremital portion of the tail is apparent externally.

In *Histriophoca* there are 18 caudals, in the fur seal 7. In many cetaceans they may somewhat exceed 25, including the sacrals, and may even number 35 when the latter are included in the estimate. In *Castor* there are 23, but in this case the segments are depressed and the transverse processes are greatly developed. *Enhydris* has 20 caudals, 24 with sacrals, with only feeble transverse processes as compared with those in the tail of *Castor*, where they are probably dependent upon the special function of the tail for their pronounced development. In the

Cetacea, the transverse and vertical processes (neural and hæmal arches) reach a more nearly equal development respectively, but they are well marked to nearer the end of the caudal series of segments than in other mammals, obviously in correlation with the subdivided tendons and penniform muscular slips into which the vast caudal musculature is broken up in these animals.

(3) *Translocation and inclusion of the hind limbs, and their degeneracy.*—Upon comparing the relation of the hind limbs to the tail in *Fissipedia*, *Pinnipedia*, and *Cetacea*, certain very striking facts are brought to light, the most important being that the limbs grow out and are progressively pushed backwards distally, in the series included by two of the above-mentioned groups, so that while the proximal parts, such as the pelvis and femur, retain their normal position in relation to the sacral region of the spinal column, the bones of the crus and foot are carried backwards, the proximal parts being involved by the contiguous soft parts and lost to sight externally.

This view it will be seen receives support upon comparing the position of the hind limbs of an embryo cat (fig. 14, pl. I) with that of the walrus (Fig. III). While it must be borne in mind that the tail of the walrus has undergone considerable degeneration, the cat has retained the primordial extension of the caudal appendage, but the tail even in this last instance has suffered degeneracy in volume or rather in diameter, and represents a condition which is far more rudimentary than even in the *Reptilia*, caudal degeneracy having apparently begun in the latter and *Amphibia*, unless we except the extremely specialized gephyrocercal fishes, such as *Mola*. The tail of vertebrates in reality represents a part of the body from which the body cavity and digestive canal has retreated forwards, for in all forms, the chorda, medulla spinalis, and mesenteron are at some stage practically conterminous posteriorly.

But even when we leave out of consideration the fact of caudal degeneracy, there is a residuum of other facts indicating that the limbs of pinnipeds have had their proximal parts included and that even in the embryo there is no joint of the leg visible outwardly except the ankle. This has carried the point where the embryonic hinder limb-fold first appears, farther back in relation to the pectoral limb than in the embryos of normally-developing *Carnivora*, of which the cat is the type. While the femur is directed forwards in the Pinnipeds, the crus and the foot are extended backwards, so that the legs become tied backwards, so to speak, by the integument and flesh in front of them. In the cat's embryo the joints of the limbs externally apparent, in an even less advanced one than that of the walrus here figured, are the ankle and knee joints of the hind limb, and there is nothing of that backward inclination of the proximal part of the limb as in the walrus and other Pinnipeds.

It is this backward inclination and inclusion of the proximal parts of the hind-limbs of pinnipeds which gives them an apparently longer trunk, a relatively wider interval between the fore and hind pairs of limbs. The backward inclination of the proximal ends of the hind limbs and their inclusion, together with the anterior part of the tail within or below the integumentary organs, also favors the development of the fish-like or fusiform aspect of the backwardly tapering thorax and abdomen, which will be intensified just in proportion as this process is carried to an extreme, as it seemingly has been in the *Cetacea*.

To generalize from what the foregoing data tend to show, it may be said that, in normal *Carnivora* there has been no tendency to include the femoral and crural parts of the hind limbs together with the tail, whereas there has been such a tendency in the Pinnipeds, leaving only the tarsal and pedal parts of their hind limbs exserted, so that the primary horizontal limb-folds have in consequence grown out farther back than in the embryos of terrestrial mammalia. In other words, the exserted terminal part of the hind limb of the pinnipeds has been translocated backwards in consequence of the process just described; which involves the inclusion of the proximal parts of the limb; this is the reverse of the process involved in effecting the translocation of the pelvic limbs of physoclist fish embryos, in which the shifting is sudden and occurs in another way, as may be gathered from my notice* calling attention to this singular phenomenon. The type which presents the morphological differentiation, and which would constitute it a connecting link bridging the condition between the existing position of the representatives of the hind feet, viz, the flukes in whales and the pedes of pinnipeds, has been entirely lost, yet there are existing data which support the conclusion that the flukes represent integumentary limb-folds, which have, by the method of development now known to be operative in the case of pinnipeds, been led to grow out ontogenetically far remote from and posterior to their archaic position on the sides of the tail instead of on the sides of the body. The flukes of whales, which I chose to regard as the representatives of hind-feet, according to hypothesis, have been translocated backwards over a wide interval, but no more extensively than have the pelvic limbs of certain extreme forms of physoclist fishes when that pair in the latter is compared in respect to position with its archaic place in the normal and unspecialized Physostomes.

(4) *Flower on the affinities of the Cetaceans.*—While Flower has not committed himself so far as to specify precisely the form from which the *Cetaceans* have been evolved, it seems to the writer that the difficulty of deriving their type of tail from that of a seal-like form which seems to him so insuperable is not so much so as he thinks, but I will let him speak for himself:

* On the translocation forwards of the rudiments of the pelvic fins in the embryos of physoclist fishes. (Am. Naturalist, XIX, 1885, pp. 315–317.)

"The steps by which a land mammal may have been modified into a purely aquatic one are clearly indicated by the stages which still survive among the *Carnivora*, in the *Otariæ* and in the true seals. A further change in the same direction would produce an animal somewhat resembling a dolphin, and it has been thought that this may have been the route by which the cetacean form has been developed. There are, however, great difficulties in the way of this view. If the hind limbs had ever been developed into the very efficient aquatic propelling organs they present in the seals, it is not easy to imagine how they could have become completely atrophied and their function transferred to the tail. It is more likely that the whales were derived from animals with long tails, which were used in swimming, eventually with such effect that the hind limbs became no longer necessary. The powerful tail, with its lateral cutaneous flanges, of an American species of otter (*Pteronura Sandbachii*) may give an idea of this member in the primitive Cetaceans."*

Professor Flower has since reiterated the preceding views with more emphasis, as follows:

"One of the methods by which a land mammal may have been changed into an aquatic one is clearly shown in the stages which still survive among the Carnivora. The seals are obviously modifications of the land Carnivora, the Otariæ or sea lions and sea bears, being curiously intermediate. Many naturalists have been tempted to think that the whales represent a still further stage of the same kind of modification. So firmly has this idea taken root that in most popular works on zoology, in which an attempt is made to trace the pedigree of existing mammals, the Cetacea are definitely placed as offshoots of the Pinnipedia, which in their turn are derived from the Carnivora. But there is to my mind a fatal objection to this view. The seal, of course, has much in common with the whale, inasmuch as it is a mammal adapted for an aquatic life, but it has been converted to its general fish-like form by the peculiar development of its hind limbs into instruments of propulsion through the water; for though the thighs and legs are small, the feet are large, and are the special organs of locomotion in the water, the tail being quite rudimentary. The two feet applied together form an organ very like the tail of a fish or whale, and functionally representing it, but only functionally, for the time has, I trust, quite gone by when the Cetacea were defined as animals with the 'hinder limbs united, forming a forked horizontal tail.' In the whales, as we have seen, the hind limbs are aborted, and the tail developed into a powerful swimming organ. Now it is difficult to suppose that, when the hind limbs had once become so well adapted to a function so essential to the welfare of the animal as that of swimming, they could ever have become reduced and their action transferred to the tail. The animal must have been in a too helpless con-

*W. H. Flower, Article Mammalia, Encycl. Brittan., 9th ed., 4to, vol. xv, p. 394. Edinburgh: Black, 1883.

dition to maintain its existence during the transference if it took place, as we must suppose, gradually. It is far more reasonable to suppose that whales were derived from animals with large tails, which were used in swimming, eventually, with such effect that the hind limbs became no longer necessary, and so gradually disappeared. The powerful tail, with lateral cutaneous flanges, of an American species of otter (*Pteronura Sandbachii*), or the still more familiar tail of the beaver, may give some idea of this member in the primitive Cetacea. I think that this consideration disposes of the principal argument that the whales are related to the seals, as most of the other resemblances, such as those in the characters of their teeth, are evidently analogous resemblances related to similarity of habit."*

(5) *Another view of the phylogeny of cetaceans.*—I do not assert that the hinder limbs are united to form a forked horizontal tail; what I do assert is that, in consequence of the rotation and extension backwards of the hind limbs of a type in which the hind limbs were thus thrown back parallel with the tail and included by the integument of the body, these limbs were rendered more or less immobile, as a result of which the limb skeleton, its muscles and the pelvis have atrophied, leaving, however, the integuments of the feet in a posterior position on either side of the end of the tail as the rudiments of flukes. This, I submit, is to me a far more reasonable hypothesis than any which derives the flukes from an entirely different source, viz, the cutaneous flanges of the tail of the sea-otter.

The argument that "the animal must have been in a too helpless condition to maintain its existence during the transference if it took place, as we must suppose, gradually," can be met by citing the seals themselves, animals which certainly are somewhat helpless on land, yet remarkably graceful and active in the water. The *Cetacea*, on the other hand, are quite helpless on land, but certainly not in the water, the medium in which this gradual transference of function must have occurred after the hind limbs became more and more useless as a means of progression on land, when such a Protocetacean form would not again venture upon the latter. It is thus rendered evident that Professor Flower's arguments are not as insuperable as they at first appear.

While the otters have the required number of caudal vertebræ which would fit them to represent in that respect the type from which the cetaceans have descended, the assumption that the lateral integumentary ridges on the tail of *Pteronura* might be exaggerated by gradual evolution into the huge flukes of a *Megaptera* or *Balæna* is, to say the least, far less satisfactory than the hypothesis that these structures are the representatives of once functional feet. Moreover, the first traces of the flukes of *Cetacea* do not at first appear ontogenetically, as they

*Whales, past and present, and their probable origin. Nature, XXVIII, 1883, p. 229. From a lecture delivered before the Royal Institution, May 25, 1883.

ought to, as longitudinal ridges or folds extending the whole length of the tail, as in *Pteronura*, *but as short, lateral, integumentary, ridge-like folds, very like limb-folds in normal types*, and very near the tip of the tail of the embryo; these folds also gradually grow out as rounded lobes, finally becoming acuminate. How little the mode of development of the cetacean flukes resembles the adult condition of the tail in the margined-tailed otter may be gathered from the following extract, descriptive of that organ in *Pteronura*, from a paper by J. E. Gray.* On *p.* 65 (*l. c. infra*) it is stated: Tail conical, tapering, rather depressed, covered with short hair and furnished with a subcylindrical prominent ridge on each side; end more depressed, two-edged, and fringed at tip.

I frankly admit, however, that the following question may be very pertinently asked by those disposed to dispute the validity of my conclusion that the flukes of *Cetacea* and Sirenians represent the feet of terrestrial mammalia; that is, "Why is it not as reasonable to suppose that the flukes may not have arisen as lateral dermal folds in the same way that the high, falcate dorsal fin of *Orca* has been unquestionably developed?" To this I have already in part replied by showing in the first place that the dorsal fin of cetaceans is not always developed, and, secondly, that when present it is always developed, so far as we know, after the flukes have been formed as lateral folds. I may therefore pertinently put the following question for objectors to my hypothesis to answer: "Why is it that the flukes are always present, and always in a lateral position, or approximately in the place of a limb laterally, and why there is not only very often a correlation in size but also of form between the fore limb and the flukes of such types as *Megaptera* and *Rhachianectes*?" And, finally, why is it that the flukes, as a rule, exceed the fore limb in size, if such fact does not indicate that the flukes have been derived from the integuments of a pes which has been developed in an ancestral form, as in the existing pinnipeds, to dimensions generally in excess of those of the manus? Another query it may also be interesting for objectors to my hypothesis to settle, viz, the variable position of the dorsal fin in respect to the paired appendages of cetaceans, showing that it grows, as I have asserted, from some part of an extended dorsal integumentary fold, as attested by the observed facts of development, as well by its extreme anterior position in *Globiocephalus* and *Orca*, and its posterior one in *Sibbaldius* and *Berardius*. Lateral carina are, on the contrary, never found in front of the base of the flukes of cetacean embryo, these organs always developing from short lateral folds at the sides of the end of the tail. Such lateral caudal carina are also absent in the adult, judging from the casts in the U. S. National Museum.

The caudal median notch posteriorly between the bases of the flukes is also developed only after the flukes are fully formed in the embryo,

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* Observations on the margined-tailed Otter. (Pteronura sandbachii.) Proc. Zool. Soc., London, 1868, pp. 61–66; Plate VII.

in which the tip of the tail forms a perfectly round, sometimes slightly exserted hemispherical tip beyond the hinder end of the growing fluke folds before the latter have lost their rounded or lobate form. This notch between the flukes I regard as representing in the hind limb both the posterior axillary notches or re-entering angles behind the bases of the fore limbs in *Cetacea*. It represents the interval between the edges of the displaced and degenerate pedes, and not the perineum which has been left far in advance of the flukes, owing to the manner in which the pedal rudiments have been carried backwards in the course of the progress of the degeneration of the proximal parts of the limbs due to inclusion, and the gradual hypertrophy of other parts. The tail has therefore assumed the function of the hind limbs in the cetaceans, and although no longer available as an organ of locomotion on land, as are the hind limbs of pinnipeds: it is strange that the forces of Nature, which have obviously been tending to the same end in the latter as in the former, should have had to evolve, according to the old view, a new organ when through natural processes of degeneration in one direction, coupled with hypertrophy in another, an old one could be transformed into the structure demanded by new conditions.

The partial loss of the ungues in the pes of pinnipeds has been replaced by a condition in which they are completely absent in the flukes of the cetaceans and sirenians, the hairless pedal integuments extending in the first far beyond the nails. This hairless and nailless condition of the cetaceans is doubtless correlated with habit, and has begun to manifest itself on the limbs of pinnipeds, in fact has been almost completely attained by the nearly nude walrus, the simple teeth of which are also not to be left out of account in this comparison.

(6) *Anatomical and embryological data.*—Huxley, with his usual sagacity, has told us by implication in language of inimitable clearness, in speaking of the structural characters of the Pinnipeds, what are some of the morphological changes suffered by these animals in the course of their evolution. Although in part almost a restatement of what has been already said, I may be pardoned for quoting the observations of so eminent an authority. He says, * "The *Pinnipedia*, or seals and walruses, are those *Carnivora* which come nearest the *Cetacea*. The tail is united by a fold of skin which extends beyond its middle, with the integument covering the hind legs. These are, in most species, permanently stretched out in a line with the axis of the trunk." The English anatomist was obviously impressed by the inclusion by integument of the femoral and crural parts of the hind limbs, together with the tail, as seen in Pinnipeds.

Huxley then proceeds (*l. c.*): "The toes are completely united by strong webs, and the straight nails are sometimes reduced in number, or even altogether abortive. The inner and outer digits of the pes are very large."

* Anatomy of vertebrated animals, p. 359.

The more or less complete abortion of the interdigital emarginations in the manus and pes of pinnipeds has been quite completed in the cetaceans; the digits themselves having become in the latter much prolonged in the anterior limbs in which they have also acquired an increased number of often very short phalanges, sometimes as many as nine or even more in the second and third digits. This condition is, however, probably an adaptive structure, evolved in consequence of the acquisition of additional segments necessary when they first permanently took to the median in which they now live and through which they move. The tendency to abbreviate the mobile part of the limbs and shorten the segments is manifest in the construction of the limbs of almost all the fishes of the group *Lyrifera*, in which it has also been necessary, as in the whales and pinnipeds to shift, the insertions of the flexor and extensor muscles outward upon the more distal elements, so as to render them physiologically more effective. In most of the *Lyrifera* the muscles which move the fins have the most peripheral insertion of any to be found within the limits of the *Vertebrata*, or upon the proximal ends of the many-jointed rays shown by me to develop beneath the epidermis from coalesced rods or primitive unjointed rays, just as the limbs of the higher *Vertebrata* at first develop with an unjointed bar of cartilage extending through their central axes.

While traces of interdigital emarginations are visible in the fore limb of cetacean embryos they are much more distinctly visible in the embryos of pinnipeds where they are better developed than in the adult of the latter, the meaning of which facts will be clear to the evolutionist.* The increase in the number of phalangeal segments, however, begins abruptly in the cetaceans; in most forms the middle digits contain more than the number three, normal to the mammalian class, so that the whales and porpoises are, in this respect, very different from the pinnipeds. But it must be borne in mind that there are at least two precedents of this kind which occur within the limits of the *Reptilia* which have apparently, like the cetaceans, been modified for an exclusively marine or aquatic existence; these are the *Plesiosauria* and *Ichthyosauria*. As many as nine phalanges are found in a single digit of the pes of the first type, and twenty-six in the third digit of the manus of *Ichthyosaurus intermedius*. These forms seem indeed to have represented the existing Cetaceans in the seas of the Mesozoic ages.

This parallel is rendered still more striking when we recall the circumstance that in *Ichthyosaurus*, as in Cetaceans and Sirenians, the pelvis is not connected with the spinal column, and that it has evidently undergone considerable degeneration, but in *Ichthyosaurus* there has been no shifting of the distal part of the hind limb backwards, as in Pinnipeds and Cetaceans. The hind limb derived, in *Ichthyosaurus*, from that

* Irregular emarginations are noticeable on the hind margin of the flukes of *Megaptera*. According to Eschricht such irregular emarginations are visible along the posterior border of the flukes of an advanced fœtus of a species of this genus.

of a short-limbed reptilian type, resembling the crocodile, evidently could not be permanently extended backwards by inclusion together with the tail to such an extent as happened in the case of the cetaceans through the intermediation of a form approximating that of the *Pinnipedia*, with rather elongated hind limbs.

Ichthyosaurus may also serve to throw some light upon the genesis of the dorsal fin of Cetaceans, if it is true, as surmised by Huxley (Anat. Vertebrated Animals, p. 208), that there is some reason to suspect that it had a vertical dorsal fin-like expansion of the integument of the tail. Traces of such a structure are present in the dorsal and ventral integumentary carina of the tail of the *Crocodilia*. By local hypertrophy such a fold might, by having mesoblast proliferated from within, have its dimensions increased, but even if the process so far resembled the early stages of normal limb-formation, one could not legitimately infer for that reason that the flukes of the Cetaceans were structures of the same nature as the dorsal fin, namely, a mere integumentary fold, such as we have grounds for suspecting was evolved in *Ichthyosaurus* from an antecedent type with an extended dorsal, caudal fold, as it has been shown, on the basis of the comparison of generic types and embryos, must have been the case in Cetaceans, so that in both the reptile and mammal the dorsal fin was developed as a new structure, or was developed through reversion out of one which had been inherited from the more remote lyriferous or amphibian types, which had continuous dorsal and ventral median fin-folds, but which had no relation whatever to paired limbs.

The same immobility of the phalanges of *Ichthyosaurus* upon each other and the excessive abbreviation of the humerus, ulna, and radius, which must have involved the suppression of the finger muscles, are characters which the limbs of this reptile must have possessed in common with the fore limbs of Cetacea, but these characters obviously indicate no relationship, but rather that environing conditions of a similar nature have led to the production of very similar degrees of morphological differentiation in these two types otherwise totally unrelated.

(7) *The genesis of extra phalangeal elements in Cetacea.*—Upon making an examination of the limbs of pinnipeds it is found that in *Eumetopias* and *Callorhinus*, for example, the ungual phalanges consist of two parts, namely, a short proximal osseous part, to which the nail is attached, and a very long distal part composed of cartilage which is extended beyond the nail into the produced marginal integumentary folds of the manus and pes. A careful examination reveals the fact that the osseous portion of the ungual phalanx is actually prolonged as cartilage as above described. This cartilaginous extension of the ungual phalanges, I take it, has afforded the basis, in some ancestral seal-like form, for the development of an increased number of digits beyond the ungual phalanx, as in *Cetacea*. Let such a cartilaginous extension of the ungual phalanges become segmented, and then have ossific deposits laid

down in the center of each additional segment so formed, we would have phalanges produced in excess of the number found in the digits of normal forms. Upon comparing this hypothetical method of the evolution of the supernumerary phalanges in the digits of the manus of cetaceans with what actually happens during development in the latter, it is found that the actual development favorably countenances the hypothesis.

The terminal or distal phalanges in Cetaceans while they are indicated by segments of cartilage very early, as will be seen by the fœtal manus represented on Plate II, by fig. 17, ossify from centers which actually appear enchondrally much later than those of the proximal phalangeal joints, as minute round ossific nodules in the middle of the cartilaginous segment. These nodules or nuclei of the osseous terminal phalanges also diminish in size from within outwards. It would therefore seem that the supernumerary terminal phalanges of the cetacean manus develop last, which is in conformity with the hypothesis.

(8.) *The muscles of the limbs of seals and the vessels of the flukes of Cetaceans.*—The hind limbs of the pinnipeds and *Ichthyosauri*, however, retained their capabilities of movement through a special arrangement of muscles arising from the axial skeleton and inserted mainly into the middle third of the skeleton of the limbs. While there has been a considerable shifting peripherad of the insertions of the muscles in the former there has been a tendency for the whole hind limb to diminish in size in the latter type and no tendency towards the complete atrophy of the distal part of the appendicular skeleton and musculature of the hind limb as in Cetacea, in consequence of which in the latter the fluke or distal part of the hind limb has become a mere rigid hollow lateral diverticulum of the integument, filled with fibrous tissue and possessing no mobility distinct from that possessed by the tail as a whole. In short, the degeneracy of the hind limbs of Cetaceans is complete and presents the unexampled condition of part of a limb permanently developed in the adult to a stage which is practically comparable to a transient condition in the embryo when the limb fold is filled with undifferentiated mesoblastic cells. These folds, as the flukes, however, approximate the form of the distal half or two-thirds of the fore limbs, from which the skeleton has vanished together with the muscles, tendons, and nerves appertaining to them, the normal mammalian arrangement of the vessels and nerves being approximated by a superficial dorsal and ventral system which is not at first sight so obviously homologous with the vessels and nerves of the typical mammalian hind limb. The vessels are arranged in about ten dorsal and eleven ventral pairs just below the integument of the fluke. The fourth pair reckoning from the front is most strongly developed and extends to the tip of the fluke, giving off smaller branches on either side from its distal two-thirds. These secondary branches carry the blood supply to the tips of the flukes. The other ten pairs of vessels sent into the base of the fluke, three in front of the main vessel and seven behind it, are short and only pass out to about as far as the basal third of the fluke. In all there are 42 vessels supplying the flukes, 21 to each side, and they correspond only partially with the number of vertebral segments, of which as many as fifteen may be included between the bases of the flukes of opposite sides. This is the arrangement in *Phocæna*, and it is doubtless similar in other forms. The superficial and not axial position of the vessels is a striking peculiarity and is very different from the arrangement of the blood supply of the dorsal fin, as elsewhere described.

The arrangement of the vascular supply of the flukes thus affords a strong argument in favor of the view which I have defended, viz, that the flukes are the homologues of feet and not special lateral integumentary outgrowths. On the hypothesis that the flukes are mainly homologous with a pes, or perhaps the digital part of a pes, there *ought* to be about ten vessels present on the dorsal and as many on the ventral side of the flukes representing the paired interdigital arteries, of which there are two pairs to each digit in the manus, as well as pes of normal mammals. In the foot of the latter these arise from the dorsalis pedis on the dorsal side and from the external and internal plantar artery on the ventral side. This close correspondence between the normal number of dorsal and ventral interdigital arteries in normal forms and those found in the flukes of *Cetacea* is, to say the least, suggestive, though it must be admitted that it cannot be proved that they arise in the *Cetacea* from the femoral and popliteal continuations of the external iliac, but have acquired a new origin from the caudal continuation of the aorta and its dorsal branches serially homologous with intercostal arteries anteriorly.

The arrangement of the principal and deeper vessels of the manus of *Phocæna* I have not investigated, but it has struck me as being very remarkable that the distal third of the manus should be supplied by longitudinal vascular trunks lying between the second and third digits, these trunks giving off lateral twigs on either side to supply the whole of the terminal third of the flipper or manus, just as the distal two-thirds of the flukes are supplied by the long fourth dorsal and ventral arterial trunks, which, like the distal trunks in the former, give off lateral twigs, which run to the anterior and posterior borders of the flukes. This arrangement of vessels in both seems to me to indicate more than a mere analogical resemblance; that, in fact, the two principal trunks of the fluke are the interdigital vessels which were most strongly developed alongside of the longest, probably the second digit of the pes, before the phalanges of the others began to atrophy.

Murie* figures the principal superficial ventral vessel of the flukes of *Globiocephalus*, but does not show the accessory shorter ones running parallel with it in front and behind its proximal end. Here, as in *Pho-*

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* On the organization of the Caaing whale, *Globiocephalus melas*. Trans. Zool. Soc. London, VIII, 1874, pp, 235–301 (fig. 58, pl. 36).

cœna, these arteries are probably accompanied by veins, which run parallel with the arteries of the flukes. In *Globiocephalus*, according to Murie's figure, this principal vessel gives off lateral branches nearer its origin than in *Phocœna*, and its proximal end is turned forward as though connected laterally or at the side of the vertebræ of the tail with branches given off by the median inferior caudal continuation of the aorta.

In the memoir cited above (p. 269) Murie also disputes the conclusion of Hunter and others that the abdominal aorta does not send off any external iliac branches. The arrangement which he described in the female *Globiocephalus* seems to be similar to that found in *Phocœna*. The common iliac after giving off the hypogastric divided into what he regarded as external and internal iliac arteries. The external, immediately beyond its origin, split and sent rami to the parietes of the abdomen and genital parts. Its other main branch passed beneath the os innominatum and interpelvic facia or ligaments and there broke up into several diminutive channels; some of these were distributed to the pubo and ilio-coccygens muscle; others with a nerve pierced the interpelvic fascia at the notch, just behind the anterior capitulum of the bone. Beyond this, in consequence of the complete atrophy of the functional parts of the limb, viz: femur, tibia, bones of the pes and the muscles which actuate them, one would not expect to trace these vessels so that the flukes would seem to get their blood supply from another source through secondary adaptation, as has in fact been already stated.

(9) *The digits of pinnipeds and cetaceans.*—As in the seals the digits of the manus of Cetaceans diminish in length from within outward, that is, from the second to the fifth, the first digit or that corresponding to the thumb being anterior and exterior, so that the fore limb is permanently prone and is rotated backwards, as are the hind limbs of the former. There is, however, an even more interesting correspondence between the form and structure of the fore limb and the flukes, as seen in *Phocœna*, in which the layer of blubber extends out under the skin investing the manus for something more than one-half of its length from the base outwards. In the flukes, on the other hand, no blubber is found; in fact, the layer of fatty tissue bearing that name does not extend even as far as their anterior borders, ceasing beneath the integument covering the caudal peduncle, considerably in advance of the flukes.

The subdermal coating of blubber which invests the fore limb is interposed between the degenerate tendons of the finger muscles and the skin, whereas in the hind feet or flukes the superficial stratum of longitudinal tendon-like bundles of fibers lie immediately under the integument. These superficial tendinous bundles in the flukes I have elsewhere spoken of as possibly representing the degenerate system of the flexor and extensor tendons of the pes, though I am aware that a similar arrangement is found in the dorsal fin when it is developed, in which there is, however, no connection or close relation with the tendinous insertions of any muscles whatsoever, such as is the case in the flukes. The muscular connection of the flukes is indirect; that is to say, the tendons of the supra- and infra-caudal muscles send only a small portion of their fibers into the flukes, yet even this is a condition which contrasts very sharply with the relations of the superficial tendinous fibers of the dorsal fin, which have absolutely no connection with any muscles either directly or indirectly.

(10) *The nervous supply of the flukes of Cetaceans.*—The sensory nervous supply of the flukes has a distribution slightly deeper but similar to the vessels, and is derived from the four great lumbo-caudal cords,* which represent the lumbar plexus of normal *Mammalia* extended backwards into the tail. In my own dissections I have found it difficult to make out more than two or three pairs entering the anterior basal part of the flukes, and these arise from the dorsal pair of cords dorsally, and from the ventral pair ventrally. There are, doubtless, other smaller pairs behind those found by me, but the excessive toughness of the fibrous tissues in their vicinity has rendered the determination of their number a difficult undertaking. The nervous supply is obviously not derived from the continuation of a homologue of the great sciatic as in normal *Mammalia*, unless, as seems probable, it would be possible to trace the terminal fibers of the great caudal plexus as the homologue of those of the terminal part of the great sciatic trunk of normal forms. This aspect of the question under consideration must, however, be viewed in another connection, but it may not be amiss to now point out the fact that the four cords found to enter into the lumbo-caudal plexus of Cetaceans are represented by structures which, even in so highly a differentiated organism as man, may be homologized with what is found in the *Cetacea*. The dorsal cord in the latter is represented in man by the posterior branches of the lumbar and sacral nerves, the ventral cord by the anterior lumbar and sacral. While the ventral system is mainly developed in man in correspondence with the massive and essentially ventral musculature of the pelvic limbs, on the contrary, the dorsal and ventral systems are about equally developed in the cetaceans, in consequence of the fact that functional hind limbs have been aborted in the latter, while the dorsal and ventral caudal muscles have been more posteriorly developed, and have acquired about equal volumes, a condition which has called for an equally-developed nerve supply for both the upper and lower set of hypertrophied caudal muscles.

(11) *Translocation of muscular insertions in hind limbs.*—The manner in which the limbs of pinnipeds have been bent backwards has already been considered, but the remarkable shifting backwards of the muscu-

* These were first described by D. J. Cunningham, Journ. Anat. and Physiol., XI, pp. 209 to 228, Plate VII, the title of his paper on the subject being "The spinal nervous system of the porpoise and dolphin."

lar insertions of the muscles of the hind limbs of these animals must now be considered in its bearing upon the question of the evolution of the Cetacean type.

In *Phoca vitulina*, Huxley* observes that "the fore limb is buried beyond the elbow in the common integument, but the flexible wrist allows the weight of the body to be supported by the palmar surface of the manus. The hind limbs, on the contrary, are permanently extended and turned backward parallel with the tail, which lies between them, and with which they form a sort of terminal fin. When the seal swims, in fact, the fore limbs are applied against the sides of the thorax, and, the hinder moiety of the body being very flexible, the conjoined hind limbs and tail are put to the same use as the caudal fin of a cetacean. The seal has twenty dorso-lumbar vertebræ, of which five are lumbar. There are four sacral vertebræ, but only one of these unites with the ilia. Eleven vertebræ enter into the formation of the short tail."

(*Op. cit.*, p. 362.) "The ilium is short, and the long pubis and ischium are greatly inclined backward, so that the long diameter of the *os innominatum* makes only an acute angle with the spine. The femur is much shorter than the humerus. The tibia and fibula are anchylosed, and more than twice as long as the femur. The pes is longer than the tibia. The astragulus has a peculiar, roof-shaped, tibial surface, and sends a process backward which contributes to the formation of the very short heel. The hallux is the strongest of the digits; while this and the fifth digit are the longest of those of the pes.

"The cutaneous muscle is largely developed and inserted into the humerus. The *pectoralis major* is very large, and arises from each side of the prolonged manubrium, and even in front of it, beneath the neck; the fibers of the muscles of opposite sides are continuous. The *palmaris longus* is a strong muscle, but the proper digital muscles are weak or absent, as in the case of the *abductor*, *adductor*, *flexor brevis*, and *opponens* (p. 363) of the fifth digit. A special long abductor of this digit, however, passes from the olecranon to the distal phalanx. The *iliacus* is wanting, and there is no *psoas major*; but the muscles which represent the *psoas minor* and the subvertebral muscles of the Cetacea are very large and play an important part in effecting the locomotion of the seal. The *pectineus* is very small, and the other adductors are inserted, not into the femur but into the tibia. The *gluteus maximus* is inserted into the whole length of the femur. The *semimembranosus* and *semitendinosus* are replaced by a *caudo-tibialis*, which arises from the anterior caudal vertebræ and is inserted into the tibia, some of its tendinous fibers extending to the planter aspect of the hallux. The *poplitæus* and *gastrocnemius* are strong, but there is no *solæus*. The tendon of the *plantaris* passes over the calcaneum and ends on the

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* Anatomy of vertebrated animals, 361.

plantar fascia of the perforated tendon of the fourth digit. The other perforated tendons seem to arise from the fascia attached to the calcaneum."

Professor Humphrey has also noticed the inclusion of the hind limbs of the seal in a paper* from which I quote these words: "In *Phoca* the knees are bent up beneath the abdominal muscles and the two hinder limbs are inclosed with the tail for some distance, in one fold, so as to form a flattened termination to the animal, reminding us not a little of the tail of a cetacean; the wing-like processes of which (the flukes) might seem to be represented by the laterally expanded feet of the seal."

Dr. Humphrey's account of the muscles of the hind limb of *Phoca communis* differs slightly from that given by Professor Huxley. The *iliacus internus*, according to Humphrey, was represented only by a few fibers passing from the anterior surface of the ilium (internal to the attachment of the large quadratus lumborum which occupies almost all this surface of the ilium), and joining the psoas in the thigh.

The *psoas magnus* is present, according to Humphrey, in *Phoca*, arising from the lumbar transverse processes and last rib, and is inserted into the brim of the pelvis in front of the hip-joint; some of its fibers were continued down the inner side of the thigh, and inserted into the large rough supra-condyloid ridge. These were chiefly the fibers that arise lowest down, and which had therefore a nearly horizontal course. It is remarked, however, in a foot-note, that: "It may be a question whether these fibers, arising low down and passing to the femur, appertain to the *psoas* or *iliacus*.

There is no distinct internal trochanter in the seal, and none of the fibers, either of the *psoas*, or *iliacus internus*, are inserted in that situation, translocation backwards of these insertions, as noted above, having occurred.

Psoas parvus was large, and arose from the bodies of the lumbar vertebræ and slightly from the edge of the hindmost rib, and was inserted into a projecting process of the pubes internal to the psoas magnus.

The *gracilis* in *Phoca* is very broad, and covers the symphysis pubis, being continuous with the muscle of the opposite side. The chief direction of its fibers is transverse, but they radiate as they approach the leg, the upper fibers ascending nearly to the knee, and the lower fibers descending to the inner ankle, covering the interval between the internal malleolus and os calcis, and extending as a fascial expansion over the plantar fascia and muscles. Many of its fibers are inserted at right-angles, or nearly so, into a tendon which ran along its fore-part parallel with the tibia. This tendon, passing the inner ankle, is continued on the plantar aspect of the hallux into a tendon which represented the *flexor brevis* and *adductor hallucis*, and was inserted with them into the base of

*On the myology of *Orycteropus capensis* and *Phoca communis*, Journ. Anat. and Physiology, II, 1868, pp. 290–322, plates III–VI.

the first phalanx of the hallux; some of its fibers extending to the distal end of that phalanx. In one foot of this seal the hinder margin of the gracilis tendon was also thick, and formed or contributed to form the superficial flexor tendon of the fifth digit.

In *Phoca* the muscles of the front of the abdomen overhung the knee; and when these were removed a wide, deep chasm was exposed between the long pubes, on the one side, and the thigh, knee, and leg on the other. This chasm was crossed by a large muscle passing from the side of the symphysis pubis to the front of the upper part of the leg and knee beneath the *gracilis*. It may perhaps be regarded as an *adductor magnus*.

Gluteus maximus in *Phoca* arose from the back of the crest of the ilium, the sacral spines, and the sacro-iliac ligaments, and was attached to the trochanter and the external supra-condyloid ridge of the femur, while its lower part expanded over the knee joint. Some of its fibers were continuous with those of the *vastus externus*.

This somewhat extended discussion of the muscular anatomy of the hind limbs of the *Pinnipedia* has been thought necessary in order to bring out as prominently as possible the fact that some of the insertions of the muscles of the hind limb have really traveled backward behind their usual position on the bones of the same pair of limbs of normal *Mammalia*. This is obviously a teleological modification, or one which has been needed in order to make the muscles more effective upon the distal or exserted part of the limb or the pes. The fact that the abdominal muscles overlap or extend over the knees of *Phoca* shows how real is this backward extension of the musculature of the body, which has been obviously aided by the shortening of the femur and lengthening of the crus in this type, the *Pinnipedia*. In one case even the origin of a muscular pair seems to have been pushed backward somewhat; it is that of the muscle called the *caudo-tibialis* by Huxley, and regarded by him as the homologue of the *semimembranosus* and *semitendinosus* of normal mammals.

Quoting again from Humphrey, I may illustrate the fact that the posterior girdle and muscles of the pinniped are actually undergoing degeneration in certain directions. He says: "In the seal the terminal parts of the limbs, especially of the hind limbs, are large, and spread out fan-like, the digits being thin, long, of nearly equal length, and in the same plane; and the size of the fan is increased or diminished in each foot, chiefly by the distancing or approximating of the other digits to the first, and the lateral movement of the digits therefore increases from the first to the fifth. The dorsal and plantar surfaces of the terminal parts of the hind limb are in the same plane with those of the leg; the projecting part of the heel-bone, which is small, is drawn forward or upward, and the hinder part of the astragulus, carrying the groove for the flexor tendon of the toes, is draw up with and projects nearly as far. The lumbar and hinder five or six dorsal vertebræ are constructed so as to admit of full antero-posterior movement; whereas the iliac bones are short and directed outward, presenting flat surfaces anteriorly, and the ischiatic bones, though long, are slender, showing that the muscles which pass from the pelvis to the short thighs are small. These features have, of course, relation to the fact that the propulsion of the animal is effected not, as in ordinary mammals, by the movements of the limbs upon the pelvis, but rather, as in the fish, by the movements of the hinder part of the vertebral column upon the rest of the trunk, the limbs of the seal serving chiefly like the tail rays of the fish to give width to that part of the column."

(12) *Degeneracy of the pelvis in pinnipeds.*—The relatively small pelvis, with its thin and slender pubes and ischia in the *Phocidæ*, is remarkable, though a similar pelvic degeneracy is even more obvious in the skeleton of the fur-seal *Callorhinus.* I regard this degeneracy of the pelvis and proximal musculature, and the evident translocation of some of the muscular insertions backward, the inclusion of the knees by the hinder part of abdominal musculature, as very clearly indicative of the mode in which the pes of *Cetacea* were shifted backward, the skeleton finally aborting utterly, so as to leave only a pair of pedal folds projecting from the sides of the tail, stiffened by a peculiar arrangement of fibers, fully described by Roux,* who develops an elaborate hypothesis to account for the arrangement of these connective-tissue fibers in the flukes, but he continually speaks of the flukes as *Flossen* (fins), and seems to have no suspicion in regard to their true nature, viz, that they are the degenerate translocated distal portions of the hind limb.

Dr. Gill,† who seems to have been the first author to appreciate the importance of the inclusion of the proximal parts of the hind limbs of pinnipeds, and to avail himself of it in taxonomy, uses the important character discussed above as diagnostic of the *Pinnipedia*, contrasting the latter with *Fissipedia* as follows: Body prone, with the legs confined in the common integument beyond the elbows and knees (with the feet rotated backwards, and with toes connected together), and especially adapted for swimming. Manus and pes with first phalanges and digits enlarged and produced beyond the others."

Allen‡ contrasts the *Phocidæ* and *Otariadæ* as follows:

[1] "In the *Phocidæ* the hind limbs are extended backwards in a line parallel with the body; the legs are so inclosed within the integuments of the body that they have little or no motion, and the feet are movable only in a relatively small degree, in an obliquely lateral direction.

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* Beiträge zur Morphologie der functionellen Anpassung. 1. Structur eines hoch differenzirten bindegewebigen Organes (der Schwanzflosse des Delphin). Arch. f. Anat. u. Physiol., 1883, pp. 76–161, 1 pl.

† Synoptical tables of characters of the subdivisions of mammals, with catalogue of the genera. Smihsonian Miscel. Coll. 230, Nov., 1872. In arrangement of the families of mammals.

‡ On the eared seals (*Otariadæ*) with detailed descriptions of the North Pacific species. Bull. Mus. Comp. Zool. II, No. 1, pp. 108, pls. 3.

[2] "In consequence of this peculiar structure the only purpose which these organs can subserve is that of swimming. On land progression is mainly accomplished by a wriggling serpentine motion of the body, slightly assisted by the extremities.

[3] "In the *Phocidæ* the tarsal articulation allows but a small amount of movement of the foot, which, when naturally at rest, forms but a slight angle with the leg.

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[4] "The bones of the pelvis (of the *Phocidæ*) are all thin and slender."

[1] "In the *Otariadæ* the hind limbs are somewhat free, and when in a natural position (on land) the feet are turned forward, and serve to raise the body from the ground.

[2] "They also (imperfectly) serve the purpose of walking; these animals being able to progress when out of the water several miles an hour, and to run for a short distance with nearly the rapidity of a man.

[3] "In the *Otariadæ* the foot when similarly at rest forms with the leg an angle of at least 90°.

[4] "The bones of the pelvis are all thick and stout, especially the walls of the acetabula. The acetabula are themselves very much larger than in *Phoca*."

"The length of the ischio-pubic part [of the pelvis of *Phocidæ*] to the length of the ilia is as *three* to *one*." In the *Otariadæ* the proportions of these bones is nearly as *one* to *one*.

It is thus rendered obvious that these two families are divergent and quite distinct. The effects of degeneracy are most apparent in the pelvic girdle and hind limbs of the *Phocidæ*, as is shown by the contrasts given by Mr. Allen.

(13) *Tendency to pronation of the pes in pinnipeds.*—Professor Lucæ in an elaborate paper on the osseous skeleton of the seal and otter,* has given some account of the swimming habits of *Phoca* and its osteology which are of interest in this connection. He calls attention to some of the facts already alluded to, and in addition directs attention to the strongly marked pronation of the leg and foot, the dorsum of the latter being directed outwards and the plantar surface inwards.

This pronation of the foot was probably carried still farther in the Protocetacean type, which gave rise to the existing forms. In them the foot was probably directed backward and so greatly pronated as to bring the hallux or longest digit to the outer or external margin of the extremity of the limb. The plantar surface would then be brought into its original ventral position, while the dorsal side would be superior, the reverse of which would have been the case had the limb been simply swung backwards parallel with the tail without pronation or semi-rotation upon its own axis. But the hallux, which was probably

* Die Robbe und die Otter in ihrem Knochen und Muskel-skelet, eine anatomisch-zoologische Studie. Abh. I. Senckenbergischen naturforschenden Gesellschaft, VIII, 1872, pp. 277–378, pl. 14.

the longest digit for a time, would become the fifth instead of the first, when counted from within outwards. The hallux then probably grew gradually shorter when the second and third digits became the principal ones in the pes as well as in the manus, after which they atrophied entirely, leaving only the vessels to serve as traces of their former presence.

The extremely short neck of the cetaceans, due to the abbreviation of the cervical vertebræ, has brought the origins of the fore limbs nearer the head and to some extent obscured the inclusion by the soft parts of the arm and fore-arm which has taken place in these forms. Such an inclusion of the proximal joints of the fore limbs has also occurred in the pinnipeds, but in them, as in *Eumetopias*, for example, the normal length of cervical vertebræ has been retained, so that when the living animal is observed the neck seems longer than it actually is, because of the inclusion of the upper parts of the fore limb so as to leave little more than the manus free, a condition which gives rise to the illusive appearance of a long neck; in fact, the neck of the sea-lion as beheld and understood by one knowing nothing of the internal anatomy of the animal, would include some of the anterior dorsal or trunk vertebræ, together with the true cervicals. In the whales, however, so great has been the actual shortening of the neck that the effect of the inclusion of the proximal parts of the fore limb on the apparent length of the neck is lost, but if the neck vertebræ of a cetacean are imagined to be of their usual proportional length in a skeleton, and if the extension so gained be added with a pair of dividers to a figure of the latter the effects of the inclusion of the upper parts of the fore limb at once become apparent. In fœtal cetaceans the neck is proportionally somewhat longer than in the adults.

(14) *The auditory bullæ of Phocidæ and rudimentary pinnæ in Cetacea.*—It is worthy of notice that the *bulla* tympani in the *Phocidæ* are very large and thick walled and not so intimately joined to the adjacent bones of the skull as in the typical land Carnivora, thus approximating the *Cetacea* somewhat. The eared seals have a distinct though rudimentary pinna or external ear developed, which is wanting in the *Phocidæ.* That even the ancestry of the *Cetacea* were possessed of well developed pinnæ or external ears seems to be countenanced by the fact that Howes* has found a minute cylindrical appendage close to and just behind the external auditory meatus of the embryo of *Phocæna*, Such rudiments of pinnæ seem to be unusual in embryo Cetaceans, as the writer has not found them present in any of the fœtuses of the species examined by him.

II.—DEVELOPMENT.

In all the figures of cetacean embryos which have been published and to which I have had access, the same law which presides over the

*Journ. Anat. and Physiol., XIV.

order of the outgrowth of the limbs is shown to hold as for all other vertebrates, provided the fluke folds be regarded as representative of the hinder limb folds; otherwise the cetaceans must be regarded as anomalous or exceptional in this respect and permanently without any traces of externally developed posterior appendicular organs, even in the embryonic condition. Granting, however, that the discussion of the morphology of the adult has justified the acceptance of the doctrine of the translocation of the limb backwards by the progressive inclusion of more and more of the proximal parts of the hind limbs of some decidedly ambulatory ancestral form by the gradual advance from before of the integuments of the body in common over the hind limbs and tail until nothing but the feet have remained exserted, a process which we see has already begun and reached a very marked development in the existing pinnipeds, the reader may be led to admit that my hypothesis when applied to the interpretation of the order of appearance of certain parts in the embryo is not so unreasonable as might at first be supposed. He must at any rate admit that the process which has begun to modify the limbs and pelvic girdle of pinnipeds if carried still farther must actually lead toward what now exists in the cetaceans; and that as a result of the process of inclusion of the limbs their skeleton must necessarily first become immobile and then atrophy, and that not only the muscles but the nerves and vessels must also atrophy or be so modified as to leave scarcely any recognizable representatives of their homologues as found in the hind limbs of normal mammals. We are thus, I venture to fully believe, put upon the clew which will lead us along the course which the evolution of the cetacean tail has taken; and, while asserting that the pinnipeds very distinctly give us the intimation of *how* this structure was developed, it does not necessarily follow that the pinnipeds are tending to become whales or that a typical pinnipedian ancestry for the *Cetacea* is assumed. In other words, I do not mean to imply that the latter have been evolved from seals, but I do insist that the ancestor of the *Cetacea* must have been more or less seal-like in the organization of the hind-body and hind-limbs; yet I am not at all certain after considering the many resemblances existing between the seals and whales that they are not genetically allied. In that event their common ancestry must be referred to a remote period in the history of the development of the higher organic types. That the *Cetacea* are allied through descent to the *Ungulata* is, it seems to me, founded on far less convincing evidence than the assumption that they are affiliated through descent with the terrestrial and amphibious *Carnivora*, especially the latter.

The *Sirenia* have possibly descended from a quite different ancestral type, and while they have been modified in an analogous manner, so far as the hind limbs are concerned, they present every evidence in other respects of having arisen from an herbivorous progenitor.

The mode in which the shifting of the hind limb has been accomplished being understood, we find, as already urged, that the laws of limb development support my hypothesis, as may be seen upon considering the following general principles:

1. The hindmost pair of limbs is always the last to grow out in the embryos of *Vertebrata*, the fore limb at an early stage being larger and longer as a limb fold than the rudiment of the hinder limb fold. The fluke-folds of cetacean embryos grow out after the pectoral limb has its cartilaginous skeleton well developed. The inference to be drawn from this is that the former probably represent what remains of the hind limbs to be externally developed through functional adaptation or loss of function, and its assumption by the caudal musculature actuating the whole caudal series of vertebræ, with the degenerate distal remnants of the hind limbs shoved back, as described, and more or less rigidly affixed to the sides of the tail, so that the feet or flukes have become secondarily functional, so to speak, and part of an apparatus evolved *pari passu* with the almost complete atrophy and inclusion of the pelvis and rudiments of limbs within the integuments investing the hinder part of the body and tail.

The degenerate or skeletonless state of the pelvic limb folds is so strongly influenced in this group by heredity directly that I am aware of few or no parallels. Its posterior origin is paralleled by the attypical or abnormal anterior origin of the pelvic limb folds of *Physoclisti*, as in *Lophius*, for example, in which translocation forwards of the pelvic limbs has occurred, instead of a backward translocation, as in the cetacean. But these two types again differ in that in *Lophius* it is the whole of the hind limb, together with the girdle, which is so translocated while in the *Cetacea* it is obviously only the exaggerated integumentary investments of the pes which are carried backwards at the end of the hind limb. In *Lophius* the original site where the pelvic limb fold first appears in the embryo is nearly as far in advance of its archaic site in the embryos of the most undifferentiated Physostomes as the pedal folds in cetacean embryos are behind their archaic site or position of origin in normal mammalian fœtuses.

My own observations on *Globiocephalus*, as well as those of Eschricht on *Delphinapterus* or the white whale (fig. 13 *a*, Plate II), show that the first traces of the flukes or hind feet appear in the embryo cetacean as a lateral terminal pair of very low short folds, with a gently curved margin, as seen from the dorsal side, giving the end of the tail of the embryo when thus viewed the appearance of a lance head.

Sections at this stage show no traces of a skeleton, nothing but a medullary mass of indifferent mesoblastic cells filling up these folds of epidermis, which represent the rudiments of the pedes. Coincidently with this early stage the cartilages of all the bones of the pectoral limb are fully developed; all the carpal and phalangeal cartilages are also fully formed, as shown in the enlarged figure of the manus of *Globiocephalus* (Fig. 17). No traces of interosseous muscles or of flexors and extensors of the digits were discoverable in longitudinal sections of the manus of an embryo 2 inches long. Intereossei muscles, on the contrary, are developed in a relatively earlier stage of the embryo cat, or in a normal form.

It thus appears that the displacement and degeneration of embryonic representatives of the distal portions of the hind limbs of Cetacea has greatly retarded or influenced their development as compared with the fore limb, and that the mesoblast instead of being transformed into cartilage, and finally built into bone axially, and muscle superficially, has been mostly converted into a tough kind of fibrous tissue running in two directions at right angles to each other, and in the main parallel with the dorsal and plantar surfaces of the flukes. This tissue has the appearance and consistency of tendon; in fact the longitudinal superficial fibers are in part continuous, according to the observations of Murie, Roux, and myself, with the terminal fibers of the great tendons of the flexor and extensor muscles of the tail; that is, with the tendons of the posterior extensions of the lateral *intertransversarii*, the dorsal *erector* and *multifidus spinæ* and the ventral or subcaudal system, partially homologous with psoas muscles.

This last fact shows how persistently the psoas muscles share in flexing the hind limbs of mammals; in the cetaceans some of their tendinous fibers being actually sent backwards to be inserted into the flukes and last vertebræ instead of, as usual, into the lesser trochanter of the femur, a bone which is quite aborted in most of these forms. It seems to me that there is good reason to believe that both the *psoas magnus* and the *psoas parvus* are represented by the powerful subcaudal muscles of cetaceans, and that probably both send some tendinous fibers into the flukes. This is in keeping with the hypothesis of cetacean limb development here defended; for we found that certain muscular insertions were migrating backwards on the femur and tibia *pari passu* with the demands of functional adaptation in the *Phocidæ;* this translocation backwards of the muscular insertions has reached its extremest expression in the cetaceans where the continued psoas, as infracaudal and sacrococcygeus, actually sends tendinous fibers to the flukes instead of the femur, which has long since atrophied or become functionless.

2. The development of the paired vertebrate limb begins primarily as a lateral outpushing of the embryonic skin, or as a hollow, flat, lobate, horizontal diverticulum of the epiblast, into which mesoblast proliferates and from which the appendicular skeleton and musculature are differentiated.

The cetaceans follow this rule of development but soon diverge from the normal mammalian type in two respects, viz, that the embryonic limb rudiment does not become so markedly clavate or club-shaped as in embryos of mammals with ambulatory limbs modified for terrestrial progression, but remains more distinctly flat and pinniform as in fishes. The intermediate condition in this respect between that found in normal mammals and cetaceans is seen in pinniped embryos. Finally, the posterior limb-folds also fail to develop a skeleton in their medullary substance.

Eschricht (*Untersuch. über die nordischen Wallthiere*, 1849, p. 78) remarks of the development of the flukes, "Bei ihrem ersten Auftreten erscheinen die Schwanzflügel der Cetaceen als zwei sehr zarte Hautfalten ganz am äussersten Ende des Schwanzes. Auf dieser Entwickelungsstufe hat der Schwanz die Form einer kleinen Lanze." He then describes the mode in which the folds rapidly elongate or widen laterally, becoming more and more acumniate and longer and somewhat falcate. Different stages of the lobate condition may be noted in the embryos figured in the plates accompanying this paper, as shown digrammatically in fig. 15, pl. II.

Dr. Jeffries Wyman (in Proc. Bost. Soc. Nat. Hist., III, 1848–'51, p. 355), on the 6th of November, 1850, made the following remarks on the development of the flukes of *Balæna mysticetus*, basing his observations on a fœtus of that species, 6 inches in length: "Instead of the long flukes and central depression (caudal notch) seen in the tail of the adult, the tail of the embryo was rounded as in the tail of the manatee; there was also a vertical crest above and below the tail."

Some of the older authors regarded the flukes of cetaceans as representing the hinder pair of limbs in normal mammals, such expressions as "*cum pedes in caudam coadunati*"* occurring in their writings, by which it is implied that the feet have been fused, together with the tail, into a conjoined organ. They were nearer right than they knew, but were without scientific reasons for their statements, yet, as late as 1849, D. F. Eschricht (*op. cit.*, p. 78) criticises this old view as follows and considers it to be quite untenable, urging, indeed, that when the question is viewed in the light of embryology, those data which are not at least unfavorable to such an interpretation are quite insufficient to sustain it. But I will here reproduce his remarks and then criticise them further:

"Die Schwanzflügel der Wallthiere werden sehr allgemein für rudimentäre Bauchglieder angesehen, wofür in der That ihr ausschliessliches Vorkommen bei ihnen und den Sireniformien, also grade nur bei den Säugethieren, denen wirkliche Bauchglieder abgehen, sehr viel sprechen kann. Es zeigt sich aber diese Analogie, wenn man die Entwickelungsgeschichte, diesen Probirstein der anatomischen Analogien, zu Hülfe zieht, wo nicht unhaltbar, doch wenigstens sehr unvollständig.

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* This quotation is from the *Systema Naturæ* of Linnæus, 12th ed., *Tom.* I, *pars* I, p. 105, Holmiæ, 1767. It occurs in a foot note, and entire reads as follows: "*Cetis quibusdam pinna dorsalis, omnibus pinna caudæ et pectorales; nullis p. ani, aut ventrales cum pedes in caudam coadunati.* Drs. Gill and Baur have called my attention to this interesting observation by Linnæus, who, however, does not assign any reasons for his opinion as expressed above. Gmelin, in the later editions of the *Systema*, expunged the above-cited foot-note.

Die erste Erscheinung der Schwanzflügel ist nämlich in der Form von zarten Hautlappen, ganz dicht an der Spitze des Schwanzes, in einer bedeutenden Entfernung vom After und Becken. Dagegen zeigen die Schwanzflügel sich in ihrer Entwickelung ganz analog mit der Rückenflosse, welche selbst eine in der Säugethierklasse ganz neue, nur den Walithieren zukommende Form der Hautfaltung ist."

As I have already disposed of the last objection raised in the preceding quotation as to the dorsal fin which this author, together with later ones, so persistently compares with the flukes, I would now simply call attention to the very singular dorsal hump filled with adipose tissue so remarkably developed in certain races of the zebu or *Bos indicus.* In this terrestrial animal the dorsal hump has as much right to be called a fin as in some cetaceans. And it is but a step from the dorsal hump of the zebu to the one or two dorsal humps found in the existing species of *Camelus.* In fact, the dorsal fin of cetaceans is largely filled with adipose matter, as in these terrestrial forms, though of course it would be pushing the *reductio ad absurdum* argument to an extreme if I were to deny that the dorsal fin of Cetacea is not different in function from the adipose humps of terrestrial Herbivora. What is meant here is that the similarity or likeness existing between the flukes and the dorsal fin of whales and porpoises, is delusive and is merely analogical, and that the argument that the flukes are also mere integumentary folds, with no phyletic relation to hind limbs, is, if based upon nothing more, not a very formidable one, especially since I have demonstrated beyond any possible doubt that a limb rudiment may be and is translocated together with its girdle from its archaic position in other forms. It was the lack of a knowledge of this last fact that might well induce an anatomist to hesitate to enunciate the doctrine here developed.

The difficulty in regard to the distance (*Entfernung*) or hiatus between the point of origin of the flukes and the anus and pelvis, which Eschricht very properly considers important, I venture to think has been quite overcome by the theory of inclusion, which we may say now really assumes the dignity of a theory rather than that of a hypothesis, after the analysis and explication of the facts relating to the structure of the hind limbs, tail, and posterior part of the body of the *Phocidæ* as developed in the foregoing pages.

3. The mammalian fœtus nearly always has the head, body, and tail flexed more or less, so that the head and tail are approximated on the ventral side.

In illustration of this, see Figs. 12 and 14, the first representing the fœtus of the cat and the latter that of *Delphinapterus.* This trait seems to be in part inherited, as a similar flexure of the embryo occurs in large yolked *Sauropsida*, but is obviously in part also due to confinement of the growing fœtus within the hollow vesicular chorion, the curvature being hence more or less mechanically adaptive in conformity with the curvature of the walls of such vesicle. That such a view is in the main true is shown by the manner in which the early embryonic axis of certain *Rodentia* is bent in the opposite direction; that is, the dorsal profile is concave and the ventral convex, or just the reverse of Figs. 12 and 14. This condition in *Rodentia* is, however, transitory, and is due to the invagination of the embryonic area or one side of the blastodermic vesicle into the opposite half, on account of which it was for a long time supposed that the primary layers were inverted in some of these animals. Later the embryo of the latter assumes the flexure normally seen in other forms and apparently for the same reason. Flexure of the embryo, to a greater or less extent, is, therefore, of little or no importance in taxonomy.

The flexure of the tail of the fœtal cat, Fig. 14, and of a fœtal porpoise, Fig. 8, forward under the body is no greater in the first case than in the latter, because the tail of the fœtal cat shown in the figure has been raised and drawn backward somewhat from between the hind limbs in order to show its length.

The hind limb of the fœtal cat is extended not quite fully so that the ends of the toes are not brought as near the tip of the tail as they might be in the figure. It is easy to see, however, that if the tail and hind limbs of this fœtus were fused together or invested by a common integumentary envelope that the volume of the tail would be thus increased threefold, and would be proportionally almost of the same bulk as the tails of the fœtuses of the cetaceans shown on the same plate. The effect of such a fusion would be to carry the pes of the cat's fœtus back to the end of the tail, leaving a little more of the latter exserted behind the pedes than is found in the fœtus of the manatee, figs. 20 and 21, Plate III.

The articulation of the teeth of many of the *Delphinoidea* with the jaw is not a fully developed gomphosis, but there are more or less well marked dental grooves filled superficially with a tough tissue, which is as essential in fixing the teeth to the jaw as the shallow, often imperfect, sockets, which are excavated in the mandibular and maxillary bones. This superficial supporting tissue around the bases of the teeth is more or less elastic, and allows more or less free motion of the tips of the teeth, which actually for this reason give one the impression of being loose.

This mode of dental implantation is primitive or embryonic or degenerate, because no such high grade of differentiation of the dental system has been attained in the *Cetacea* as in the higher land mammals which use their teeth specifically for grinding the food, whereas the *Delphinoidea* use their teeth mainly for prehension.

Eschricht's researches on the dentition of the fœtus of the Balænoid *Megaptera longimana*, shows that the number of evanescent tooth germs in the upper jaw of one side is 28 and in the lower 42. Those in the lower have a regular distribution, while those of the upper display more or less irregularity of arrangement in the dentary groove. Three germs in the upper jaw in one case are double; that is, are formed of two primary simple cusps of the haplodont form fused together. The spaces between these double or bicuspid germs is greater in two instances than between the simple haplodont germs. This raises an interesting question as to the genesis of bicuspid and two-rooted teeth. Whether, indeed, teeth of the bicuspid type have not arisen in some cases by the fusion or concrescence of two primitively distinct haplodont or unicuspid germs. Such a mode of origin of certain types of teeth from a more numerous unicuspid series of germs is, at least, worthy of serious consideration.

In the fœtus of *Globiocephalus* (Fig. 9, Plate I) the tooth germs were not yet distinguishable in sections as more than pronounced thickenings of the oral epidermis at the point where the dental furrow would appear later. No traces of the enamel organ or of the dentinal elements of the teeth could be made out.

At a similar stage the mammary glands appear as simple thickenings of the epidermis on either side of the genital opening of the female fœtus of *Globiocephalus*. There are as yet only the faintest traces of the mammary fossæ shown in the sections. The rudiment of the gland is a solid pyriform mass of cells which is thrust inwards from the epidermis into the mesoblast.

The brain is quite smooth in the fœtus represented in Fig. 9, Plate I, as in the embryos of other mammals of the same relative stage of advancement. There is a very pronounced cranial flexure, nearly or quite as great as in a human fœtus of the same stage of advancement. This flexure also involves the brain. I find no evidence of the existence of olfactory lobes such as are so well developed in the brains of fœtal Rodents. The cerebral vesicles are quite thin-walled and smooth, so that the lateral ventricles are spacious. The cerebral vesicles are also depressed, and reflected back over the mid-brain to some extent.

III.—The hypertrophy and differentiation of the caudal vertebræ of cetaceans into two series.

One of the most remarkable traits of the cetaceans is the differentiation which their caudal vertebræ have undergone. One may divide these into two groups, viz, (1) those caudal vertebræ intervening between the last of the lumbars and the first one in front of the flukes, and (2) those terminating the vertebral column and lying between the bases of the flukes. The first group is characterized by the remarkably uniform vertical diameter and length of their centra and well-developed chevron bones; the second, on the other hand, have lost all but the merest traces of processes, and rapidly diminish in size so that the last centrum may be present only as a diminutive osseous or cartilaginous nodule.

The uniform dimensions of the centra of the first or anterior group indicates that the posterior ones of that series at least have been hypertrophied, obviously in correlation with the vast supra and infra caudal musculature, while the second group shows unmistakable signs of gradual degeneracy increasing from the first to the last. The change from the type of the first series to that of the posterior or second one is remarkably abrupt in some forms, the latter exhibiting degeneracy in the most striking way by the loss of the cylindrical form characteristic of the centra of the first part of the caudal series and the assumption of a depressed, rounded, or in some cases almost globular form.

This uniformity in the length of the centra of the first subdivision of the caudal bones is probably an adaptive character, and one which has been evolved *pari passu* with the differentiation of the great caudal muscles, the caudal skeleton and musculature actually assuming the function of the hind limbs. The hypertrophy, however, which we have noticed must, since it would have tended to increase the length of each one of the first series of centra, also have tended to lengthen, as well as strengthen, the tail, and thus aid in carrying the flukes farther back from their original position in the ancestral cetacean type, with the thighs and legs of its hind limbs bound together with the tail by integument, and when the tail must still have been extended between the pedes, this supposed ancestral form doubtless being the possessor of a greater number of caudal vertebræ than are found in the existing seals.

We at any rate find nothing like such a remarkable differentiation of the caudal vertebræ in any other mammals except cetaceans, and the inference is that such a differentiation into regions is intimately bound up with the acquirement of an important new function in connection with the outward vestiges of the feet now borne upon its sides, and which, by the process of hypertrophy of the anterior series of osseous caudal segments, it aided in still farther translocating backward after the skeleton and muscles of the hind limb had atrophied in the ancestral type. In other mammals the centra of the caudal vertebræ at once gradually diminish in vertical diameter from the sacrum backwards to the end of the tail, the posterior ones often tending to become depressed, a tendency which is also exhibited by the posterior or second caudal series of whales. This character places the cetaceans in contrast with all other mammals except, probably, *Halitherium*, *Rhytina*, and *Halicore*.

"Muscles which represent the *psoas minor* and the subvertebral muscles of the *Cetacea* are very large and play an important part in effecting the locomotion of the seal," says Huxley, so that we actually find that a beginning has been made in the development of an axial muscular apparatus in the seal which in the *Cetacea* has been extended both forward and backward and has attained tremendous proportions. The movements of pinnipeds and cetaceans in the water are somewhat similar. Both can in fact move rapidly along an undulating course by flexing the hinder part of the body up and down. Such a similarity in the habits of movement of the two animals it is hard to believe are not related to each other as to origin through a remote common ancestry. It is nevertheless difficult to understand the way in which the caudal musculature of the *Cetacea* has been developed with the concomitant differentiation of the caudal vertebræ into an anterior and posterior series, unless it be supposed that, as the flukes become more or less rigid the posterior vertebræ included between their bases would tend to degenerate, whereas the anterior series of vertebræ would tend to develop in proportion to their functional importance as a substitute for the skeleton of the hind limbs. This still leaves the question as to the origin of the degenerate caudal vertebræ of the pinnipeds unanswered and brings us face to face with an aspect of the question which does seem to throw some light upon this phase of the subject. I hardly think any naturalist will dispute the conclusion that a mammalian type could have originated anywhere else than on land in order to successfully develop its air-breathing and characteristic modifications of structure. Such a conclusion carries with it the implication that the whales have been derived from land forms, as seems indeed to be conclusively proved by the adult anatomy and especially the presence of certain structures which are on the way to complete atrophy. In land mammals, however, the tail is in reality always degenerate and often quite as much so as in the seals, for no matter how long the tail may be, if the diameter of its base is far less than that through the pelvic region immediately in front of its base, we may be certain that degeneracy from the primordial type, as seen in fishes, amphibians, and some reptiles, has occurred. In the last-mentioned types there is no such abrupt distinction between the trunk and tail as in land mammals. The inference, therefore, is that the tail of cetaceans, though probably derived from one in which there were more vertebral segments than are found in the tail of any existing pinniped, has been developed from that of a land mammal in which the tail was already degenerate and of comparatively little functional importance, just as we have seen is the case in the seals.

The difficulty which seemed to present itself in regard to the degeneracy of the pinniped tail, therefore also disappears, and a new question arises, viz: How was the gradual muscular degeneracy of the hind limbs of our ideal protocetacean form related to the increasing functional importance of the tail with a gradual new development of muscle over a region where it had been once before lost, in the course of the evolution of the mammalian type? The answer to this, it seems to me, has been already given, but it may be well to discuss it anew in another form.

As the fish-like form of the hind part of the pinniped's body became more pronounced as a result of advancing inclusion, we saw that the hyposkeletal flexors of the back part of the trunk became more developed. With increasing enfeeblement of the hind limbs the caudal skeleton and musculature would become stronger, indeed the one would *gradually exchange functions* with the other, so that no violent or sudden transfer of function is contemplated or even necessary. In fact, the exchange in all probability occurred in the water, in which medium it would be alone possible to develop a tail like that found in cetaceans, in which it indeed attains the maximum of importance as an organ of locomotion. While an old organ was vanishing and itself no longer capable of dissipating vital energy in the execution of its office as a part subservient to locomotion, a part of this old organ combined with another coexisting degenerate organ, the tail was hypertrophied and assumed the office of the posterior pair of limbs.

IV.—Degeneracy of the pelvic girdle and hind limbs in Cetacea.

One of the most striking features in the structure of the pelvis of *Pinnipedia* and *Cetacea* is the absence of a well-defined *symphysis pubis*, the pubes forming no extensive amphiarthrodial union as in most *Mammalia*. A well-developed symphysis pubis is absent in all of the species of the first-named group, with the exception, perhaps, of the walrus, which seems to be less modified generally in the structure of the pelvis and hind limbs. The other types in which there is a loose or distant connection of the pubes by means of a transverse interpubic ligament are the Sloths amongst the *Edentata*. The separation of the pelvic elements in the median line is carried to an extreme degree in the existing *Cetacea*, and in consequence of the fact that the pubic bones are probably absent in these forms, Struthers has named the ligamentous bond which joins the pelvic rudiments together across the median line the interpelvic ligament. To this are attached the crura of the penis in the *Cetacea*.

Struthers regards the pelvic bones of the latter as consisting of the ischium alone, since it developes from a single center of ossification, which I can fully confirm on the basis of the evidence presented by the structure of its cartilaginous rudiment in sections of an embryo of *Globiocephalus melas*, 2 inches long. In this embryo it seems to be proportionally of greater dimensions, however, than in the adult, which is simply evidence in favor of the view that it is really degenerate in the adult and has been reduced from a pelvis which in some ancestral form was still more developed.

The ilium has been atrophied, and in this way it happens that the pelvis of *Cetacea* and *Sirenia* has been separated from the vertebral column by a very considerable interval, and has been brought to assume only a subsidiary function, as shown by the researches of Struthers, viz, that of giving support and attachment to the organs of generation, and not that of giving attachment to functionally or strongly developed limb muscles as in normal mammals.

The atrophy of the pubes has left only an imperfectly developed ischium, and, perhaps, if anything of ilium, only the abaxial or distal part. The nodules of cartilage observed at the ends of the pelvic element in some forms do not necessarily indicate rudiments of the ilium and pubes, but possibly epiphyses only.

The displacement of the pelvis of cetaceans downwards, it seems not unlikely, has been helped by the great development of the bellies of the psoas or hyposkeletal group of muscles above it, as the massive flexors of the tail.

Rudiments of the femur and tibia were discovered by Reinhardt in 1843 in *Balæna mysticetus*. Since then the most valuable contributions to this subject have been made by Dr. John Struthers in papers* dealing with the anatomy of this region.

In a number of specimens Dr. Struthers obtained the following measurements: Length of pelvis of males, $8\frac{1}{4}$ to 20 inches; in females, $10\frac{3}{8}$ to $18\frac{7}{8}$ inches; length of femur in males, $5\frac{1}{2}$ to $8\frac{1}{4}$ inches; in females, $3\frac{5}{8}$ to $8\frac{1}{2}$ inches; the length of the rudimentary tibia ranged from $2\frac{3}{8}$ to $4\frac{1}{4}$ inches. It is thus rendered obvious that there is a great range of variation in the development of these elements, in fact in one instance it was found that in a female the head of the femur of one side was anchylosed to the pelvic bone of the same side.

The femora were found to be flattened laterally, the head and neck partaking of this character. A posterior proximal tubercle was observed which was regarded as a *trochanter major*. "If the ordinary mammalian femur, much shortened, be flexed, adducted, and rotated outwards, it will be brought into the position of the femur of *mysticetus;* more exactly, if the pelvis and femur of a seal be taken in the hands and so manipulated, the correspondence becomes evident, and it is seen then that this tubercle is the *trochanter major*." (*Op. cit.*, p. 155.)

Cartilage was markedly developed on the upper and condylar extremities, and the head was received into an imperfectly developed acetabulum in some cases. The tibia was represented by what is evidently only its proximal end, and was wholly cartilaginous and pyriform in shape.

Struthers† states that in *Megaptera longimana* "he found the thigh bone to be entirely composed of cartilage, of a conical shape, the length being $5\frac{1}{2}$ inches on the right side and 4 on the left. It was encased in a mass of fibrous tissue. This fibrous case was connected internally to its fellow of the opposite side; superficially and on the outside to the posterior pelvic muscular mass, and anteriorly passing from the thigh bone itself, was a special band appearing like a fibrous prolongation of the bone. The thigh rested loosely on the pelvic bone without articular surface, but was bound loosely to the latter by a strong posterior ligament, and by a weaker ligament in the position of the hip joint in the

* The bones, articulation, and muscles of the rudimentary hind limbs of the Greenland right whale (*Balæna mysticetus*). Journ. Anat. and Physiol. XV, 1880–'81, pp. 141–176 and 301–321, with Plates XIV–XVII.

† On the rudimentary hind limb of *Megaptera longimana*. (Am. Naturalist, XIX, 1885, p. 125.)

right whale. A muscle about the size and shape of a forefinger, within a ligamentous tube, connected the thigh bone backwards to the great interpelvic ligament. This was the only muscular structure directly connected with the thigh bone. It would retract the bone. The fibrous connections of the bone were mainly adapted to resist outward and forward traction." This quotation, I think, indicates quite clearly that the most recent functional relations of the muscles of the rudimentary thigh in the series to which *Megaptera* belongs were posterior to it, as in fact all the other available evidence has tended to show.

In every specimen of these parts from *Balæna* figured by Struthers the femur had its lower end swung forward, as it seems the femur of the seals usually is, and as it is found in the living eared fissipeds when standing on all-fours. The tibial rudiment, on the other hand, lies with its axis in a horizontal position or nearly, such as is assumed by that bone in the pinnipeds, the distal apex being directed backward toward the flukes.

This arrangement of the limb bones of *Balæna* not only justifies to a great extent the views here assumed as to the nature of the flukes, but also that of Struthers, who, on the basis of his observations on the rudimentary finger-muscles of *Megaptera longimana*,* concludes that the *Cetacea* have descended from a form in which limbs were much better or functionally developed; an opinion also entertained by Flower. Such a conclusion is also justified by the existence of synovial bursæ between the head of the femur and the pelvic bone and between the femur and tibia of *Balæna*, according to the former author's observations.

I think, indeed, we may go a step farther and declare with perfect safety that inasmuch as only the proximal end of the tibia is developed in *Balæna* as a degenerate element, which is not even ossified, and which has its distal end pointing backwards, the tibia, if fully developed and extended posteriorly to its normal length as found in other mammals, or as in the seals with the tarsus superimposed upon its distal extremity, it must be evident to every reasonable morphologist that the limb or pes would not be extended outward laterally from the body in a transverse vertical plane with the acetabulum, as is the case in terrestrial mammals, but would be extended back horizontally from the lower end of the femur as in the seals, and the limb not become outwardly apparent until some distance behind the vertical line drawn through the hip-joint. It thus becomes obvious that translocation of the distal part of the pelvic limbs of cetaceans has positively taken place, or, in other words, that the crural, tarsal, and phalangeal parts of these limbs have been rotated backward, and included from before backward by the integuments as in the seals. This inclusion, however, has probably been even more complete in cetaceans than in pinnipeds as a consequence of disuse of the still exserted feet as ambulatory organs and their utiliza-

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* See American Naturalist, Feb., 1885, XIX, pp. 126, 127.

tion as swimming paddles or oars in the water exclusively, thus affording an explanation of the atrophy of the bones and muscles of the crus and pes. That the inclusion of the hind limbs has been more extensive than in the seals is shown by the fact that the end of the caudal series of vertebræ is included between the bases of the flukes or pedes of cetaceans, and that no trace of the end of the tail as found in the former is externally visible, unless the rounded tip of the early embryo cetacean's tail is comparable to that part of the seal's which is still exserted.

"In the small *Balænoptera rostrata* a few thin fragments of cartilage, embedded in fibrous tissue, attached to the side of the pelvic bone, constitute the most rudimentary possible condition of a hind limb, and could not be recognized as such but for their analogy with other allied cases. In the large Rorqual, *Balænoptera musculus*, 67 feet long, previously spoken of, I was fortunate enough in 1865 to find attached by fibrous tissue to the side of the pelvic bone (which was 16 inches in length), a distinct femur, consisting of a nodule of cartilage of a slightly compressed irregularly oval form, and not quite 1½ inches in length. Other specimens of the same animal dissected by Van Beneden and Professor Struthers have shown the same; in one case partial ossification had taken place."*

It is singular that no traces of rudiments of these proximal limb-bones are to be seen as cartilaginous nodules in the region of the pelvis of very young *Delphinoidea*, but I find no evidence of the existence of any such structures in sections of the pelvic region of a very young fœtus of *Globiocephalus*.

In the cases of the adult specimens of *Balæna* dissected by Struthers there was an interval of several inches between the pelvic bones, which was bridged by an interpelvic ligament. On comparing the pelvis of a pinniped (*Otaria* or *Phoca*) with that of a Cetacean, a very great difference is apparent. While in the former there is no well-developed symphysis pubis, the pubic bones are not widely separated in the middle line as in the latter. In the former also the pelvis is posteriorly prolonged and the pubic bones together form an acute angle with each other, the opposed bones forming a sort of pubic carina, with the ischia as well as pubes drawn together posteriorly.

The pelvis is quite well developed in the walrus, but in *Phoca* and *Callorhinus* there is obviously a tendency on the part of the whole *os innominatum*, to degenerate and become weak. This fact becomes very obvious when the thin slender ischia and pubes of some pinnipeds are brought to mind, and becomes still more apparent upon comparing the pelvic girdle with the well-developed scapula of the same skeleton, though in order to thoroughly realize the fact that the pelvis of the pinnipeds is degenerating one must compare a skeleton of the latter with the skeleton of a Fissiped of about the same size. The very great

* On Whales, past and present, and their probable origin. Nature, XXVIII, 1883, p. 228. A lecture by W. H. Flower, before the Royal Institution, May 25, 1883.

disparity in the size and strength of the scapula and pelvic bones of *Callorhinus* is obviously indicative of the commencing atrophy of the latter elements.

The fact of the proximal parts of the limbs and pelvis becoming included in the pinniped, as already described, explains how this tendency toward degeneration of the pelvic girdle has been brought about. If we now imagine such a process of inclusion to be carried still farther so that even the tarsus becomes tied down to the side of the tail, the pes will become immobile even though there were an exertion of power manifested by the muscles of the limb. This would carry the condition of inclusion of the hind limb a step farther than that found in any seal and represent a condition intermediate between the latter and the whales, and, as a result of the increased immobility of the hind limbs following upon the supposed condition, not only the muscles but also the bones of the leg and pes would atrophy. In consequence of this atrophy of muscles and bones two other systems of organs would become involved, viz, the blood-vessels and nerves, especially all the distal branches or continuations of the external iliac and femoral arteries, and the efferent veins would suffer modification and gradual diminution, because they had now become more or less useless as conveyers of nutriment and waste to and from muscles which were becoming useless. The motor and sensory nerves in like manner which pass to the hind limb would for similar reasons atrophy, inducing profound changes in the structure of the lumbar plexus, involving the suppression or abortion of the great sciatic, crural, and obturator nerves, and concomitantly with the atrophy of the nerve supply ordinarily passing to the skeletal, muscular, and dermal parts of the functional limb, there would follow a hypertrophy of the nerves of the tail, commensurate with its functional importance, ending in the formation of a lumbo-caudal plexus extending from the lumbar region to its termination.

The atrophy of the parts of the skeleton of the limb ought to occur on my hypothesis, in an order which, passing from without inwards, would be just the reverse of that of its development. Upon comparing the mode in which the pelvic girdle and the limbs develop, with the different degrees of atrophy as displayed in a number of cetacean forms, we find that the preceding statement is verified.

It is found in fact that the pelvis at an early stage of development is separate from the vertebral column and that the girdle and limb bones are formed as segments in a serial order from within outwards, the pelvis and femur being first developed, then the tibia and fibula, then the tarsus, and finally the phalanges. In this same order they also become differentiated as distinct pieces, or from within outwards.*

The reverse of this is obviously the order in which the skeleton of

*See a paper entitled: On the development of the pelvic girdle and skeleton of the hind limb in the chick, by Alice Johnson. Studies from the Morph. Laboratory of the University of Cambridge. II, pp. 3–25, pls. IV–V.

the limb in the cetaceans has atrophied, that is, the phalanges first, then the tarsus, then the fibula and tibia, and finally the femur, affecting also more or less the degeneration of the pelvic girdle.

But it will be inquired, why do the limb-folds, or pedal folds, which represent the former in cetaceans, grow out at all after such extensive atrophy of the limb skeleton? To this it may be replied that the distal parts of limb-folds generally do not at first have the skeleton developed within them at all, and that, as I have pointed out, the limb bones develop from within outwards; the terminal part of the limb-fold, or epidermal pocket representing it, contains at first nothing but undifferentiated mesoblast. It thus seems to me that in the skeletonless flukes we have this inverse method of development illustrated, and that the flukes represent the earliest condition of a pes and therefore the last to vanish, unless indeed the flukes represent the produced integuments distad of the last phalanges of pinnipeds, which I think hardly probable, for the reason that their blood-supply, as already described, simulates that of the normal mammalian pes.

Struthers' figures indicate that the femora are adducted distally in *Balæna mysticetus* to a remarkable extent, in fact to such a degree that if the limb were fully developed with the crus extended in a line with the shaft of the femur, the limbs of opposite sides would cross each other. This adduction of the femora by which their distal moieties approximate each other, is probably due to the after effects of the process of inclusion which must have begun with a seal-like ancestral form, and which has reached its extremest expression in existing cetaceans, where the growth of the subcaudal muscles has influenced their final position.

The inclusion and degeneracy of the pelvis of cetaceans being so complete, there is however not so great a posterior extension of the abdominal muscles backward as one might be led to expect, but certain muscles are nevertheless provided with remarkably posterior insertions.

V.—The caudal muscles of Cetacea.

These are dorsally continuations of the deep *multifidus spinæ* and the superficial *erector spinæ*, posteriorly; anteriorly as continuations of the above, as found in the human subject, the *sacrolumbalis*, *longissimus dorsi*, *spinalis dorsi*, and possibly the *semispinalis* of man are represented in the vast dorsal and supracaudal musculature of whales. Murie* states that in the black-fish "the longissimus dorsi and spinalis dorsi are most intimately bound up together in the dorsal region, forming a long, but enormous fleshy mass, interwoven spinally and costally with tendinous fascia. That which may be considered equivalent to a transversalis cervicis commences by a short, strong tendon at the paramastoid. Immediately becoming fleshy and thick, it ascends posteriorly

* On the organization of the Caaing Whale (*Globiocephalus melas*), Trans. Zool. Soc. London, VIII, 1872–'74, pp. 235–301, pls. 30–38.

on the side of the neck to the anterior dorsal region, and is lost in the combined longissimus and spinalis dorsi. Where the body begins to taper behind a division of the two latter is perceptible. Hereabouts a superficial tendon passes obliquely upwards and backwards from the outer longissimus to the inner spinalis. A little way behind, another bridge of two oblique tendons similarly crosses, and immediately posterior to this five more, which together unite into a strong cord, wrapped one within the other. Meanwhile from each muscle there is continued posteriorly, quite to the end of the spinal column, a single, thick, massive tendon. Besides the foregoing, both longissimus and spinalis dorsi possess a deep series of long, narrow tendons, one to each vertebra, but mingled together by interstitial fleshy fibers. It results that these dorsal muscles act upon every vertebra independently, whilst at the same time the motor power of the fibro-cartilaginous tail is derived from the lengthened and more powerful cords, for from these there extends backwards a firm, glistening fascia, spread over and incorporated with the deep tail substance.

"Supra caudal. The single muscle (or compound muscle, if so regarded) to which I give this appellation lies external to the last, along the narrow portion of the caudal vertebræ and on the upper side of the transverse process, narrow in front, where fleshy, it widens somewhat and forms a tolerably thick fusiform belly, which again flattens and becomes tendinous. In its course it is attached partly to the vertebral bodies and partly to the transverse processes, sending off a special tendon to each of the latter. Posteriorly the flattened tendon lies against the sides of the bodies of the terminal vertebræ, and ultimately is lost in the general expansion of the upper surface of the tail flukes.

" Coming under the denomination of multifidus spinæ and rotatores spinæ, because of their position, origins, and insertions, are a great number of musculo-tendinous bundles, very apparent and well marked, but difficult individually to separate and define. These are still more numerous and closely packed together in *Lagenorhynchus* than in *Globiocephalus*, in consequence of the number and approximation of the vertebræ in the former. Stannius recognizes such a deep set of muscles in the porpoise; and I can corroborate his observation in that genus. Their general arrangement is by tendons from the dorsal metapophyses, and trending forwards and inwards are attached muscularly to the sides of the roots of the spinous process in advance of their origin. The most anterior one is fixed to the atlas.

" But there are besides a deeper layer of fascicles springing tendinously from the spines and dorsal arches, and these becoming fleshy are inserted into the transverse processes of the same vertebræ, doubtless semispinales ,as Stannius* names them in *Phocæna*. He alludes, moreover, to another set of fasciculi, close to the last, and connected with the vertebral processes, but he has not named them.

* " Muskeln des Tümmlers," Muller's Archiv, 1849, p. 30.

"In the four-limbed mammals generally there are three, or at most four, muscles described as occupying the iliac region, viz: the psoas major, psoas minor, iliacus and quadratus lumborum. But in cetaceans, as most writers state, there is only one enormously large inferior lumbocaudal muscle, which, at first sight, might be supposed either to represent the psoas magnus alone, or the psoas minor, iliacus, and quadratus lumborum incorporated with it. Whatever relation exists, division at least is inappreciable in *G. melas.* This enormously developed sacrococcygeus muscle is long and fusiform. On each side it occupies the lateral and inferior surfaces of the vertebræ and their transverse processes from the ninth dorsal vertebræ backwards; and as the transverse processes of the caudal elements are lost, it still continues upon them in the shape of a bundle of tendons continued on to the very end of the spinal column. The volume of its solid fleshy fiber may best be comprehended in the fact that it ranges in our specimen of *Globiocephalus* from one foot to six inches in transverse diameter, and with a corresponding thickness or depth. Further to particularize attachments and relations, it passes beneath the diaphragm, has the kidneys, &c., lying upon it, and narrowing behind the rectum sends off, downwards and backwards, superficially, a series of flat tendons. These are so connected together as to constitute a very strong tendino-aponeurotic sheath, spreads out and is continued on to the inferior surface of the broad fibrous tail. The main body of the fleshy mass meanwhile terminates in a single strong tendon, which passes direct along the spine and is fixed to the very last vertebra. Moreover, there is an appreciable flat layer of fleshy fibers, which come from the sides of the vertebræ and spread over part of the aforesaid tendinous sheath. This muscular layer appears to be a kind of reduplication of the body of the muscle itself.

"A muscle, the exact counterpart of the supracaudal, lies on the under side of the transverse processes of the caudal vertebræ, and it bears the same relation to the sacro coccygeus that the supracaudal does to the longissimus dorsi, save the fact of inversion of position. I distinguish it as the infracaudal.

"The long spinal muscles of Cetacea have received different names and significations from successive anatomists, though the descriptions, save that of Stannius, tally. Meckel * demonstrates the parts in the narwal (*Monodon communis*) and the dolphin (*Phocæna communis?*). His text appears to me to imply that he considers present and more or less differentiated: 1. An equivalent of the spinalis dorsi, biventer cervicis, and complexus, a longissimus dorsi, trachelo-mastoid, and splenius capitis; 2. A sacro-lumbalis with cervicalis ascendens anteriorly ('trachelo-mastoïdien, ou l'intertransversaire du cou' of his translators); 3. Flexor caudæ lateralis; 4. Depressor caudæ, quadratus lumbarum, psoas and iliacus; 5. An inferior depressor caudæ. Frederick Cuvier † speaks of

* Anat. Comp. Vol. VI., p. 128 *et seq.*

† Art. Cetacea. Cyclop. Anat. and Physiol. I, p. 569.

a levator caudæ, evidently No. 3 above. Rapp* and Stannius† coincide that there obtains: A splenius capitus longissimus and spinalis dorsi, sacro-lumbalis and transversarius superior and inferior. The former thinks the great lower loin-muscle a psoas major; to the latter it implies more. Stannius, moreover, describes a caudalis superior, a caudalis inferior, a longissimus inferior, a sacro-lumbalis inferior, and a set of caudal muscles unnamed by him. He also traces the short, deep spinal muscles, of which more hereafter. Carte and Macalister, in the piked whale,‡ have noticed a trachelo-mastoid, a longissimus dorsi, a sacro-lumbalis, with a slip supposed to be the homologue of splenius capitis, a levator caudæ, a depressor caudæ major, and depressor caudæ minor.

"Notwithstanding the amplitude of nomenclature and recognition of two or more *en masse* or separate, the anterior divisions of the various observers present a certain harmony; but there is less concord of opinion regarding the posterior tendinous parts and infero-lumbar region. Rapp and Stannius differentiate as transversarius superior the compound tendinous enwrapping sheath of the longissimus and spinalis as described by me. But the latter, moreover, unites it with the anterior fleshy belly of my supracaudal, and traces it forwards to the ribs, thorax, and neck, *i. e.*, includes part of what more strictly is sacro-lumbalis and cervicalis ascendens. Carte and Macalister's levator caudæ agrees partially with Rapp's transversarius, and partially with Stannius's caudalis superior. The latter muscle, again, is equivalent to Meckel's flexor caudæ lateralis and F. Cuvier's levator caudæ, one and the same with my supracaudal. None suggest the superior superficial terminal tendons, or aggregate fibrous investing-sheaths of the longissimus and spinalis dorsi, as the homologues of the levatores caudæ externus and internus of other mammals. Yet in every sense they are undoubtedly such, continuity with the dorsal fleshy masses being the only special deviation from their usual condition. The cetacean supracaudal, again, offers homology in its posterior short slips with the intertransversarii caudæ of the quadrupeds; it is longer bellied and more fleshy, anterior moiety being occasionally in mammals almost separate from the intertransversarii caudæ, though not specially recognized as a distinct muscle. In *Manatus*, however, it is uncommonly well developed, and has been named by me lumbo-caudalis. The inferior depressor caudæ of Meckel, depressor caudæ minor of Carte and Macalister, caudalis inferior of Stannius, and his unnamed musculo-tendinous caudal bundles, correspond with the present infracaudal.

"As regards the depressor caudæ of Cuvier and Meckel, the depressor caudæ major of Carte and Macalister, this undoubtedly is Rapp's psoas major, &c. Stannius viewed it as composed of three divisions,

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* *Die Cetaceen*, zool-anat. dargestellt, 1837, p. 92.

† Muller's Archiv, 1849, pp. 22–32.

‡ On the anatomy of *Balænoptera rostrata*, Philos. Trans., 1868, p. 225.

equivalent to the dorsal muscles, and named by him respectively longissimus inferior, sacro-lumbalis inferior, and transversarius inferior. So far I agree with the latter, and therefore differ from Rapp, that the great sublumbo-caudal cetacean muscle is not purely an ilio-psoas. This latter, I believe, as in *Manatus*, is all but aborted, certainly not recognizable. The homologue of the cetacean sublumbar muscle, then with its tendons and investing sheath, seems to me to be the sacro-coccygeus, whatever its significance as to the dorsal series. My infracaudal may represent partly inferior intertransversarii caudæ or perhaps include infracoccygeus.

"In default of being able to determine with accuracy spinal insertions in *Globiceps* I was more fortunate in *Lagenorhynchus*. In this genus the rectus abdominis tapers to a point at the fortieth vertebra, behind this intermingling with the caudal fascia. The pubo-coccygeus goes to the chevron bones as far as the sixtieth sacro-coccygeus, muscular to forty-fifth, tendons to sixtieth; between these points the secondary tendons which form the sheath emerge. Supracaudal from fortieth to sixty-sixth vertebra; the infracaudal is from two to three vertebræ shorter. Longissimus dorsi, &c., narrows at sixtieth; two oblique tendons given off at thirty-seventh; the others behind, ere producing aponeurotic sheath the spinalis dorsi, &c., its final tendons inserted from the sixty-fourth to the seventieth vertebral diapophyses.

"A series of levatores costarum, of moderate strength, and passing from the transverse processes to the ribs, exists in all the species of whales I have dissected.*

"In the lumbar region of *G. melas* the intertransversales† are powerful, they diminish in strength forwards, and can barely be detected in the most anterior dorsals and cervicals. In *L. albirostris*, whilst fleshy, they are shorter, owing to the close approximation of the very numerous and long divergent transverse processes. In *P. communis* caudally they are tendinous; in the lumbar region, semitendinous and fleshy, a superior and inferior division is noticeable.

"According to the development of the neural spines, cervical, dorsal, lumbar, and caudal, so are the interspinales‡ strong or weak. But as a series of muscular bundles they are, I believe, present in every cetacean. They have been met with by me in five genera.

"Both Rapp§ and Stannius‖ have described in the porpoise a set of muscles linking together the chevron bones. They name these M. interspinales inferiores. They are distinctly marked in *Globiceps*, *Grampus*, and the white-beaked Bottle-nose and Rorqual. They undoubtedly resemble the interspinales superiores of these authors, but pass from one chevron hæmo-spinal element to the adjoining. I prefer to designate

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* Described also by the oft-quoted German authorities.

† The intertransversarii of the foregoing.

‡ The m. interspinales superiores of the preceding writers.

§ *Op. cit.*, p. 83. ‖ *Op. cit.*, p. 40.

them as interhæmo-spinales, this term being more in accordance with morphological anatomy. Stannius likewise differentiates and names as m. interaccessorii a number of tendino-fleshy fascicles which intervene between the one and the other accessory spinous processes of the lumbar and dorsal vertebræ, in a longitudinal direction. These have not been observed by me, but I am inclined to regard them as intermetapophysiales."

As already urged there can be no doubt of the fact that the great infracaudal or hyposkeletal muscles of the tail of cetaceans are in part homologous with the psoas major and minor of quadrupeds. In fact, the infracaudal and sacro-coccygeus of Murie are but a system of psoas muscles prolonged rearwards together with caudal muscles, and developed to an extent not encountered in other types. The quadratus lumborum may also be represented. Whatever is the truth as to the exact homologies of these muscles, a fact which will not have escaped the critical reader's attention, is Murie's mention of the final direct and indirect insertion of the tendons of the caudal musculature into the flukes. The psoas being represented in the hyposkeletal musculature is thus found to have had its insertion greatly shifted in a posterior direction so as to act upon the flukes—degenerate pedes of *Cetacea*—instead of upon the lesser trochanter of the femur as in normal forms. We thus find that the backward translocation of the muscular insertions of the limb muscles which began in a seal-like type has reached its extremest expression in the whales, in which we can with certainty, however, assume this much of what is in reality part only of the psoas of land forms, in which it is usually inserted into the femur.

This tendency towards a backward extension of its insertion is also obvious, for instance, in the rectus abdominis. Murie* remarks of it: "The rectus abdominis, which I have already described, partly mingles with the generative muscles, inasmuch as its posterior narrowed extremity and terminal tendon enclasp the deeper fleshy structures of the vulva and winds round each innominate bone, finally being inserted into the neighborhood of the chevron bones."

VI.—The lumbo caudal plexus of nerves in cetaceans.

The only published account of the posterior part of the spinal nervous system of cetaceans which I have been able to find and which is at all complete, is that given by D. J. Cunningham, based on dissections of the porpoise and dolphin.† In the porpoise, Cunningham found that the spinal cord extends from the foramen magnum to the interval between the sixth and seventh lumbo-caudal vertebræ, and ends opposite the foramina giving exit to the twenty-seventh pair of spinal nerves.

* *Op. cit.*, p. 288.

† The spinal nervous system of the porpoise and dolphin. Journ. Anat. and Physiol., XI, pp. 209–228, Plate VII.

The *filum terminale* passes back into the vertebral canal for a short distance and is lost. The origins of the spinal nerves are crowded together in the cervical region in correspondence with the shortening of the vertebræ of this portion of the column. In the dorsal region the origins of the pairs are farther apart, but from the lumbar enlargement backward they are much crowded together. The seventh, eighth, ninth, tenth, and eleventh pairs of the lumbo-caudal nerves unite to form the genital or internal pudic, but as there is no functionally mobile hind limb, the branches corresponding to the genito-crural, obturator, external cutaneous, anterior crural and sciatic are absent. The internal pudic is well represented. Small twigs only from the seventh and eleventh lumbo-caudal pairs enter into the formation of this nerve. It pierces the great inferior lumbo-caudal muscular mass, and passing obliquely backward through it divides inferiorly into several branches which innervate the reproductive organs.

From the eleventh lumbo-caudal pair all the inferior divisions join to form the inferior longitudinal cord or plexus, the last pair entering the lower cord opposite the twenty-sixth lumbo-caudal vertebra. The inferior lumbo-caudal cord supplies the psoas or infracaudal muscles in *Cetacea* the same as do the ilio-hypogastric and ilio-inguinal nerves in man.

The hinder pairs which go to form the great inferior and superior lateral cords, the first above the latter below the transverse processes, pass backwards for a long distance, the hinder ones for about the extent of nineteen vertebræ as a strongly developed bundle or cauda equina, twigs from which pass out on either side, a dorsal one to the dorsal cord, and a ventral one to the ventral cord, through the intervals between the neural arches of the lumbo-caudal vertebræ. The ventral twigs pass down between the transverse processes.

The four great lumbo-caudal cords, two above the transverse processes and two below them in the porpoise, judging from the muscles which they innervate in the latter, are respectively the homologues of the "posterior" and "anterior" branches of the lumbar nerves in man. Unlike the latter, however, in consequence of the great bulk of the dorsal extensors of the tail, *longissimus dorsi*, *erectores spinæ*, and *multifidus spinæ*, there has also been a dorsal plexus differentiated which leads to the formation of the dorsal lumbo-caudal cord. Inferiorly the plexus has not the limited extent posteriorly as found in man where it is partially represented by the lumbo-sacral cord, but is extended backwards quite to the flukes, as the inferior lumbo-caudal cord.

Comparing the nervous system of the fish and cetacean, Cunningham remarks: "From the spinal cord passing so far back in the vertebral canal (in the former) it follows that the nerves which supply the caudal apparatus have a very short course to run from their points of origin to their distribution. Very different is the arrangement of the corresponding nerves in the *Cetacea*, which spring from the lumbar enlargement at a point far in front of their areas of distribution. In the first, therefore, there is no need for the longitudinal cords for the purpose of conveying the nerves to the caudal apparatus—the spinal cord is their substitute.'' He also points out that the vagus trunks running back to the tail in fishes are not homologous with the lateral caudal trunks of *Cetacea.*

While the adult anatomy of the caudal nervous systems of Cetaceans and most fishes are dissimilar (for it must be borne in mind that some Teleosts have a cauda equina developed, *Mola* for example), in the early embryonic condition the medulla spinalis of the mammalian embryo is without a cauda equina. This is so in the human fœtus (*vide* Kölliker, *Entwick. des Menschen*) and is also the case in the Cetacean fœtus according to my own researches on the fœtus of *Globiocephalus melas*, represented in Fig. 9, Plate I, where, as in the former, the medulla spinalis extends to the end of the tail, and, as shown by its microtomy, contains a central canal when examined in consecutive longisections. It is thus rendered obvious that the mammalian embryo recapitulates the ichthyopsidan mode of development of the nervous system, but subsequently reverts to the more recently evolved mammalian type as respects its posterior extension. Its rearward extension in the mammal is shortened in consequence of caudal degeneration and the development of tendons as the terminal or caudal extensions of muscles developed from a succession of muscular somites or myotomes, from between which intermyocommal septa on fasciæ have disappeared. The principal muscles which may be considered to have arisen directly from single myotomes are the intercostals and intertransversarii. The *rectus* is known, according to researches on fishes, to arise from the lower portion of a series of successive myotomes, from between which intermyocommal fasciæ have partially or wholly disappeared. Other muscles, such as the *trapezius* of man, arise proximally according to embryological theory from 17 myotomes; the *latissimus dorsi* from 20; the *rhomboideus major* and *minor* from 5. The manner in which the shifting of the course of the fibers from the direction which they originally pursued in the indifferentiated myotomes and the acquisition of restricted insertions is still one of the greatest problems of embryology, for which we may hopefully look forward to a solution, only through extensive studies on the development of the muscular system from the amphibians upward.

The rearrangement, differentiation, and great specialization of the muscular system of higher forms through the suppression of the myotomes, as seen in fish-like forms, has affected the development of the nervous system and led to the differentiation not only of ganglionic centers along the course of the medulla spinalis, such as the cervical and lumbar enlargements, from which arise the nerves which innervate the fore and hind limbs, but also conditioned the evolution of the limb-plexuses and caudæ equina. *Mola*, a fish which presents a remarkable differentiation of the lateral musculature, accompanied with extensive abortion of the myotomes, illustrates this principle. In this case, the tail being aborted for the most part, the muscles of the sides of the thorax, which is much elevated, are prolonged backwards and end in tendinous cords which actuate the rudder-like caudal as well as the dorsal and anal fins. The consequent advance of the origins of these muscles forward admits of their nerve supply being sent to them farther forward. We have apparently, as a consequence of this advance forward, the restriction backward of the medulla spinalis.

The inconsiderable development of the musculature of the paired fins of most fishes, and the segmental arrangement of that of the vertical fins, would obviously tend to maintain the uniform backwardly tapering form of the medulla spinalis, as seen in its simplest form in *Branchiostoma*, in which we also behold the most unmodified and archaic type of the myotome or muscular segment.

A consideration of these facts therefore leads me to state the following as a general principle, viz, that *pari passu* with the gradual suppression of myotomes in the course of the progressive evolution of forms and the differentiation of the musculature of the appendicular skeleton was the medulla spinalis differentiated into regions and its rearward extension curtailed in consequence of the degeneration into tendon of the musculature of the urosome.

While the muscles of the base of the tail of cetaceans are prodigiously developed as rearward extensions dorsally of the *erectores* and *multifidus spinæ* and ventrally as extensions of the system represented by the *psoas* of terrestrial types, they nevertheless, in the region of the caudal peduncle end as tendons, these animals therefore so far resembling other land forms with degenerate tails, so that it is altogether doubtful if motor nerve fibers enter into this portion at all, the presence of sensory and vaso-motor fibers alone being indicated.

The *Cetacea*, according to Cunningham, have the medulla spinalis swollen in the same way as other mammal in the cervical and lumbar regions, whence the limb plexuses originate. A similar differentiation is foreshadowed in the anterior part of the medulla spinalis of the skate, *Raia batis*, according to Owen, in which there is "a slight (brachial or pectoral) enlargement of the myelon, where the numerous large nerves are sent off to the great pectoral fins; a feebler brachial enlargement may be noticed in the sharks. I have not recognized it in osseous fishes, not even in those with enormous pectorals adapted for flight, *e. g.*, *Exocœtus* and *Dactylopterus ;* in the latter the smaller ganglionic risings upon the dorsal columns of the cervical region of the myelon receive nerves of sensation from the free soft rays of the pectorals and the homologous ganglions are more marked in other gurnards (*Triglæ*), which have from three to five, and sometimes six, pairs, e. g. in *Trigla Adriatica*. Similar myelonal cervical ganglions are present, also, in *Polynemus*. In the heterocercal sturgeon there is a feeble expansion of the myelon at the beginning of the caudal region, whence it is continued, gradually diminishing to a point along the neural canal in the upper lobe of the tail. In some bony fishes (trout, Blenny) the caudal ganglion is not quite terminal, and is less marked than in the cod and bream, in which it is of a hard texture, but receives the last pair of spinal nerves.*

A little further on the same author states that in *Mola* the myelon "has shrunk into a short, conical, and, according to Arsaki,† gangliated appendage to the encephalon. A like singular modification, but without the ganglionic structure, obtains in *Tetrodon* and *Diodon*, in a species of which latter genus I found the myelon only four lines long in a fish of 7 inches in length and measuring 3 inches across the head. The neural canal in these plectognathic fishes is chiefly occupied by a long 'cauda equina.' But, insignificant as the myelon here seems, it is something more than merely unresolved nerve fibers; transverse white striæ are discernible in it, with gray matter, showing it to be a center of nervous force, not a mere conductor. In the *Lophius* a long cauda equina partly conceals a short myelon, which terminates in a point about the twelfth vertebra. In other fishes the myelon is very nearly or quite co-extensive with the neural canal, and there is no cauda equina or bundle of nerve roots in the canal; a tendinous thread sometimes ties the terminal ganglion to the end of the canal." (Owen, Anat. Vertebrates, I, 272.)

In *Gastrostomus Bairdii*, a fish with an attenuated flagelliform tail, the medulla spinalis at its extreme posterior end becomes very greatly depressed so as to assume in sections the form of a flattened band in which it is almost impossible to discern the existence of a central canal. In very young eels the hinder end of the medulla appears to be connected with a globular enlargement which is quite terminal and possibly external to the neural canal.

Amongst the reptiles, says Owen, "With the exception of the anurous Batrachia, the myelon (spinal chord) is continued into the tail, gradually decreasing to a point, and is not resolved into a 'cauda equina.' Such, indeed, is its condition in the tadpole state of the frogs and toads; but, with the acquisition of the mature form, the myelon shrinks in length and terminates midway between the fore and hind limbs, being resolved in the frog into the three pairs of nerves which form the sciatic, and into a few filaments passing on to the sacrum." (Anat. Vertebrates, I, 295–6.)

The development of the *Anura* therefore confirms the rule, which was laid down above, as to the genesis of a cauda equina. In them the whole of the caudal musculature aborts, together with the caudal end of the myelon, while the hind limbs attain an extraordinary development and specialization of the muscular system, calling for an extraordinary motor nerve supply such as is rarely encountered amongst fishes,

* Owen, Anat. Vertebrates, I, 271.

† De Piscium Cerebro et Medullâ Spinali, 4to, 1813.

and in the latter only when specialization of the lateral musculature has proceeded in another direction, as in the cases of *Mola*, *Tetrodon*, and *Diodon*. The case of *Lophius* is more difficult to understand, though it is a fact that several of the last caudal vertebræ are co-ossified in this genus into a rigid piece, a fact which very possibly indicates a corresponding modification of the musculature of the end of the urosome. In respect to the other modifications, that in *Gastrostomus*, for example, is correlated with the development of a flagelliform tail; that of the eel is not so easy to understand.

The manner in which the lumbo-caudal plexus of cetaceans is developed is not wholly without partial parallels, for the lumbar nerves as they are continued beyond the end of the medulla spinalis subdivide and give off branches to the dorsal and ventral cords external to the neural canal. It results in this way, that two series of commissures are formed, a dorsal and a ventral one; but the latter is in reality formed of fasciculi which are sent down from the dorsally-placed cauda equina, between the transverse processes; the continuous accession of such fasciculi by the ventral trunk, as well as by the dorsal, from each lateral interspinous opening, leads to the formation of what have been called "cords," but they really represent a continued plexus, the segmentally arranged fasciculi of which are easily separated, as I find in *Phocœna*, and traced to their sources. Such a splitting or subdivision at each vertebral segment is apparent in the last pair of lumbar nerves, forming part of the short and rudimentary cauda equina of *Rana*. The formation of the so-called lumbo-caudal cords in *Cetacea* has obviously occurred through adaptation in response to the requirements of the caudal musculature. The suppression of the crural, obturator, and sciatic pairs, on account of the abortion of functional hind limbs, has left over the nerve pairs ordinarily entering into the formation of those trunks, so that their homologues are sent back into the tail, and they therefore potentially, if not actually, enter into the lumbo-caudal plexus, and thus ultimately send filaments at least to the caudal muscalature, and not improbably sensory fibers to the flukes.

If it is admitted that inclusion and abortion of the function of the hind limbs has occurred in the way that I have urged, a transfer of the crural and sciatic fasciculi from the limbs to the tail must have occurred. The anatomical facts show that such a transfer has taken place. I therefore see no reason to doubt the sufficiency of my hypothesis, because I find no evidence of the presence of the nerves which ordinarily pass to the hind limb, as such; on the contrary they ought to be found incorporated into the caudal plexus according to the requirements of the hypothesis. One set of muscles have been almost wholly, or, in some cases, entirely suppressed, and their offices assumed by another set, either of which the same set of nerves can alone supply with motor impulses. Then comes in the suppression of myotomes in the extensor and flexor muscles of the tail, in *Cetacea*, for instance, where the myotomes over 12 to 14 vertebræ are obliterated and converted into tendon posteriorly, so as to call for a new mode of distribution of the nerves different from that which obtains in fishes in which the paired nerves and muscular segments correspond almost exactly in number with the vertebral segments.

VII.—Translocation of the distal ends of the hind limbs in the Sirenians.

The fœtus of *Halicore dugong*, figured by Harting,* about 11 inches long, Fig. 22, Plate III, shows the flukes well developed and of much the same form as in cetaceans. Judging from the permanent adult form of the tail of *Manatus* (outer outline, Fig. 20, Plate III), which has the most rudimentary type of fluke, found either amongst cetaceans or sirenians, it is probable that the flukes, in those types having them well developed, viz, *Halicore* and *Rhytina*, grew out as in the former as low lateral horizontal folds. It seems that in Manatee the flukes have been arrested in development so that they simulate somewhat the early stages of the outgrowth of the cetacean flukes, as shown in the accompanying figures of embryos of the latter.

In those fossil forms which are less degenerate than the existing species, *Halitherium Schinzi*, for example, had the rudimentary femur directed backwards towards the flukes just as in the tibia in the existing cetaceans and pinnipeds, according to the interpretations of Lepsius,† who has given excellent figures of the skeleton of this type. This direction of the femur, as already urged in the case of analogously modified forms, is very significant, and goes a great way in helping to substantiate the view that the flukes are also modified hind limbs in the sirenians.

In *Halitherium* there is a well-developed acetabular fossa developed on the pelvic bones for the reception of the head of the femur. Neither femur nor acetabulum is developed in the living genera *Halicore* and *Manatee*. Rhytina probably had the pelvic bones as well developed as in *Halicore*, in which they are present as two pieces, an anterior probably corresponding to the ilium and ischium of normal mammals. The pelvis in *Manatee* seems to be composed of a single almost quadrate element, as seen from the side, and is so reduced that it represents the extremest condition of atrophy of the pelvic elements yet known, unless, as Mr. F. W. True thinks, after an unsuccessful search for this element, it is altogether absent in *Kogia*, the pygmy sperm whale.

This condition of degeneracy of the pelvis of sirenians is manifested

* Description de l'œuf et du placenta de Halicore dugong, suivie de considerations sur le valeur taxonomique et phylogénique des caractères différentiels, fournis par le placenta des mammifères. Tijdschrift der Nederlandsche Dierk. Vereen, Dl. IV, 1879, pp. 1–29, pls. I–II.

† Halitherium Schinzi, die fossile Sirene des Mainzer Beckens. Abhand., des Mittelrheinischen geolog. Vereins, I, Lieferungen 1 and 2, 4to, Darmstadt, 1881 and 1882.

in three well-marked stages, starting with *Halitherium* and ending with *Manatee.* The extreme degeneracy of the pelvis of the latter it would seem is in keeping with the undeveloped flukes of this type, which are mere rounded expansions of the tail, which seems to be simply flattened and widened posteriorly into a sort of spatulate form, as in Fig. 20, Plate III, showing in the outer outline the form of the adult and in the inner outline that of the tail of the embryo, both being quite unlike the tail of *Halicore*, Plate III, Fig. 22, and *Rhytina* with their pointed flukes.

That *Halitherium* ever possessed external limbs appears to me to be exceedingly doubtful inasmuch as its femur is more rudimentary than in *Balæna mysticetus*, and no tibial rudiment seems to be developed.

There is no dorsal fin developed in any one of the three genera of sirenians which have fallen under the observation of naturalists.

As to the affinities of the sirenians, I think it very doubtful if they are to be regarded as having descended from the same mammalian type as the cetaceans, for, with the exception of the degenerate pelvis and distal remnants of hind limbs, they diverge from the normal type far less than do the cetaceans; in fact, relatively but little more in other respects than do the Pinnipedia. That it is possible that they were differentiated by a process similar to that which has brought about the modification of the cetaceans, but from a quite distinct form, I think quite conceivable. Indeed it is quite easy to understand that a perfectly similar change might be induced in two types originally very greatly dissimilar through the long-continued action of similar influences affecting the functional adaptation of the hind limbs, as already suggested in the case of *Ichthyosaurus*.

The length of the free parts of the pectoral limbs of the fœtal Dugong described by Harting was almost exactly half of the total width across both flukes, the length of the former being 5 centimeters, and the transverse width of the latter 10.3 centimeters. This is a very suggestive correspondence, but need not be insisted upon as indicating anything like so near a likeness between the manus and pes as in *Cetacea*, because the fore limb in Sirenians has the arm bones better developed than in the former and extended outward farther beyond the level of the common integumentary covering of the animal. The nails are also more or less well developed on the manus in the manatee.

The smallest fœtal sirenian of which I have been able to find figures and a description is by Prof. B. G. Wilder.* This specimen, of which I reproduce Wilder's original figures, measured 2.3 inches from the vertex to root of tail, 3.7 inches if fully extended. Greatest width of tail 11 millimeters or nearly one-half inch. A view of the hinder part of this embryo, Fig. 20, Plate III, from below shows that the trunk is much more abruptly swollen at the point in front of where the tail begins

* On a fœtal manatee and cetacean, with remarks upon the affinities and ancestry of the Sirenia, Amer. Journ. Sci. and Arts, 3d ser. X, 1875, pp. 105–114, plate VIII.

than the adult, as shown in the outer outline, Fig. 20. The flat lobes of the tail are relatively not as wide transversely as in the adult, and are more gently rounded laterally so as not to have that squarish posterior outline from above as in the adult. It is thus very evident that the tail of the manatee in all probability at first grows out as in the *Cetacea*, as a low longitudinal fold on the side of the tail.

Wilder, however, describes and figures a feature in this embryo which is probably one of the most important which we have had to discuss in this paper. I refer to what he calls a median papilla. He says: "The tail forms nearly a right angle with the trunk. *Upon its ventral border near the tip is a minute median papilla*, which does not appear to have been observed in larger specimens, but there is no trace of the notch or depression described by Dr. Murie in both of his specimens." (P. 106, *l. c.*) I have italicized part of one of his sentences.

This "minute median papilla" is obviously nothing more than the last remaining vestige of the end of a tail exserted beyond the lateral flanges or flukes in this type, and which, as development proceeds, is covered in by the tail folds from before backward; that is to say, as the flukes or pedal folds during development grow still more in length they include this papilla, and finally leave the median notch figured by Murie. The above is nearly the same as what happens in the embryos of Cetacea, as the flukes become falcate, when the tip of the tail proper is found to lie in a more or less well-marked notch, Fig. 15, Plate II, between the flukes of opposite sides, whereas in the very early stages the tip of the tail proper, and not the fluke, is the most posterior point of the creature's backward extension.

But Professor Wilder expressly states (*op. c.*) that "it may at first seem strange that there are no traces of hinder limbs in this fœtus, and that the front limbs are not more like the legs of its supposed quadrupedal ancestors."

"It is by no means *impossible* that an embryo just forming would present rudimentary hind limbs in accordance with the usual vertebrate type." When farther along, Professor Wilder states in his summary that "this, while contrary to the usually accepted rule, may be really an exemplification of a more comprehensive law, namely, *that the young of animals resemble their ancestors*," he has stated a generalization which is to a larger extent true than generally supposed, as I have sought to show in previous papers.

The question here, however, is, have all external traces of hind limbs vanished? The median caudal papilla we have regarded as the end of the tail proper in the fœtal manatee; the great lateral expansions of the tail therefore become comparable to lateral limb folds or to the last vestiges of external limbs, heredity having attempted after complete atrophy of the hinder limb skeleton to repeat the story of their development. So it has happened that their present condition as lateral folds filled with comparatively undifferentiated mesoblast coincides with the first stages of the development of the vertebrate limb. In other words, the general law that the first stage of limb-growth to be evolved by the class is the last to disappear is here most emphatically confirmed by the development of the backwardly translocated distal vestiges of the limbs of sirenians.

The argument from *Pteronura* here also utterly fails to be satisfactory because the terminal exserted end of the tail of the fœtus of the Manatee shows that the limb folds are truly to be considered lateral as in other vertebrates, and are not evolved from a continuous marginal caudal ridge or fold extending along the whole length of the tail, but from short folds representing limb rudiments which have been derived from functional limbs.

A consideration of the muscular system is important in its bearings upon my hypothesis, so it will be desirable to cite Murie's * observations on the muscles of this region of the Manatee. We will first note the dorsal muscles of the tail, or those lying above the vertebral column.

"What corresponds to the combined or continuous *spinalis dorsi* and *levator caudæ internus* is a long, narrow, but in the back vertically, deep muscle, which runs from the neck backwards as far as the end of the tail. Anteriorly, where laterally compressed but fleshy, it fills vertically the hollow between the cervical spines and transverse processes. Posteriorly it becomes tendinous and aponeurotic, and is fastened to the caudal vertebræ superiorly.

"There is a massive and in great part fleshy *longissimus dorsi*, which extends outside the last from the first rib backwards to the very end of the caudal vertebræ, thus including what constitutes the levator caudæ externus of most other mammals. Like the preceding, the tail-tendons are interwoven into an aponeurosis, partially fixed to the transverse and to the spinous processes." (*Op. cit.*, p. 144.)

The ventral or hyposkeletal, lumbo-caudal system is not prolonged so far forwards, and has a posterior insertion different from the dorsal set.

"The first and notable muscle is that which in the profile and underview appears as a great and only mass filling the interval between the last rib and the caudal extremity and the space between the chevron bones and the tips of the lumbo-caudal transverse processes. This aspect is in some respects deceptive, as the muscle, when manipulated by the scalpel, is found to be only one of two thick and long layers occupying the area in question. The superficial stratum or musculo-tendinous lamella arises from the outer half and inferior surface of the last rib, being here partially overlain by the external oblique and panniculus; thence, with inwardly oblique fibers, it is inserted mesially from the third chevron bone backwards to the termination of the spinal col-

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* On the form and structure of the manatee, by Dr. James Murie, Trans. Zool. Soc. London, VIII, 1874, pp. 127–202, pls. 17–26.

umn, and outwardly is fixed to the tips of the transverse processes. Anteriorly, the muscle is strong, thick, and very fleshy; but half-way along the tail, and nearly throughout the middle line, it becomes tendinous, by degrees thinner, and towards the end is little else than a glistening aponeurotic fascia with coarse, tough fibers. These fibers, when unraveled with care, separate into broadish tendons, one to each vertebræ, which posteriorly commingle with the great flat-tail aponeurosis.

"The second or deeper muscular lamella, also taper-shaped, is, as a whole, much thicker and fleshy, but not quite so broad as the last. Besides a very small slip anteriorly derived from the last rib, it has firm attachments along the under surfaces of the two lumbar and all the caudal vertebræ, filling the interspace betwixt the vertebral bodies, the sides of the chevron bones, and the distal extremities of the transverse osseous elements. This sheet, like the former superficial one, is fleshy anteriorly and tendinous inwardly and behind. Its terminal fasciæ or tendons are more cord-like, and with less difficulty resolvable into separate elements." (*Op. cit.*, pp. 145, 146.)

Dr. Murie then continues and describes a lateral subcaudal muscle, which is of considerable interest, in that it sends its tendinous insertion backward to the vicinity where the margin of the great lateral tail folds end anteriorly. His account of it is as follows: "Lastly, if considered amongst the subcaudal muscles, and not what it to some extent simulates, a continuation of the sacro-lumbalis, we have the lateral or superficial outlying fusiform muscle intermediate between the dorsal and ventral surfaces of the tail. This numerically fifth infracaudal muscle, narrow, roundish, and tapering, has origin close to the termination of the sacro-lumbalis, from the cartilaginous tip of the transverse process of the sacral or first true caudal vertebra, and lies horizontally along the next eight processes. It terminates in a long but strong tendon upon the surface of the subcaudal muscle, mingling with its fascia." (*Op. cit*, p. 146.)

Dr. Murie also speaks of an anterior subcaudal pair, which are marked *quadratus lumborum* in his plates.

While the writer would not wish to appear hypercritical, he cannot agree with Murie and Stannius in regard to the homologies of the hyposkeletal muscles of the tail. It is of course obvious from the preceding description that the whole of the infracaudal muscular mass in the Manatee cannot be homologized with the psoas muscles of human anatomy, but it is evidently impossible to homologize the anterior muscular bundles of the deeper of these muscles, arising from the under face of the two lumbar vertebræ, with anything else than the psoas magnus of man. Obviously, if we bear in mind the importance of serial homologies, the muscular slips arising from and behind the sacrum cannot be psoas, and *infracoccygeus* and *sacrococcygeus* may therefore be good names for those hinder portions. The inner pair of muscles alluded to above as quadratus lumborum, have a far better right to be considered psoas parvus than to bear the former name, because it must be remembered that the vertebræ from which they arise, though dorsal in Manatee, are lumbar in man.

It is thus made evident, it seems to me, that tendinous terminations of a muscle in the Manatee perfectly homologous with the psoas usually inserted into the trochanter minor of the femur of normal forms, actually find their way to the tendinous aponeurosis of the great flat tail which represents the feet of normal forms. This would seem to follow from the consideration of the arguments adduced in favor of the doctrine that the insertions of certain limb muscles are translocated backwards in the pinnipeds.

The fibers in the great lateral tail folds have a generally backward and outward direction from the spinal column, according to Murie's figures, and the great medullary plate of "aponeurotic fibers" along its inner border or attachment to the side of the caudal chain of vertebræ lies below the level of the transverse processes, its anterior portion showing a very strongly marked inclination to assume a ventro-lateral position, which, if continued forward, would strike the pelvis lying some distance below the axial column.

It is probably along this line extending from the pelvis to the flukes that the atrophy of the limbs of the sirenians has occurred.

VIII.—On what appear to be tactile hairs or vibrissæ in cetaceans and sirenians.

A few scattered hairs are found about the lips of the adults of some of the right whales, and it may be interesting to call attention to an embryonic trait of *Rhachianectes*. In an embryo of *Rhachianectes*, Fig. 1, Plate I, there are present minute dermal pits having a very singular distribution between the external openings and the tip of the muzzle. A smaller number of them are found just below the edge of the lower lip, as seen in the side view of this embryo. The distribution of these rostral hair follicles is shown from above, in Fig. 2. There is some evidence that these structures, as in those from which the vibrissæ of the upper lip of *Carnivora* grow, are arranged in rows, but not so regularly as those shown in the embryo walrus, as seen from the side. In the embryo kitten about an inch long, as in the walrus, they are confined to the upper lip on the sides of the muzzle, and are limited to a small circumscribed area somewhat elevated from the adjacent integument. In none of the other cetacean embryos studied by me were these pits for the vibrissæ so numerous as in *Rhachianectes*, and in an embryo of *Phocæna communis*, Fig. 7, there is a single row of seven of them on either side of the muzzle lying in a shallow groove one-eighth of an inch above the edge of the upper lip; none present on the sides of the lower lip. In the younger ones and in *Globiocephalus* they were not present or at least distinguishable with the aid of a pocket lens.

In an advanced fœtus of *Phocœna communis*, in the museum collections, there are present on either side of the snout two strongly developed vibrissæ in the situation corresponding to the position of the vibrissal pits or follicles noticed in a much younger specimen, in which these are, however, much more numerous. This advanced stage was kindly brought to my notice by Mr. True. Eschricht, however, calls attention in his *Untersuch. über nordischen Wallthiere* to a number of the earlier allusions to the occurrence of such hairs on young cetaceans, figuring the distribution of the follicles which give rise to them, especially those seen on the snout of the fœtus of *Megaptera longimana*, Fig. 16, Plate II, between the blowholes and the end of the muzzle, where a considerable number of dermal follicles are shown as elevations of the integument, though they do not show much greater regularity of arrangement in rows than do those of *Rhachianectes.* Eschricht also figures their follicles in a fœtus of *Balœnoptera rostrata*, Figs. 18 and 19, Plate III, where three are shown above the margin of the upper lip, and four on the lower, the upper series being arranged more like the seven shown on the upper lip in Fig. 5, Plate I, or in a single row, yet it appears in this last case, after comparison of this stage with later ones of the same species, that only two of the follicles develop outwardly apparent bristles, five of them subsequently aborting when the young animal is about a foot in length. Between this last-mentioned stage and the adult condition the two remaining vibrissæ seem to disappear so that in the adult *Phocœna* no vibrissæ are distinguishable.

Inia, with its feebly developed dorsal fin we have already had occasion to notice as less specialized in that respect than other forms, has the beak provided over both its mandibular and maxillary halves with short bristles, apparently indicating that in this form there has been a less marked loss of what were once, in part at least, vibrissæ, such as are found over the upper lip of fissipeds and pinnipeds, and below the mouth and above it in *Dicotyles.*

The strong short vibrissæ of the walrus on the sides of the muzzle and the vibrissæ found within the inflected margins of the lips of the Manatee are somewhat similar, but it is very possible that the protractile and retractile lips of the latter animal enables it to use these stiff bristles as prehensile organs, and in part as substitutes for incisors in grasping and tearing off the soft aquatic or marine vegetation upon which it feeds.

The distribution of the vibrissæ on the snout in carnivorous types seems to be mainly over the sides of the muzzle above the mouth, but in the Ungulates, especially the suilline group, vibrissæ are found both above and below the mouth. Inasmuch as the whales and porpoises exhibit both of these distributions of their vibrissæ, it is impossible to draw any conclusions from their mode of arrangement which will be of any value in determining their taxonomic relations. The most that can be said is that the Balænoid cetaceans seem to approximate the suilline Ungulates in the distribution of the vibrissæ in the fœtal condition. The Delphinoid forms, on the other hand, show three types of distribution of the same organs, namely, that seen in *Inia*, which approaches that of the pigs, that of *Phocæna*, which approximates slightly that of the *Carnivora*, and a third which approaches neither, all indications of vibrissæ being absent even in the fœtal condition. That the distribution of tactile hairs cannot be of much importance in taxonomy is shown by the fact that a cluster of tactile hairs is found above the eyes in the pig, dog, and seal, and another at the lower border of the cheek near the angle of the lower jaw in *Dicotyles* and *Canis*.

It may occur to the reader to ask why the dermal follicles found about the muzzle of cetacean embryos should be considered to give rise to vibrissæ and not simply to hairs. The reasons why I chose to consider them in the former light is this: They resemble singly very strikingly in the cetacean fœtus the appearance of the single follicles forming the cluster found in the same vicinity, but above the mouth only, in the fœtus of the cat and seal. A tactile hair or vibrissa is only a hair developed to an unusual size, and in *Cetacea* as well as in *Carnivora* these organs seem to have their follicular rudiments formed in the latter at least before the follicles which give rise to the general hairy covering of the body are apparent. Their situation close to the mouth is another reason. The remarkably regular arrangement of the vibrissæ of the muzzle of *Carnivora* in rows, which may be traced in two directions at an acute angle with each other, is not apparent in any cetacean.

In none of the early fœtuses have I found vibrissæ actually developed so as to be outwardly visible; the follicles which give rise to the latter alone seem so far to have been formed in the fœtuses. This is the case so far as I have been able to make out in both the early fœtuses of *Carnivora* and *Cetacea*.

IX.—Summary.

The results of the preceding studies may be briefly embodied in the following paragraphs:

1. The structure of the pinnipeds indicates that the process by which their hind limbs were directed backward and partially included together with the tail in a common integumentary investment, would, if exaggerated, lead to the translocation and fusion of the feet with the end of the sides of the tail as in the cetaceans, in which the now degenerate, backwardly-displaced feet are represented by the flukes.

This general thesis is supported by the following minor considerations which have been developed in the successive subdivisions of the preceding memoir as follows:

1. The inconstancy of the dorsal fin; its variability in size, from none at all to a well-developed one, and its variable position.

2. The non-connection of the dorsal fin with any muscles and its

median blood supply. Its late development in the embryo after the pectoral limbs and flukes are formed, and its evolution from a median dorsal tegumentary fold or carina.

3. The presence of a well-marked cervical constriction in early cetacean fœtuses, indicating a closer affiliation at some remote period with ambulatory amphibious or terrestrial mammals than the type now manifests.

4. The probable evolution of extra terminal phalangeal segments in the digits of *Cetacea* from cartilaginous terminal prolongations of the ungual phalanges developed in a seal-like ancestral type.

5. The presence of two sets of vessels in the flukes corresponding to a dorsal and a plantar set, and arranged somewhat after the manner of the vessels on the manus, and the probably similar position of the hallux and pollex on the outer border of the manus and pes in the *Protocetacea* as well as in the *Pinnipedia.*

6. The connection of the hyposkeletal muscles of the tail with the flukes by tendinous fibers or fascia in both *Cetacea* and *Sirenia* as a result of the translocation backwards of the insertions of the muscles corresponding partly to the ilio-psoas, which is partly inserted in terrestrial forms into the femur.

7. The tendency to shift the insertions of the muscles of the hind limbs rearward in pinnipeds, a process which was also presumably active in the protocetaceans.

8. The belated outgrowth of the rudiments of the hind feet (flukes) of cetaceans, in conformity with the general embryological law that the rudiments of fore limbs in vertebrate embryos generally appear somewhat earlier than the hinder ones. Degeneracy in the *Cetacea* has also affected their unusually belated outgrowth in this type.

9. The lateral position of the flukes, as corresponding serially with rudiments of hind limbs.

10. The mode of development of the flukes as diverticula of the epiblast filled with indifferent mesoblast the same as the primary limb rudiments of other vertebrates.

11. The hypertrophy of the caudal musculature and skeleton of the *Cetacea* and the differentiation of the tail vertebræ into two well-marked series.

12. The atrophy in cetaceans of the elements of the pelvis and limb skeleton in exactly the inverse order in which they are developed in normal forms.

13. The tendency to degeneracy of the pelvis and proximal elements of the limbs of pinnipeds, which are tending to degenerate in the same direction as have the same elements in the cetaceans.

14. By the tendency in cetaceans to prolong the lumbar plexus towards the tail to supply the cenogenetically developed caudal musculature.

15. The direction of the axis of the bones of the crus, when developed, towards and in a line with the pes in swimming, in both pinnipeds and cetaceans.

16. The direction of the axis of the rudimentary femur in *Halitherium*, and the tibia in *Balæna*, towards the flukes.

17. The presence of a supposed free rudiment of the tail in the fœtus of the manatee, which is exserted beyond the flukes.

18. The effect of the translocation of the paired limbs as observed in other types, especially as indicating that the outgrowth of the limb folds in advance of or behind their original or archaic site is influenced by heredity, which acts more powerfully through immediate than through remote ancestry, in this as in many other cases.

EXPLANATION OF PLATE I.

Reference letters: *a*, anus; *b*, blow-hole or holes; *cl*, clitoris; *d*, dorsal fin; *e*, external auditory meatus; *f*, flipper, or fore limb; *h*, lateral fluke folds or outward rudiments of pedes; *m*, mouth, in Fig. 8; *p*, penis; *u*, umbilical cord or navel-string.

Fig. 1. Female fœtus of *Rhachianectes glaucus*, or California gray whale, natural size, seen from the side, showing the distribution of the follicles for the vibrissæ on the snout above and below the cleft of the mouth (N. M. Coll.).

Fig. 2. Head of the same, seen from the front, showing the separated blow-holes and the follicles for vibrissæ between the nostrils and the tip of the snout.

Fig. 3. Sketch of the perineal region of the same, as seen from below, showing the anus, the vulva behind the clitoris, and the very minute mammary fossæ or clefts on either side of the latter.

Fig. 4. The tail of the same, as seen from below, to display the rounded or lobe-like fluke folds.

Fig. 5. Male fœtus of *Phocæna communis*, natural size (N. M. Coll. 14294, Provincetown, Mass., Freeman & Hillman), showing follicles for seven vibrissæ on the side of the snout above the mouth.

Fig. 6. View from below of the perineal region of the preceding.

Fig. 7. View from above of the tail of the same.

Fig. 8. Side view of a somewhat damaged fœtus of *Phocæna* (N. M. Coll. 11204, Eastport, Me., G. B. Goode.)

Fig. 9. Side view of a female fœtus of *Globiocephalus* the Caaing whale or blackfish, natural size (N. M. Coll. 14295, Wood's Holl, Mass., V. N. Edwards).

Fig. 10. View of the tail of the same, showing the very low horizontal fluke folds just beginning to be apparent on the sides of the end of the tail.

EXPLANATION OF PLATE II.

Fig. 11. Fœtus of the narwhal, natural size, from the side. After Eschricht.

Fig. 12. Male fœtus of the white whale, *Delphinapterus*, from the side. After Eschricht.

Fig. 13. Male fœtus of *Delphinapterus* as seen somewhat obliquely from below, natural size. After Eschricht.

Fig. 13*a*. Tail of the preceding, showing the first stages of the outgrowth of the fluke folds. After Eschricht.

Fig. 14. Fœtal kitten, twice natural size, to show the relatively early differentiation of digits and the outwardly apparent wrist, elbow, ankle, and knee joints, and the similarity in curvature of the cetacean and fissiped embryo of relatively the same age. From a specimen given me by Mr. J. L. Wortman,

Fig. 15. Diagrammatic figure illustrating six stages of the outgrowth of the flukes of cetaceans, the successive contours being compiled from various sources; the last stage being approximately that of the flukes of the adult to show the way in which the caudal notch is developed over the end of the tail.

Fig. 16. View of the top of the head of a fœtus of *Megaptera longimana*, natural size, to show the arrangement of the hair follicles or vibrissæ on the snout. After Eschricht.

Fig. 17. View of right flipper or fore limb of the fœtus of *Globiocephalus* represented in Fig. 9, Plate I; drawn after the whole limb was detached and rendered transparent with clove oil. Enlarged 16 times, *h* humerus, *r* radius, *u* ulna, *p* pisiforme, I pollex, and II, III, IV, and V, digits.

EXPLANATION OF PLATE III.

Fig. 18. Head of male fœtus of *Balænoptera rostrata*, natural size, showing the two blow-holes and three follicles on either edge of the snout for vibrissæ. After Eschricht.

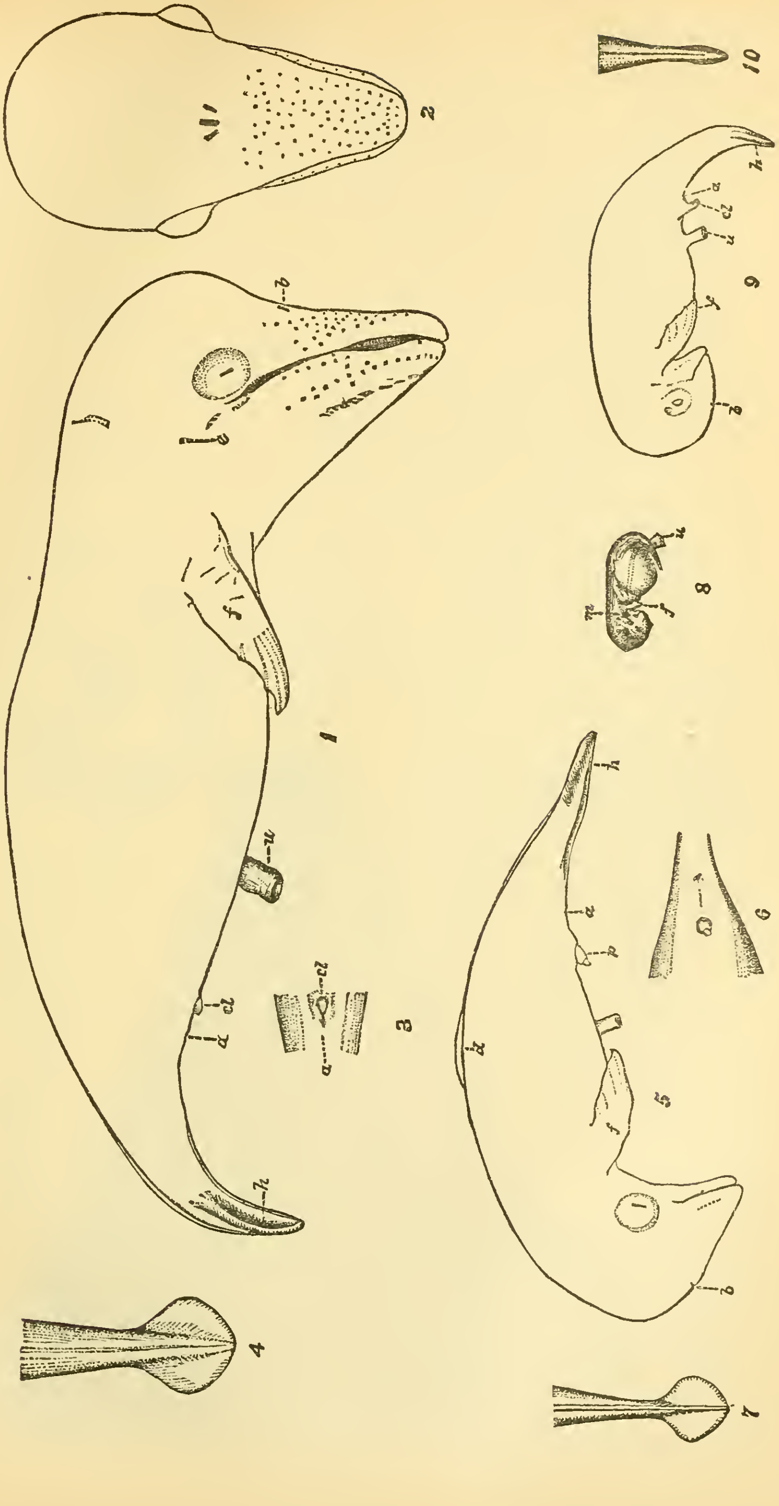
Fig. 19. Side view of the same fœtus displaying four follicles for vibrissæ below the edge of the lower lip, and showing the median notch at the end of the tail. After Eschricht.

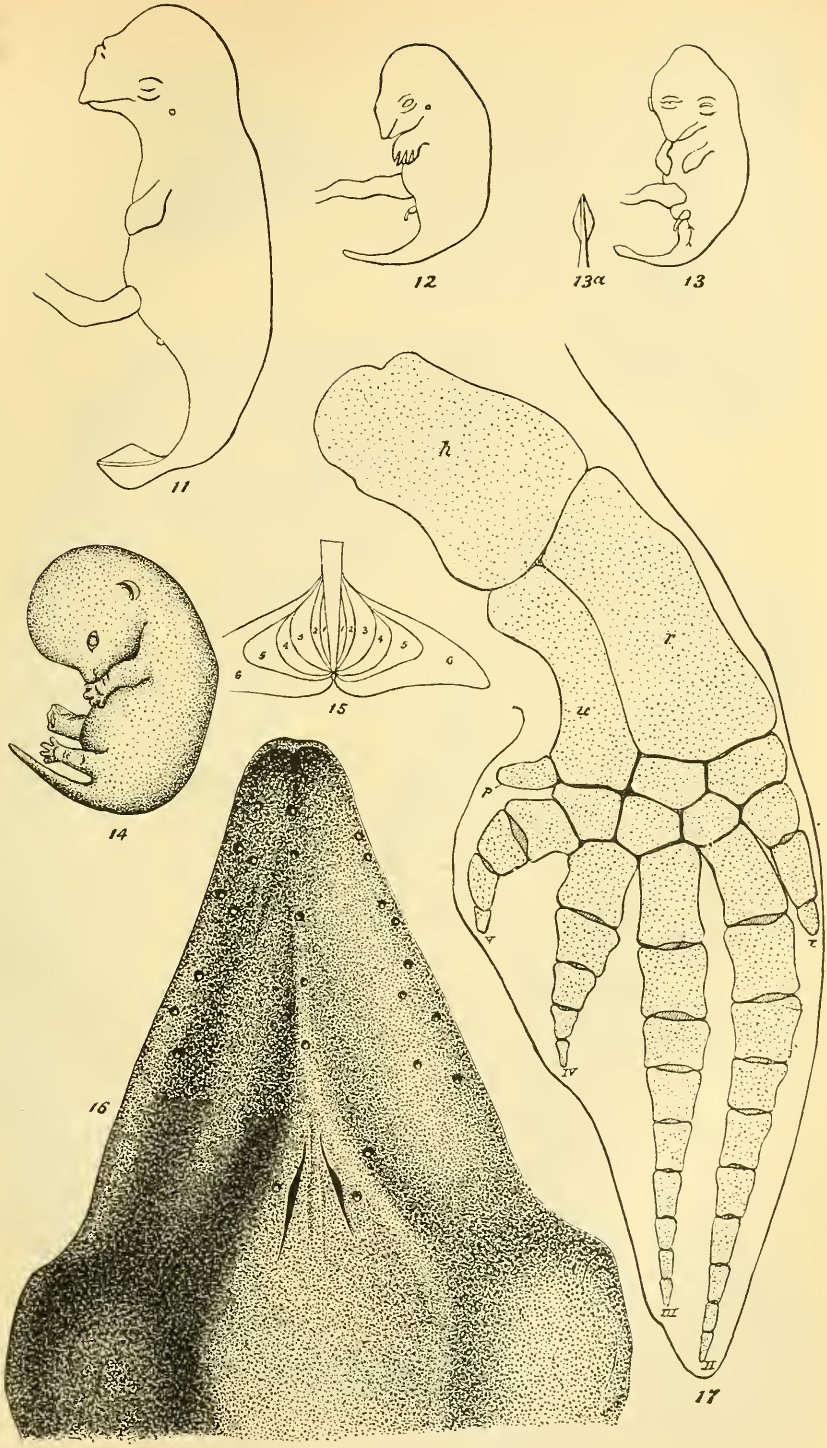
Fig. 20. The inner contour lines show the form of the tail of a fœtal manatee, natural size, from below, with a median papilla near the end and within the lower margin, *a* anus, *cl.* clitoris. After Wilder.

The outer contour shows the configuration of the tail of a young male manatee 4 feet long, as seen from above, and reduced from Murie's figure to nearly one-fifteenth natural size in order to show the changes of form undergone by the tail in passing from the fœtal to the adult condition.

Fig. 21. Female fœtus of manatee, 3.7 inches long, obtained by the late Professor Orton, and figured by Wilder. Natural size, viewed from the side, *a* point of elbow, *c* carpus, *n* nostril, *e* ear. After Wilder.

Fig. 22. Male fœtus (?) of *Halicore dugong*, one-half natural size, *n* nostril, *e* ear, *u* umbilical cord, *p* penis (?), *a* anus. After Harting.

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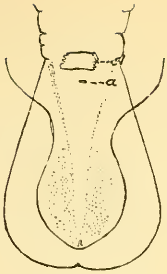

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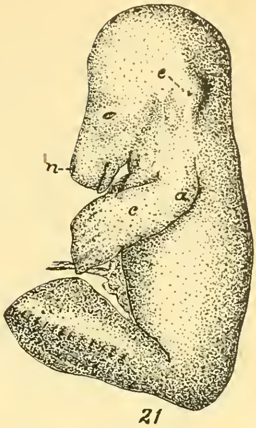

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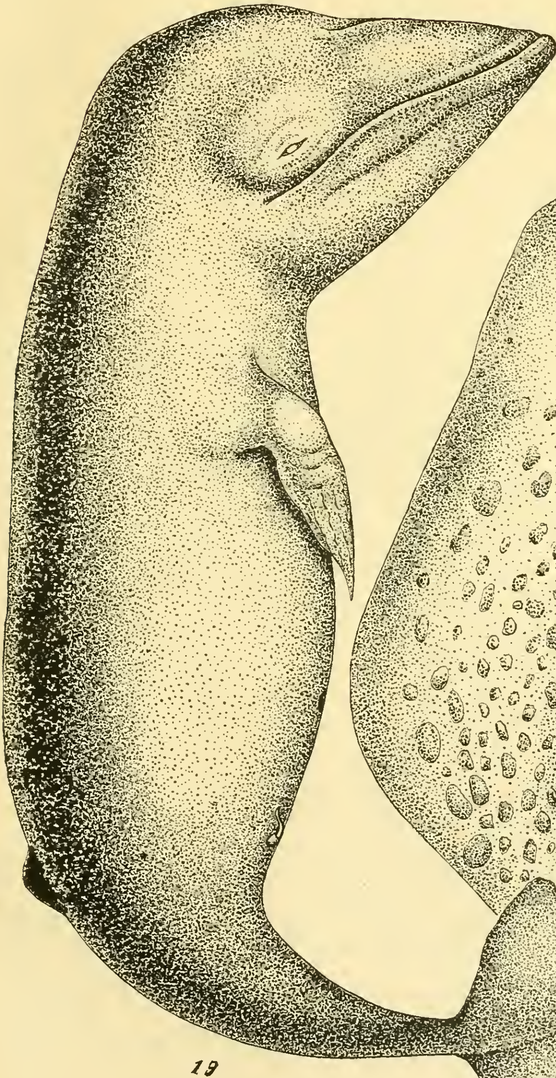
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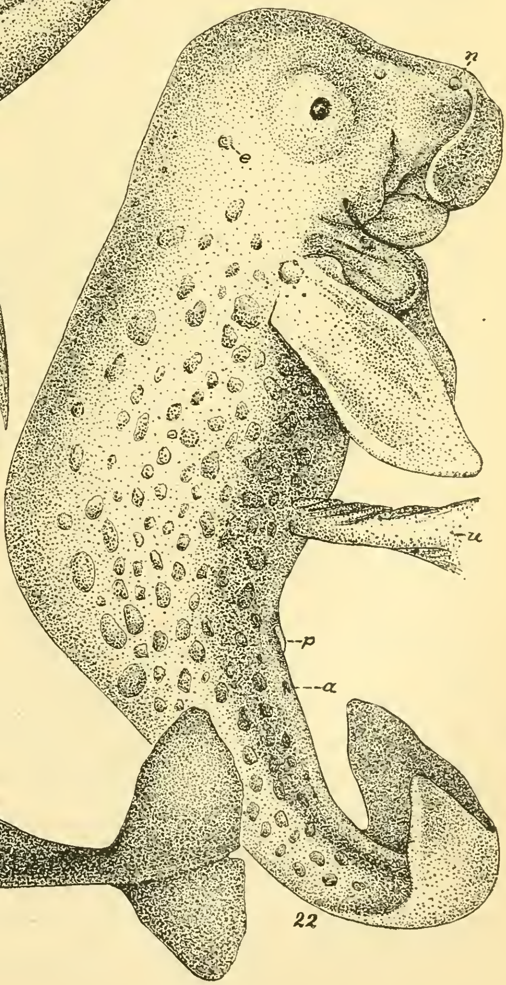

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[NOTE.—The references are to page figures in brackets.]

XX.—ON THE DEVELOPMENT OF OSSEOUS FISHES, INCLUDING MARINE AND FRESHWATER FORMS.

BY JOHN A. RYDER.

I.—GADUS MORRHUA L. (*The Cod.*)

The main features of the development of this species have been described and illustrated in a previous memoir[1] by the author, so that it will not be necessary to do more than to add observations made since the publication of that paper, and otherwise complete the record of the early life-history of this important food-fish.

The views of Hoffmann[2] as to the meaning and sequence of the phenomena attending the fertilization of fish ova have been disputed since the above-cited essay was written, and apparently upon the basis of well-determined data. The most recent contribution to this subject is by Agassiz and Whitman,[3] who state, page 19, in reference to the development of *Ctenolabrus*, that "immediately after the penetration of the spermatozoön a disk-like thickening of the cortical layer appears at the lower pole of the egg; and at the center of this disk may be seen, in mounted preparations, the minute male pronucleus. It is a curious fact, of which the proof will be given in our second memoir, that the male pronucleus becomes the center of attraction around which the discoidal aggregation of protoplasm takes place, and towards which, after the formation of the second polar globule, the female pronucleus gravitates."

In another paper[4] Agassiz and Whitman have also discussed the origin of the *periblast*, as it is called by them, reaching the conclusion that the "autoplasts" (Lankester), the free nuclei of authors, do not arise spontaneously in the layer of protoplasm underlying the germinal disk, nor from a single nucleus developed at the time of the first cleav-

[1] A contribution to the embryography of osseous fishes, with special reference to the development of the cod (*Gadus morrhua*). Report of the United States Commissioner of Fish and Fisheries, part x, for 1882, pp. 455–605, pls. xii. Washington, 1884.

[2] C. K. Hoffmann. Zur Ontogenie der Knochenfische, chapters i–viii, 4to. Amsterdam, 1881.

[3] A. Agassiz and C. O. Whitman. The development of osseous fishes. I. The pelagic stages of young fishes. Studies from the Newport laboratory. Mem. Mus. Comp. Zool., xiv, No. 1, part 1, 4to, pp. 56, 19 plates. Cambridge, 1885.

[4] On the development of some pelagic fish eggs, preliminary notice. Proc. Am. Acad. Arts and Sciences, xx, 8vo, pp. 23–75, 1 pl. 1884.

age, as held by Hoffmann (*op. cit.*), but are segmented off from the marginal cells of the segmenting blastodisk as suggested by the writer in his first paper on the cod.

With the further growth in diameter of the blastodisk the marginal cells, which are without well-defined outlines, are finally covered over by the spreading blastodisk. In this way the nuclei of the periblast (a layer which is in reality a syncytium) are finally brought into such a position that they seem to underlie the blastodisk. The nuclei in the periblast are, however, always most abundant near the edge of the blastodisk at an early stage of development. During the later stages the nuclei of the periblast are most numerous just beneath the embryonic axis, especially under the head.

The marginal segmentation, which gives rise to the so-called "free nuclei" of the periblast, first clearly described by Agassiz and Whitman, leads to the formation of a wreath of flat cells which form a more or less well-marked zone around the blastoderm upon the completion of the segmentation of the blastodisk. This marginal wreath of cells, "nuclear zone" of Kupffer, has been figured by the latter,[5] E. Van Beneden,[6] the writer,[7] Brook,[8] Cunningham,[9] and by Agassiz and Whitman. The essential agreement of so many observers working upon very different species shows that this nuclear zone must be very generally developed in the eggs of Teleosts, and even amongst the Salmonidæ, where it is not so easily observed in the living egg, but which is shown in the sections figured by E. Ziegler.[10]

The development of this "nuclear zone" in the eggs of the cod escaped my observation when I studied the development of that species in 1881, but I have during the past year (1885) observed it, and have, moreover, satisfied myself that it arises as observed in *Ctenolabrus*, by Agassiz and Whitman, and that it is subsequently covered over by the spreading blastoderm, while the nuclei of the periblast, also subdivide by the indirect method, and proliferate inwards beneath the blastodisk. Cunningham's observations are in accord with these.

The synonymy of the term periblast may profitably be considered here. It obviously corresponds to the "white yelk" of the bird's egg;

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[5] Kupffer. Beobacht. ü. der Entw. der Knochenfische. Arch. f. mikr. Anat., iv, pl. xvi, fig. 1. 1868.

[6] E. Van Beneden. A contribution to the embryonic development of the Teleosteans. Quar. Jour. Mic. Sci., xviii, 1 pl. 1878.

[7] J. A. Ryder. Development of the Spanish mackerel. Bull. U. S. Fish Com., i, 1881, pp. 135–172, pl. i, fig. 4.

[7a] J. A. Ryder. Development of the silver gar. Bull. U. S. Fish Com., i, 1881, pp. 283–301, pl. xix, fig. 3.

[8] Brook. Preliminary account of the development of the Lesser Weever-fish, Trachinus vipera. Journ. Linn. Soc. Zool., xviii, 1884, pp. 274–291, pl. iii, figs. 8, 9–9*a*.

[9] J. T. Cunningham. On the relations of the yelk to the gastrula in Teleosteans, and in other vertebrate types. Quar. Jour. Mic. Sci., 1885, pp. 38, pls. iv.

[10] Die embryonale Entwickelung von Salmo salar. Inaug. Diss., Freiburg i, B., 1882. Taf. i, figs. 6–10.

"*Subgerminale Platte*" of Kupffer; *Dotterhaut* and *membrana vitellina* of Œllacher; *couche intermédiaire* of Van Bambeke; intermediary layer of authors; *parablast* of His, Waldeyer, Hoffmann, Gasser, Kupffer; *yelk-hypoblast* of the writer; *couche hæmatogéne* of Vogt; and the *plasmedium* of Rauber.

The annular thickening of the periblast, just under the edge of the blastodisk, is clearly homologous with the *Keimwall* of His or the *Keimwulst* of Kölliker, as seen in the ova of Sauropsida. The function of this periblast is also clearly established throughout the various series of Vertebrates which develop meroblastic ova; its cells, in fact, incorporate yelk particles, by a process which is essentially one approximating that of intracellular digestion. Finally, the periblast may give rise directly to free cells, which pass into the vascular channels of the embryo as blood-corpuscles.

This disposition to absorb the underlying quiescent plasma is also shown by the lower cells of the true hypoblast which immediately overlies the periblast. Such hypoblastic cells which are larger than their neighbors have been called megasphæra by His, and have also been figured by Kölliker in the Avian blastodisk, while they have been encountered by the writer in the blastodisks of Teleosts.

In the eggs of the cod, as in most pelagic fish ova, the periblast is quite thin after the closure of the blastopore, but as the yelk diminishes in quantity with the progress of development this layer becomes decidedly thicker. The entire yelk is, in fact, first converted into the plasmodial substance of the periblast before it is absorbed by other parts of the embryo. It therefore results that the last portion of the yelk to disappear is the periblast.

The periblast is undoubtedly hypoblastic in position, and in many large-yelked forms is homologous with the splanchnopleure, as in the case of the embryos of Salmonoids, in which, together with the vascular network traversing it superficially, it eventually occupies the position of the splanchnopleural mesoblast in relation to the other layers.

(1) *Development of the hypoblast or the gastrulation of the egg.*—This almost threadbare subject I return to reluctantly, because so much which is erroneous has been written about it. Balfour's account in his Comparative Embryology, ii, 57, is far from clear, and conveys but little definite information as to the origin of the hypoblast. That the latter is developed as a "centripetal ingrowth of cells from the margin of the blastodisk" (Agassiz and Whitman) there can no longer be any doubt, though in my earlier studies on the development of the cod I opposed that view, because I had not succeeded in witnessing the process, which I have observed since in detail, as has also been done by Cunningham.

I find that the cells at the edge of the blastodisk are inflected around its entire margin, but that at the point where the future embryo is formed the ingrowth is most rapid, and soon becomes somewhat wider.

Later, the hypoblastic layer, which has arisen by the process of inflection just described, forms a sort of rounded promontory or tongue of cells, several deep, which is prolonged inwards under the epiblast with the progress of the development and the growth in length of the two-layered rudiment of the embryo. The views of Gœtte,[11] Haeckel,[12] Henneguy,[13] Ziegler, Kingsley and Conn,[14] Agassiz and Whitman, Brook, and of Cunningham, on this point, agree pretty closely as to the main fact of the occurrence of a marginal inflection of the blastodisk.

As observed by a number of investigators, the centripetal inflection of the margin of the blastodisk of Teleosts does not lead to the formation of a continuous plate of cells underlying the sensory layer of the epiblast, and of the same area as the latter. A very considerable area beneath the epiblast, and occupying an excentric position in the blastodisk, is not invaded by the ingrowing hypoblastic layer. The space not so invaded and bounded by the epiblastic layer above, the inflected lips of the hypoblastic layer at the sides, and by the periblast below, is the depressed or flattened blastocœl of the Teleostean ovum. It is perfectly homologous with that of *Branchiostoma*, but is flattened or depressed by the way in which the growth of the blastula is modified by the presence of a large yelk, which is itself invested by the periblast or yelk-hypoblast. The blastula becomes, in fact, a hollow disk.

The yelk-periblast or yelk-hypoblast, and the inflected hypoblast are hypoblastic in their relations, and must accordingly be invested in the course of development by the epiblast by epibole. The epiblast and hypoblast are accordingly fused at the margin of the blastodisk. The entire margin of the blastodisk must consequently be regarded as the blastopore or archistome of the developing Teleostean ovum, as originally implied by Haeckel. Such a condition of things would be brought about by loading or surcharging the cells of the hypoblastic pole of the blastula of *Branchiostoma* with yelk substance. The way in which the discoblastula arose may be very easily understood, if the gastrula stages of *Branchiostoma*, *Rana*, and *Gadus* are carefully compared.

With the gradual increase in the size of the yelk in the vertebrate series, it finally happens that the principal morphological features of the embryo are distinctly developed long before yelk absorption is completed. As a result of this, the yelk, which occupies a ventral position in reference to the intestine, is finally excluded from direct connection with the latter, and the periblast (hypoblastic in origin) is made to assume a new function, viz, that of ministering to the incorporation of

[11] Gœtte. Berlin. medicin. Centralblatt, 1869, No. 26, pp. 404–466, and Arch. für mik. Anat., ix, 1873, p. 679.

[12] Haeckel. Die Gastrula und die Eifurchung. Jena. Zeitschr., ix, 1875.

[13] Henneguy. Note sur quelques faits relatifs aux premiers phénomènes du développement des poissons osseux. Bull. Soc. Philom. de Paris, 10 Apr., 1880, p. 4.

[14] Kingsley and Conn. Some observations on the embryology of Teleosts. Mem. Bost. Soc. Nat. Hist., iii, pp. 183–212, pls. xiv–xvi, 1883.

the vitelline matter. Kollmann[15] has lately presented some strong evidence in favor of this view, but is in error in assuming that the lips of the inflected rim (hypoblastic stratum) of the blastoderm are the lips of the blastopore. If this view is admitted, we are logically forced to conclude that the yelk is something extraneous, and is not an integral part of the ovum, as we know it to be, judging from the way in which the periblast arises. The manner in which the latter is formed shows that the continuity of the blastodisk with the plasmic layer investing the yelk is perfect, and that the cleavage cavity is exactly homologous with that developed in a holoblastic ovum. There is, therefore, a blastula stage developed in Teleosts which is most distinctly evident at the time the "nuclear zone" is formed. The vesicular syncytium formed by the periblast is, however, so enormously distended with passive yelk that gastrulation is modified to an extreme degree. Kollmann's arguments against the final closure of the blastopore at the edge of the blastoderm and at the hinder extremity of the axis of the embryo breaks down completely, if the processes of gastrulation of *Branchiostoma*, *Rana*, and *Gadus* are compared, because such a comparison shows: First, that a gradual loading of the entoblastic pole of the blastula with yelk causes the latter to be constricted around its equator in the course of development, thus leading to the formation of a blastodisk with an inflected two-layered margin. Secondly, since the foregoing is true, it results that active development is shifted so entirely towards one pole of the egg that gastrulation also occurs there, and an attempt is made to reproduce the state of things seen in the gastrula of *Branchiostoma*, but in the effort of the active pole of the blastula to envelop the passive one by epibole it appears as if the annular entoblastic invagination was incomplete, leaving the "*Urmund*" of Kollmann open. This "*Urmund*" is homologous with a circular opening which might be produced by a rupture near the center of the inflected entoblast of the gastrula of *Branchiostoma*, and therefore is in no sense homologous with the true blastopore. The opening in the floor of the discoblastula of Teleosts and Elasmobranchs, identified by Kollmann with the blastopore, I propose to call the *discopore*, in order to permanently distinguish it from the true blastopore of authors. An equally fatal objection to Kollmann's view is that on the basis of his interpretations the blastopore of Teleosts and Selachians would not open to the exterior.

A view resembling in some respects that of Kollmann was entertained by me in 1881 (see 7*a*, *supra*, p. 298), though it was immediately qualified in paragraph 2 which followed on the same page, and was subsequently adopted in a modified form in my first paper on *Gadus* (Contr. Embryog. Oss. Fishes, p. 569). I had also observed[15a] and figured the segmentation of the "nuclear zone" or "marginal wreath of

[15] Kollmann. Gemeinsame Entwickelungsbahnen der Wirbelthiere. Arch. f. Anat, u. Physiol., 1885. Anat. Abth, pp. 279–306, pl. xii.

[15a] See No. 7, p. 146, fig. 4, pl. 1; and also No. 7*a*, p. 287, fig. 3, pl. xix.

cells" from the edge of the blastodisk. And contrary to what some of the more recent writers on Teleostean development would seem to imply, I had already suggested that the nuclear zone gave rise to the nuclei of the periblast, as the following quotation will show: "The free nuclei of the yelk-hypoblast apparently proliferate as the blastoderm spreads. They are, at any rate, at first confined to the germinal pole of the ovum, and are only found at the opposite pole after the yelk-globe has been included by the blastoderm. The inference, therefore, is that they spread and multiply with the lateral growth of the blastoderm. It is these nuclei possibly which are the centers of certain free cells around the margin of the germinal disk when the latter has attained the morula stage, as in *Cybium* and *Tylosurus*, as shown in fig. 3, pl. xix, of my essay on the latter form. If such is the case, it is possible that the germinal wall (*Keimwall*) at the edge of the blastoderm of the chick is homologous with the yelk-hypoblast of the fish ovum" (Contr. Embryog. Oss. Fishes, p. 569).

The marginal inflection of the blastodisk is figured by Kingsley and Conn (No. 14) in *Ctenolabrus*, and by Brook,[16] [17] as being composed of larger cells than that of the epiblast. Kingsley and Conn represent only a single layer in *Ctenolabrus*, a condition which I have never found to exist in sections of the disks of any of the species studied by me. Brook represents several layers of larger cells in the hypoblast. That the inferior stratum of cells of the inflected hypoblastic layer are perhaps somewhat larger than those of the epiblast I admit, but that they are generally very much larger or that the inflected hypoblast is ever formed of a single layer, as held by Kingsley and Conn, I am disposed to question.

Cunningham (On the relation of the yelk to the gastrula in Teleosteans, etc.) has studied the development of three Gadoid forms, and has been the first English investigator who has declared himself an advocate of the concrescence theory, which, in its various forms, has been supported by His,[18] Rauber,[19] Whitman,[20] and myself,[21] and latterly by Duval[22] and Kollmann.

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[16] Brook. On some points in the development of Motella mustela L. Journ. Linn. Soc. Zool., xviii, Nov., 1884, pp. 298–307, pls. viii–x.

[17] Brook. On the origin of the hypoblast in pelagic Teleostean ova. Quar. Journ. Mic. Sci., Jan., 1885, pl. iii.

[18] W. His. Ueber die Bildung der Haifischembryonen. Zeitschr. f. Anat. u. Entwickelungesch., ii, 1877, pls. vii; also, Untersuch. üb. die Entwick. von Knochenfische, etc., in vol. i of same journal, 1 pl.

[19] Rauber. Primitifstreifen und Neurula; also, Die Theorien der excessiven Monstra, Virchow's Archiv. lxxi, 1877, pls. 3.

[20] Whitman. Embryology of Clepsine. Quar. Jour. Mic. Sci., July, 1878, pp. 101, pls. xii–xv.

[21] Ryder. On the formation of the embryonic axis of the Teleostean embryo by the concrescence of the rim of the blastoderm. Am. Naturalist, 1885, pp. 614–615, 1 fig.

[22] Mathias Duval. De la formation du blastoderme dans l'œuf d'oiseau. Ann. Sci. Naturelles. Zool., 6e sér., tome xviii, pp. 208, pls. 5, 1884.

The strenuous opposition to the doctrine of concrescence manifested by Balfour arose apparently from his too constantly interpreting all of the higher vertebrate types of development upon the basis of his brilliant researches on the Elasmobranchs. Later research has only confirmed the doctrine and added little except a clearer knowledge of the details of the process, and I may add that Whitman has recently gone over the subject of the concrescence of the germ bands in *Clepsine*, and will shortly present the most conclusive evidence of the soundness of the views which he originally published in 1878. The evidence as to its occurrence in *Gadus* becomes palpable upon the advent of the initial steps of the inflection of the blastodermic margin. The inflected layer soon becomes wider in the region where the embryo is formed and is prolonged with the progress of the extension of the blastoderm over the yelk. The concrescence of the lips of the primitive blastopore in the middle line of the embryo would also tend to carry a larger number of periblastic nuclei under the anterior and middle region of the true hypoblast. It does not necessarily follow, however, that the floor of the intestine is formed by cells derived from the periblast, as occurs in Elasmobranchs (*teste* Balfour), and as held by Cunningham, though there is no objection to such a view. The principal conclusions reached by Cunningham as to the homologies of the yelk-blastopore are, however, not new, as Rauber[23] and myself[24] had previously reached the same or very similar interpretations.

Rauber considers what I have called the "yelk-blastopore" to represent the "*blastostomion verum*" or true blastopore in types with a large yelk. The blastopore of the latter types, usually regarded as such by embryologists, and developed at the anterior part of the primitive streak, Rauber calls the "*blastostomion consecutivum seu intermedium.*" Both openings together are for him simply differentiations of the primitive "blastostome." This blastostome, or the blastopore, as it is usually called, of the Bilateralia, whether round or drawn out into a cleft by a process of growth in length, or of concrescence, I have elsewhere[25] distinguished as the *archistome.*

(2) *Later development.*—The more advanced stages of the cod embryo, though studied by Sars and others, have never been correctly figured by any one because of the fact that a very large vesicle on the upper side of the head has been entirely overlooked, probably because of the extreme transparency of this portion of the young fish. In my first paper on the development of the cod (Contrib. Embryog. Oss. Fishes, pls. xi and xii), figs. 45 and 49, which are side views of embryos, figured ten and seven days after hatching, give the erroneous impression that the median fin-fold extends quite forward between the nasal

[23] Rauber. Die Lage der Keimpforte. Zoolog. Anzeiger, ii, 1879, pp. 499–503.

[24] Ryder. On the position of the yelk-blastopore as determined by the size of the vitellus. Am. Naturalist, April, 1885, pp. 411–415.

[25] Ryder. The Archistome Theory. Am. Naturalist, Nov., 1885, pp. 1115–1121.

pits. The same would also be inferred from another figure representing an advanced larval cod, published in a later paper[26] by the writer.

The true state of the case is as follows, as may be gathered from figs. 1 and 2, plate i: The true median dorsal fin-fold only extends as such forwards as far as to about or slightly behind a vertical line passing through the base of the pectoral. The larval integument continuous with the median dorsal fin-fold and covering the brain and fore part of the spinal cord is not prolonged forwards as a flat duplicature or fold, but is distended as an oblong vesicle and filled with a serous fluid, as shown from the side in fig. 1 and from the front in fig. 2.

Immediately after hatching, this sinus or space between the integument and the brain is small, as may be observed in fig. 40, plate ix, of my first paper, but in about one day after hatching it begins to be obvious that the integument, over the brain and as far back as to the vertical from the end of the intestine, is being lifted up and becoming filled with fluid. This proceeds until at the end of a week or ten days the larval cod, when viewed from the side or front, presents a most singular resemblance to the conventional dolphins of the ancient sculptors. The rounded and swollen front and top of the head is in marked contrast with the majority of pelagic fish larvæ.

That the integument is actually lifted up from the underlying structures is shown by the fact that the long efferent branches of the vagus group of nerves which pass outward to button-like thickenings of the epiblast armed externally with stiff protoplasmic hair-like processes, may be traced through the wide space between the integument and the brain when the embryo is examined by transmitted light. Three pairs of such segmental sense organs or neuromasts (Wright) are found in the walls of the large integumentary vesicle overlying the head and body of the young cod. These organs are disposed quite symmetrically on the fore part of the body, but posteriorly they are not symmetrically disposed on the sides of the tail, as may be seen by referring to plate x, fig. 42, Embryog., Oss. Fishes. Agassiz and Whitman, in their last memoir (Pelagic stages of young fishes), also figure and describe larval fishes in which there was more or less asymmetry noticeable in the arrangement of the caudal neuromasts.

The great anterior dorsal integumentary vesicle of the larval cod is gradually developed after hatching, and appears to increase in size as the yelk sack diminishes and becomes empty. I first noticed and described what is obviously homologous with this vesicle, which is so exaggerated in dimensions in the larval cod, in 1881, in the Spanish mackerel, as may be learned if the reader will consult plates iii and iv, figs. 14, 15, 16, and 17, illustrating my paper on the development of that species (Bull. U. S. Fish Com., i, 1881, p. 157), where it is also stated that it is developed after hatching, as is shown by the con-

[26] Ryder. An outline of a theory of the development of the unpaired fins of fishes, Am. Naturalist, Jan., 1885, pp. 90–97, fig. 3.

dition of the vesicle in a larva just hatched and figured on plate ii of the paper cited. At that time I named the space in the supracephalic vesicle of the Spanish mackerel, the "supracephalic sinus." Now, while it is clear that this sinus is the homologue of the much larger one in the larvæ of *Gadus*, it is also clear that in the latter it extends not alone over the brain as in *Scomberomorus*, but even back dorsally beyond the hinder limits of the body cavity.

I have good reasons for believing that a sinus of the same character overlies the brain in a number of the species figured by A. Agassiz and his associate Whitman as well as in the larvæ of *Trachinus* and *Motella* figured by Brook. In fact, I doubt if the structure represented in advance of the first developed dorsal fin-ray on the head of the larva of *Lophius* by A. Agassiz[27] is a fin-fold at all, but merely the integumentary vesicle or bulla described above, though the contrary is expressly stated on page 282 of the memoir last cited. A still more remarkable instance of the extension apparently backward and laterally of what I have called the "supracephalic sinus" is represented however by Agassiz and Whitman on plate xii, figs. 7 and 8, of their recent memoir (Pelagic stages of young fishes, part I, 4to, 1885). In this form the sinus has been extended back for two-thirds of the length of the larva and also over the sides of the head. The form in question is supposed by its describers to be near *Motella*.

It is therefore probable, taking into account the facts recited above, that the true, median, dorsal fin-fold is never extended as far forward as the front of the head, as I had assumed in my paper cited above on the development of the median fins, but that such an apparent anterior dorsal extension of the fin-fold is due to the illusion produced by the extreme transparency of the integument of the dorsal vesicle or bulla just described, the presence of which is not easily made out until the living embryo is viewed from in front. The true median fin-fold in the larvæ of *Gadus* is therefore but little longer proportionally than that of other types of larvæ which are without a supracephalic bulla. The archaic extension of the fin-folds in fishes therefore, it seems, must have been about the same as that generally prevalent to-day in young larvæ, or an extension of the fin-folds which is most nearly approximated by such adult forms as the *Dipnoi*.

The contents of the bulla or sinus have been but little studied, but it is probable, judging from certain observations upon the contents of the fin-folds of larval fishes by Emery,[28] that this bulla in *Gadus* contains coagulable albumen. I have found such a coagulum in the fin-folds of hardened embryos of *Clupea*. And in embryos of *Scomberomorus* I found loose granular matter in the sinus on the top of the head and fin-folds.

[27] A. Agassiz. On the young stages of osseous fishes. Part iii, Proc. Am. Acad. Arts and Sci., xvii, 1882, pls. xvi, xvii.

[28] Emery. Sulla existenza del cosidetto tessuto di secretione nei vertebrati. Atti R. Acad. Sci., Torino, xviii, 1883.

In larvæ of *Gadus* hardened in chromic acid there seems to be such a coagulum existing in the dorsal bulla already fully described. This bulla therefore partakes of the nature of a lymph-space.

(3) *Changes of position of the cod's egg and embryo during development.*—The germinal disk of the cod's egg, like that of the ova of most Teleosteans, is developed at the time of impregnation. The single spermatozoön necessary to effect impregnation and initiate developement enters the egg through a minute round pore in the egg-membrane or zona radiata, known as the micropyle. But one such opening is found in the egg of the cod, and I believe that reliable authorities concur in the belief that there is but one such opening in the membrane which invests the ovum of Teleosts.

The male element can therefore enter the ovum at one point only, and, inasmuch as the superficial cortical layer at the time of impregnation, and from which the blastodisk or germ is developed, lies in immediate contact with the egg-membrane or zona, the point of contact between the egg and spermatozoön is also limited by the area on the ovum covered by the micropyle. That area is excessively small. The polar cells in the cod's egg are also extruded immediately beneath the micropyle and invariably in very close relation to it. Furthermore, the active plasma of the egg gravitates towards the point where the spermatozoön entered the egg, and the greater part thus accumulates in the vicinity of the micropyle, as shown in fig. 3, pl. i, where the polar cells joining the egg to its membrane are also indicated. I never saw any polar globules expelled through the micropyle.

As soon as the blastodisk becomes apparent as a thickening or aggregation of the substance of the cortical layer it assumes an inferior position, because the specific gravity of the plasma of the disk is greater than the same volume of yelk, the whole of which now occupies the upper pole of the egg. Later still, when the disk *D*, fig. 4, is better defined, the force of gravity, still acting in the direction of the arrow, which points toward the micropyle, constantly keeps the disk in an inferior position, which is maintained until the blastodisk begins to spread and the embryo to be formed. When the blastodisk or the blastoderm, as it may now be more appropriately called, has spread over one-half of the vitelline globe, as shown in fig. 5, the embryo is pretty well defined at one side of the blastoderm, and extends from its margin to its center. This causes the blastoderm to become heavier at the side upon which the embryo is formed, and, as a consequence, the whole egg is slightly rotated upon its own center so that a radius drawn from the latter to the center of the original site of the blastodisk of an earlier stage will be inclined to the horizon at an angle of 45°. As development proceeds still further the embryo of course lengthens as the blastoderm spreads, till finally the embryo embraces an arc of 180° on the yelk-globe. As a result of this the radius passing from the center of the egg to the original site of the center of the blastodisk is swung round still farther, so that the total rotation of the egg now amounts to about 90°, as a comparison of fig. 6 with fig. 4 will show, as indicated by the arrows.

Further changes of the position of embryo in the egg as development advances are hard to follow, but these are the principal and most striking ones. When hatching takes place the vitellus is always so much lighter than the embryo that the latter floats about in the water on its back. In the course of a day or so the embryo is able to right itself.

The next change in the position of the free embryo, when at rest in the water, occurs some days after hatching and seems to result from the development of the great bulla already described and which is gradually developed on the head and over the upper part of the body. When larvæ of a few days old swim they are inclined to move the body forward horizontally in a right line, but as soon as they come to rest the tail drops down into an inclined position, and forms an angle of about 45° with the horizon. This was so constantly observed to be true of advanced embryos that I have inferred that the bulla developed on the head caused the latter to be buoyed up, just as the less advanced embryo is buoyed by the yelk before its absorption. This seemed all the more probable from the fact that the very rudimentary air-bladder in larvæ of that age does not as yet appear to contain air.

The function of the integumentary bulla on the head, therefore, seems to be, in part at least, to serve as an organ aiding in the flotation of the embryo. This seems all the more probable from the strongly marked pelagic tendencies manifested by the eggs and larvæ of the cod at all stages in sea-water of normal specific gravity or in water having a density of 1.025.

(4) *The most recent and successful method of hatching cod and other pelagic eggs.*—I will here reproduce in part what I have already published elsewhere.[29]

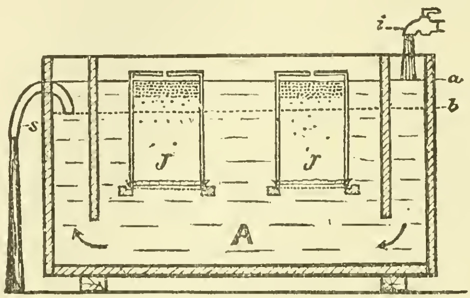
For four seasons experiments have been carried on for the purpose of discovering a practical method of hatching the eggs of the cod—one of the most fertile and valuable of the food-fishes found off our coast. During the period mentioned no less than forty forms of apparatus have been devised and operated, with varying success, by different persons connected with the work of the U. S. Fish Commission. Up to the present time no device has fulfilled the required conditions, even approximately, with such success as the apparatus just devised by H. C. Chester, superintendent of the Wood's Holl station of the Commission.

This apparatus is essentially automatic, and needs so little attention that one man will by its aid readily care for a hundred millions of eggs. It consists of a trough, 7 feet 6 inches in length, 2 feet in width, and 2 feet 4 inches in depth. At about 1 foot from either end, vertical wooden partitions, extending to within 4 inches of the bottom of the trough,

[29] Ryder. Success in hatching the eggs of the cod. Science, vii, 1886, No. 153, pp. 26–28. Also, Hatching codfish eggs. Forest and Stream, xxv, No. 25, Jan. 14, 1886, p. 488.

are secured. This leaves a space about 5 feet 6 inches in length between the partitions. In this space 6 or 8 large glass jars are supported upon a frame, with their tops downward. Those used for the purpose at Wood's Holl are ordinary cylindrical, four-gallon specimen jars, with a half-inch hole drilled in the bottom. The stoppers of the jars are removed, and a single thickness of coarse cheese-cloth is secured over the mouth with strong twine. The jar is then inverted and lowered into trough, so that its bottom is about even with the top of the trough. Strips nailed across the top of the trough serve to keep the jars upright.

The accompanying figure, showing the device in longitudinal vertical



section, modified and designed on a somewhat smaller scale than the device now in use and accommodating only four jars (two in a row), will enable the reader to get a clear conception of the way in which the apparatus is used. The trough *A* is filled with unfiltered sea-water through the faucet *i*, the water rising to the level of the line *a* before the capacious outlet siphon *s* begins to operate. This siphon, through which the water runs out of the trough faster than it comes in at *i*, soon brings the water down to the level of the line *b*, when the siphon takes in air and ceases to operate, after which the trough again slowly fills up with water to the level of the line *a*. This process is repeated automatically, and as long as the water is permitted to flow through the device. It requires ten minutes for the water to rise or fall from the one level to the other; and, since the jars have only a cloth tied over the mouth below, the water rises and falls to the same extent in them. This very slow and gentle rise and fall of the water in the jars and trough has been found sufficient to aerate the eggs and give them all the movement they need.

All of the good eggs in this contrivance float at the surface; some, during the latter stages of hatching, will fall below the surface, but if such ova are washed, they will again rise to the surface, and an exceedingly small percentage of the eggs ever sink and die, as in almost all of the other forms of apparatus hitherto used. The result is that the mortality is probably under 5 per cent—a percentage of loss not greater than that experienced in the most successful treatment of shad ova in the McDonald jar.

The freshly fertilized ova, treated with an abundance of good milt, are introduced into the hatching device through the hole in the center of the bottom of each jar by means of a glass funnel. Beyond an occasional siphoning-off of the sediment on the bottom of the trough and the cloth covers of the jars, the eggs require no attention until hatched.

Heretofore great mortality has been caused by the use of metal in the construction of hatching vessels and strainers. Since the adoption of glass, wood, and cloth as the only materials used in the construction of the hatching apparatus here described, combined with the very gentle movement to which the eggs are subjected, complete success has been attained. The eggs are caused to oscillate up and down through a space of only 5 inches from the level of *a* to that of *b*, and, withal, so gently that they suffer no hurtful shocks of any kind whatever. Captain Chester's device will doubtless be used with great advantage in the propagation of the Spanish mackerel. In twenty-four hours the embryos of the latter would be ready to be set free from the apparatus; whereas it requires eleven or twelve days to hatch the eggs of the cod, with the temperature of the water ranging from 45° to 48° Fahr.

Each of the jars *J* is 17 inches high by 9 inches in diameter, and will hold from one-half to one million of cod eggs; so that an apparatus of the style shown above, and occupying not much over a square yard of space, would accommodate from two to four millions of ova, in four jars.

These results and experiments show that violent movement of the eggs of the cod is of no advantage; that such movement is, on the contrary, injurious if not mortal when continuously maintained. The requisite conditions for the successful hatching of this important food-fish having been settled, the great station of the Fish Commission at Wood's Holl affords unlimited opportunities for conducting the work for at least three months of the year, during which time from five hundred to one thousand millions of eggs might readily be hatched out by the aid of the Chester apparatus and set free in the adjacent waters.

The proper specific gravity of the sea-water has a great deal to do with the healthy development of the eggs of the cod. By accident a broken valve admitted fresh water to the pumps which supplied our salt-water tanks, causing the specific gravity of the water to fall from 1.0256 to 1.021 or 1.022. In the latter densities the eggs immediately sank, but rose at once if placed in sea-water of the specific gravity first mentioned. The break in the valve through which fresh water was added to that which was pumped from the harbor for use in our hatching troughs, caused us to lose over two millions of good eggs. After this unfortunate experience, and also judging from the fact that ever since the break in the valve has been mended no eggs have sunk or subsided to the bottom, we have concluded that the cod egg, in order that it may develop normally, must float at or near the surface. Under no other conditions does it seem possible to get them to develop regularly and without serious losses.

It was also found in the course of subsequent experience that the constant flow of cold water around the jars immersed in the troughs tended to keep the temperature in the latter constant, so that all the eggs developed at the same rate. In other apparatus devised in imitation of Chester's device, but in which the hatching vessel was not surrounded by a constant supply of fresh, cold sea-water, irregularities of development were often very pronounced. This seemed to be due to the unequal temperature of the water at the sides and center of the vessel, owing to radiation from the atmosphere of the room. In these other forms of apparatus, development seemed to proceed normally until within a day or two of hatching, when the eggs would suddenly sink and die.

(5) *The post-larval stages of development of the cod.*—I have not seen any of the more advanced stages; none older in fact than about ten days after hatching. A. Agassiz[30] has figured two stages believed to appertain to the common cod. These show the chin barbel and the ventral fins developed, neither of which were yet developed in the oldest stages seen by me. These specimens measured respectively 20 and 28^{mm} in length, or from four to five times as long as the oldest specimens I have seen, so that there still remains a large gap to be filled up in the iconography of the stages of development of this species.

II.—Roccus lineatus (Bloch) Gill. (*The Striped Bass, or Rockfish.*)

The artificial fertilization of the eggs of the striped bass was, I believe, first accomplished by Mr. E. H. Walke, of the United States Fish Commission, in 1879, and in 1881 Mr. S. G. Worth[31] reported his success of the previous year in the artificial fertilization of the eggs of this species. The species is very fertile; a single female was estimated by Mr. Worth to have contained 3,000,000 eggs in her roes. Spawning and hatching appear to occur in fresh water, and according to Mr. Worth the eggs are of less specific gravity than those of the shad, extremely transparent or pellucid when in the water, and measuring nearly one-seventh of an inch in diameter after impregnation, when the zona radiata becomes greatly distended and freed from contact with the vitellus. The freshly extended ova were found to be smaller than those of the shad, and the vitellus was of a decidedly greenish color. From the foregoing data it may be assumed that there exists in the egg of this species, as in that of the shad, a very spacious "breathing chamber," or water space, developed between the vitellus and zona at the time of impregnation, in consequence of the distension of the latter with water taken in through the pore-canals. At a temperature of 66° to 67° Fahr. hatching began at the end of 48 hours.

The foregoing information is derived from the paper by Mr. Worth, and, as there can be no doubt of the fact that the eggs taken were those of the striped bass, we must suppose, if the young fish identified by A.

[30] A. Agassiz. On the young stages of osseous fishes, part iii. Proc. Am. Acad. Arts and Sci., xvii, 1882, pl. viii, figs. 4 and 5, p. 296.

[31] S. G. Worth. The artificial propagation of the striped bass (*Roccus lineatus*) on Albemarle Sound. Bull. U. S. Fish. Com., i, 1881, pp. 174–177.

Agassiz really were of the same species, that the development of its ova occurs in fresh as well as in sea-water. The larvæ captured and figured by Agassiz,[32] though it is nowhere specifically implied that these young fishes were not taken from fresh water, were probably captured in salt water, as were most of the forms figured by him. Specimens in my possession of young striped bass one day old, hatched from ova fertilized with the milt of the white perch, *Roccus americanus* (Gmel.) J. and G., measure 3.5^{mm} in length, or the same as the youngest stage figured by Agassiz, but the jaws and mouth are not nearly as well developed and the intestine is relatively much longer, nor are the median fin-folds as wide. The intestine also in this youngest stage extends backward beyond the yelk-sack for a distance equal to half the length of the latter before it reaches the edge of the ventral fin-fold to terminate at the anus. These differences lead me to think that the larval fishes figured by Mr. Agassiz as pertaining to the species here under consideration, must belong to another form, as none of his figures can be reconciled with those taken from larvæ of the striped bass, the parentage of which is undoubted. In this opinion I am most conclusively confirmed by a drawing which has fallen into my hands, by the late Prof. Henry J. Rice, the figure in question being drawn from a larval bass in May, 1879, on the sixteenth day after hatching, and which had been reared from a lot of eggs which were artificially impregnated. This drawing, which is reproduced here, fig. 7, was taken from a young fish measuring 5^{mm} in length, and disagrees in many important respects from a young fish of the same length and represented in fig. 3, plate i, in the paper by Agassiz already cited. The figure by Rice shows the tail of the young striped bass to be distinctly spatulate and rounded, and not tapering and rather acutely rounded, as figured by Agassiz. In Rice's figure the anus is situated at a point very nearly midway between the tip ot the snout and the end of the tail; in the figure of the same stage given by Agassiz the vent opens at a point on the ventral border far in advance of a point situated midway between the end of the snout and that of the

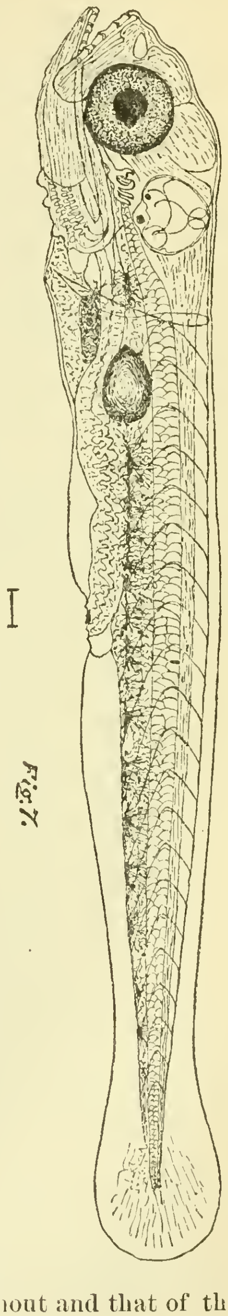


Fig. 7.

[32]A. Agassiz. On the young stages of osseous fishes. Part iii, Proc. Am. Acad. Arts and Sci., xvii, 1882, pp. 274–275, pl. i.

tail. Very pronounced hooked teeth are shown in both jaws in Rice's figure, and the air-bladder is developed relatively farther back than is shown in the figures given by Agassiz. The earlier stages which I have seen of undoubted embryos of *Roccus lineatus* are likewise more slender than those figured by Agassiz, and this point is also confirmed by the later stage figured by Rice.

HYBRIDIZATION OF THE STRIPED BASS WITH OTHER FISHES.

It is rather extraordinary that the striped bass should so readily lend itself to the purpose of cross-fertilization with other closely allied species, such as the white and yellow perch, but it is still more astonishing that it should be possible to cross this species with another belonging not simply to a different family, but even to a widely different order and sub-class. That the eggs of the shad (*Clupea sapidissima*) might be fertilized with the milt from the male striped bass seems almost incredible, yet it seems that the evidence showing that the eggs of a physostomous form may be fertilized by the milt from a physoclistous acanthopterygian is incontestable, and that the eggs of the latter type may even be fertilized with milt taken from the first-mentioned type. The shad and striped bass therefore appear to be fertile *inter se*, as the following evidence seems to prove.

That the shad ovum may be fertilized with the milt of the striped bass seems to be established by the evidence presented in a paper[33] by the writer published in 1883, from which I quote as follows:

A number of young fish which had already lost their yelk-sacks, in consequence of which it is to be supposed that they were already several days old, were received from Havre de Grace, Md., at the central station on the evening of June 13, 1882. They were immediately placed in an aquarium, but all of them died in a day or two after save about fifty, which were transferred by the writer to one of the smaller of the carp ponds in charge of Dr. Rudolph Hessel, where, as Professor Baird had suggested, they might possibly find some food suited to their wants and grow large enough for us to learn something of their future history. The case is an extraordinary one, as the possibility of interbreeding members of such very distinct families as the Clupeoids and Percoids, unless the impregnation was performed under the very eyes of the naturalist, might well be doubted by those familiar with the recorded facts which have generally been considered to prove that fertile interbreeding even between different genera was out of the question. The evidence in favor of the fact in this case is, however, too strong to be passed over, and until we know more of the later history of this singular hybrid, the following notes on the differences which were presented by the embryos in question when compared with those of the true shad

[33] Ryder. Notice of an extraordinary hybrid between the shad and striped bass. Bull. U. S. Fish Com., ii, 1882, p. 187.

must suffice. The striped bass was the male and the shad the female parent in this case.

Teeth more numerous and more recurved in the lower jaw; at least three pairs present; only two pairs in the larvæ of the shad of the same age. Lower jaw longer, with the gape of the mouth much wider; ear capsule proportionally much larger than in shad larvæ of same age, and pigment and fine radii of fins slightly more developed than in the latter. Intestine much more slender, that is, its lumen is much less spacious than in larvæ of *Clupea.* Liver in about the same position as in larval *Clupea*, but gall-bladder and eye relatively and perceptibly larger; Meckel's cartilage a fourth longer. General form that of the larval shad, but head more prolonged and acuminate anteriorly. The preponderance of characters appears to be those of the female parent, and these larvæ appear to be undoubted hybrids. The eggs were taken by some of the crew of the steamer Fish Hawk at Havre de Grace, and were impregnated with the milt of the striped bass, because no ripe male shad happened to be at hand.

The head of this singular hybrid, represented by fig. 11, plate ii, may be compared with fig. 7, representing an advanced larva of the striped bass, also with the figures of the larvæ of the shad, shown on plate xxii.

Since the foregoing appeared Mr. R. B. Roosevelt has published a a paper[34] on hybridism between the striped bass and shad, in which the former was the female and the latter the male parent. No specimens of these larvæ appear to have been preserved so that all the information I can give in this instance is to quote Mr. Roosevelt's remarks on the subject as follows:

"A ripe female striped bass or rockfish, *Labrax lineatus*, being caught in the nets during the course of operation of the shad hatchery on the Hudson River, and there being no male bass to be obtained, the eggs were taken and brought into contact with the milt of the male shad, *Alosa sapidissima.* Then these eggs were placed in a box entirely by themselves, and every precaution was taken to make the experiment perfect. The eggs hatched; of that there is no question, but whether the product was the result of that impregnation or whether it was reached by the chance contact with floating seminal animalcules from bass, or whether the young lived after they were hatched, may be regarded as still open for consideration. As there was no possibility of keeping the fry in confinement the experiment goes no farther than opening the field of study and research."

III.—Clupea vernalis Mitch. (*The Alewife or Branch Herring; Gaspereau.*)

This Clupeoid is anadromous and lays its eggs in adherent masses; the zona is much thicker than that of the egg of *C. sapidissima.* The

[34] R. B. Roosevelt. Fertility in hybridization. Proc. Am. Ass. Adv. Sci., xxxiii, 1885, pp. 510–515.

egg of this species is also very much smaller than that of the shad, and as the zona invests the vitellus or embryo quite closely, there is no spacious breathing chamber developed at the time of impregnation, as in the egg of the shad.

Fig. 8, plate ii, represents a larval *Clupea vernalis* on the second day after hatching, when it measures very nearly 5^{mm} in length. It is extremely transparent, the only ornamentation with pigment spots is a row of small ones on either side of the tail, on a level with the lower side of the intestine. The yelk is very clear and does not contain any oil drops. The liver is produced as a nearly solid, elongated outgrowth from the inferior side of the intestine and behind the yelk sack, in the same position as in *Clupea sapidissima.* The liver is represented in the figure by the long black patch behind the yelk sack. It will also be noticed that the intestine terminates very far back, as it does in fact in most Clupeoids.[35]

IV.—Idus melanotus. (*The Golden Ide.*)

The ova of this beautiful cyprinoid are adhesive, and, like those of the gold-fish, are usually found to adhere singly to the water-plants amongst which the parent fishes spawn. The zona radiata is rather thick, and there is but little space between it and the vitellus.

The young golden ide when it leaves the egg measures 6.6^{mm} in length. Its form at that time is shown in fig. 9, plate ii. The Cuvierian ducts embrace the anterior end of the yelk, which is composed of small spherical refringent granules. The yelk sack is much prolonged, and extends from the cardiac region nearly to the vent, tapering slightly as it is prolonged backwards. As in cyprinoids generally, there is a complete circulation at the time of hatching, which is not the case with the embryos of several clupeoids and many forms having pelagic eggs. The figures given by Von Baer of the embryos of other forms of cyprinoids also show the yelk-sack to be elongated. (See his Untersuchungen über die Entwickelungsgeschichte der Fische, 4to, Leipzig, 1835.)

V.—Carassius auratus. (*The Gold-fish.*)

The ova of the common gold-fish are laid singly upon weeds and other fixed objects in the water. They measure about 1.5^{mm} in diameter, and develop with comparative rapidity, hatching in 8 or 9 days after fertilization. Three of the earlier stages of the development of this form are shown in figs. 16, 17, and 18, plate iii. The yelk is quite granular and similar to that of *Idus* and *Leuciscus* (Van Bambeke[36]), and the embryonic axis embraces almost the entire circumference of the vitellus,

[35] Filippo de Filippi. Nouvelles recherches sur l'embryogenie des Poissons, Ann. des Sci. Nat. 3me Ser. Zool., vii, 1847, pp. 65–72, 1 plate. (Figures the larva of *Clupea finta.*)

[36] Van Bambeke. Recherches sur l'embryologie des Poissons Osseux. Mem. Cour. de l'Acad. ray. de Belgique, XL, 1875, Pl. II.

so that the blastopore closes beyond a point opposite the original site of the blastodisk, as also happens in *Leuciscus*. The vesicle of Kupffer is well developed just under the caudal end of the embryo, as may be seen by referring to figs. 16 and 18.

A more advanced embryo is represented in fig. 10, plate ii, measuring 5.75^{mm} in length, at five and a half days old. The ornamentation of pigment spots is quite elaborate at this stage. The yelk is elongated and fusiform, and its anterior end is embraced by the Cuvierian ducts. Just behind the urinary bladder the caudal vein is dilated and forms a fusiform sinus. It is then continued forward over the yelk, upon the dorsal surface of which it breaks up into a coarse vascular network.

For many weeks after hatching the young gold-fish does not develop any red or bluish-black pigment cells in the skin. When these are developed, which occurs after the fish is an inch or more in length, it is probable that the fish is approaching adolescence, as it has been found that this species reproduces when still comparatively small.

VI.—Elacate canada (Linn.) Gill. (*The Crab-eater.*)

The ova of this species are very well characterized. They are pelagic, in salt water having a density of 1.020. A large and refringent oil globule is imbedded in the yelk at a point nearly opposite the site of the blastodisk and at the upper pole of the egg. The blastodisk is directed downward, like that of most pelagic fish ova. The egg measures about 1.25^{mm} in diameter and the yelk is broken up into a few very large irregular masses of deutoplasm, separated by thin films or processes of the cortical layer of protoplasm, as is indicated by the network of dotted lines in figs. 13 and 14, plate iii. This subdivision of the vitellus by thin sheets of plasma running into the yelk-substance is apparent even in the yelk-sack of the young fish after it is hatched.

The changes undergone by the developing blastodisk for the first four hours are quite complex. The development is quite rapid, and hatching takes place in about 36 hours after impregnation. A broad zone of marginal cells are segmented off from the margin of the blastodisk, and the margin of the latter is rapidly inflected. The growth of the blastoderm is quite rapid, the entire vitellus being included and covered over by the epibolic growth of the blastoderm in about eight hours.

As I have already referred to the very remarkable phenomena observed by me just previous to the closure of the blastoderm in this species, and not being likely soon again to have an opportunity to study the same form, I will now describe and figure what was then observed in a number of ova, from which I infer that the peculiarity about to be described is characteristic of the development of this form.

Fig. 13, plate iii, represents the embryo formed and lying on the surface of the vitellus, and is shown as if foreshortened; anteriorly the optic lobes *op*, on the other side of the vitellus, show through the transparent surface of the latter. The embryonic axis shows the segments or somites *m*, distinctly developed, but it is very remarkable that the segmentation does not end at the point where the axis of the embryo, thus far developed, ends. The right and left limbs of the blastodermic rim, or lips of the blastopore, form a Λ-shaped mass, together with the embryonic body anteriorly; but, unlike any other normal Teleostean embryo, both the diverging limbs of the rim of the blastoderm show distinct indications of metameric segmentation at *m*, and behind the point where concrescence has already taken place.

Just within the yelk and a little in front of the yelk blastopore, which runs forward into the acute angle formed by the limbs of the blastodermic rim *br*, lies the large oil-drop *o*. A lozenge shaped mass of cells lies in the acute angle of the Λ-shaped terminal part of the embryo, which appears to contain or overlie Kupffer's vesicle, *kv*, and what was assumed to be the posterior end of the chorda *ch* at the time the drawing was made; but of the certainty of this determination I am not at present satisfied. I was enabled to sketch this and a slightly more advanced stage several times, and, as already stated, I found the same condition of things present in a number of embryos, which appeared to be developing normally. Four other sketches show that the blastoderm finally closes very much as in other Teleostean embryos, and that pronounced wrinkles radiate from the crater like opening upon the yelk where the yelk-blastopore finally closes.

The conclusions of His and Rauber, to the effect that the embryonic axis is formed by the gradual fusion from before backwards of the edges or lips of the yelk blastopore as it advances over the surface of the vitelline globe, are completely and emphatically confirmed in the case of this species. It must be admitted, however, that the presence of the cellular mass between the limbs of the blastodermic rim where they join the anterior portion of the embryonic body is not a little puzzling.

This species I was enabled to study, through the kind help of Col. M. McDonald and Mr. W. P. Sauerhoff, at Cherrystone, Va., during the first week of August, 1881.

VII.—Siphostoma fuscum (Storer) J. & G. (*Common Pipe-fish.*)

The earliest noteworthy observations upon the development of any species allied to the one here considered, which I have been able to find, were recorded by Rathke.[37] The embryos of a species called *Syngnathus argentatus* is figured on plate v of Rathke's memoir, and he shows the gill clefts exposed or uncovered in the young, a condition not observed by later authors. The next memoir in historical order is by A. de Quatrefages, and deals with another species, probably another genus, in which the eggs are not covered by lateral folds extending down from

[37] H. Rathke. Zur morphologie; Reisbemerkungen aus Taurien. 4to, pp. 192, pls. 5, Riga and Leipzig, 1837.

the sides of the body. The memoir of de Quatrefages[38] is, however, very superficial, for the courses and distribution of the blood-vessels in the embryo are drawn altogether diagrammatically and with the help of the imagination of the artist. The next paper[39] published was by the writer, in which some of the stages of development of *Siphostoma fuscum* were discussed and described. About two years later Dr. J. P. McMurrich took up the study of the development of this species and published a memoir[40] which is valuable for the information it affords as to the ontogeny of the cranial skeleton.

The eggs of *Siphostoma* are developed under a pair of integumentary folds placed behind the vent, forming a brood-pouch, which is developed on the under side of the tail of the female. The ova are small, measuring only about 0.75^{mm} in diameter. They are embedded in a viscid mucus contained within the pouch alluded to. A blastodisk is evidently formed in the usual way. The yelk is clear lemon-yellow in color, and its outer stratum contains small, numerous deeper yellow oil drops, the distribution of which is shown in fig. 20, plate iv. The presence of Kupffer's vesicle was not made out at this stage.

The next stage of development, which was observed in the eggs taken from the brood-pouch of another male, is represented in fig. 19, when the embryo, after being freed from the egg, measured very nearly 3^{mm} in length. This is a considerably earlier stage than that represented by fig. 1, pl. xlii, in McMurrich's paper, as the fold indicating the commencement of the formation of the caudal fin is not yet present in fig. 19. The median aorta and caudal artery extend almost to the end of the tail, where it is continued into the recurrent cava and the subintestinal vein which return the blood to the heart. As soon as the subintestinal vein reaches the posterior pole of the yelk it bends down and traverses its posterior median and anterior face towards the heart, the venous end of which rests upon the yelk. The branchial arches are formed, though there are no branchial filaments yet developed. The pectoral fin-fold is already present as a low lobular process just behind the auditory capsule. The dorsal fin is just becoming clearly evident as a low median fold behind the vent. There is as yet no trace of an anal fin fold visible. The oil drops have a more general distribution over the yelk than in fig. 20; the head is much flexed downward, and the brain is very conspicuous. In passing I would state that in McMurrich's fig. 1 the mid-brain is identified by mistake with the cerebellum, the cerebellum is confounded with the pineal gland, while the medulla oblongata is erroneously identified with the mid-brain and medulla oblongata together.

[38] A. de Quatrefages. Memoire sur les embryons des Syngnathes (Syngnathus ophidion, Linn.), Ann. des Sci. Naturelles, xviii, 2d ser., 1842, pp. 193–212, pls. 2.

[39] Ryder. A contribution to the development and morphology of the Lophobranchiates; (Hippocampus antiquorum, the sea-horse). Bull. U. S. Fish Commission, i, 1881, pp. 191–199, pl. xvii.

[40] J. P. McMurrich. On the osteology and development of Syngnathus peckianus (Storer), Quar. Jour. Mic. Sci., xxiii, n. s., pp. 623–650, pls. 2.

A more advanced stage is shown in fig. 21, plate iv, measuring about 3.5^{mm} in length. The pectoral fin at this stage has already partially rotated on its base. The dorsal fin is more developed, while the tail begins to show signs of the development of the permanent rays from the coalescence of the embryonic rays or actinotrichia. The circulation is more developed and the blood may be seen circulating through the gill arches, but there are still no filaments formed. A more enlarged view of the head of this stage is shown in fig. 12, plate iii, where the four gill arches are more clearly indicated.

I must here take exception to certain of McMurrich's statements in his paper already cited in reference to the development of the fins. He says (p. 648): "In the young stages an anal is present, which, however, does not pass beyond the stage in which fibrillation [development of actrinotrichia] begins, but aborts and is entirely wanting in the adult." This is an error, because a careful inspection of the adults of both sexes of *Siphostoma fuscum*, apparently the same species as was used in his studies, reveals a small but undoubted anal fin just behind the vent. The erector and depressor muscles are also not attached to the oval cartilaginous nodules at the bases of the fin-rays, as stated by McMurrich, but to the bases of the fin-rays themselves. This author's statement that the tail of *Siphostoma* is heterocercal at first is not borne out either by the method of development of the tails of fishes generally, or by the evidence supplied by figs. 19 and 20 of this species here given; these two stages just referred to being really much younger than any figured by McMurrich, and they serve to show that the young of *Siphostoma* pass through what I have called an archicercal stage.

A very curious and interesting morphological fact is revealed by a study of the development of the *Lophobranchii*, namely, the manner in which the neural arches are duplicated several times on each vertebral centrum. The proximal parts of the parallel cartilaginous bars supporting the rays of the dorsal fin in *Hippocampus* and *Siphostoma* afford the basis for the ossification of about five neural arches to a single centrum in the region of the dorsal fin. And, since the more anterior and posterior vertebræ also have a number of dorsal arches, it is probable that the cartilaginous rudiments of such arches are also duplicated in those regions in an analogous manner, but at a somewhat later stage of development. This peculiar method of development and duplication of the neural arches will very probably serve to distinguish the Lophobranchiates from other families of fishes.

In plate xvii of my first paper on the Lophobranchiates, cited above, I fell into an error in the identification of the cranial cartilages of *Hippocampus*, as pointed out by McMurrich. In the skull, figured on the plate indicated, the names of several cartilaginous elements must be changed. The unpaired element *sy*, given as "symplectic," must be regarded as genio-hyoid, the "element *x*" is the quadrate and pterygoid, while *a* is not "labial," but pterygo-palatine and not "ethmo-palatine," as it is identified by McMurrich. The element *q*, given as "quadrate," must be regarded as the symplectic portion of the hyomandibular bar.

VIII.—MONOCANTHUS BROCCUS (MITCH.) DEK. (*Fool- or File fish.*)

The eggs of this species were obtained by me from adult females captured in the pound-nets near Cherrystone, Va., about the middle of July, 1880. The eggs are quite small, and measure not quite .7^{mm} in diameter. They are very adhesive, and adhere again and again to foreign objects if detached. They are pale green in color and have a group of small refringent oil-drops embedded at one side of the vitellus. An unimpregnated egg of this species is figured on plate iii, fig. 15. The lot of eggs to which the one figured belongs was not fertilized, as far as I am aware, yet the blastodisk was very distinctly developed, as the figure shows. At the end of about two hours no segmentation was observed.

IX.—APELTES QUADRACUS (MITCH.) BREEVOORT. (*The Four-spined Stickleback.*)

For the opportunity to study the development of this interesting species I am indebted to Mr. W. P. Seal, who supplied me with developing ova and a pair of spawning adults in April, 1881, and on which I shortly after published some notes[41] and observations. I kept one pair of adults which were about to spawn in an aquarium extemporized for the purpose; the male very industriously completed the spinning and weaving of a nest under my observation.

The early stages of development I did not witness, as the first lot of eggs had the blastoderm already formed and inclosing the vitellus. The lot of eggs laid by the pair in confinement were unfortunately not fertilized.

The egg-membrane is a true zona radiata, being perforated by numerous pore canals, and is covered by an adhesive material which agglutinates the eggs together into a mass to the number of 15 to 20, the number deposited at one time by the female. The ova sink to the bottom, and must be taken charge of by the male, as the female, after having discharged them, takes no further interest in their fate. The male, with his mouth, lifts the eggs into the little nest which he has prepared for their reception.

The egg of the four-spined stickleback measures about a line, or somewhat over 2^{mm}, in diameter, and are of a decidedly dark amber color. I was not able to make out the position of the micropyle. At one pole of the egg a large number of flat, button-shaped appendages are attached to the surface of the egg-membrane by means of very short pedicels, and it is in the midst of these that the micropyle is found in the European species, *Gasterosteus leiurus*, according to Ransom.

[41] Ryder. Notes on the development, spinning habits, and structure of the four-spined stickleback, Apeltes quadracus. Bull. U. S. Fish Com., i, 1881, pp. 24–29.

There is no germinal disk developed when the egg first leaves the ovary, and the cortical layer of germinal matter is uniformly distributed at first over the vitellus, which itself incloses a number of very refringent oil spheres, very variable in size. It appears that the blastodisk in this species may develop without the influence of impregnation, but no true segmentation occurs under such circumstances.

On the fourth or fifth day after impregnation the primary divisions of the brain are marked off, one of the most striking characters being the unusual spaciousness of the cerebral vesicles, the walls of the brain cavity being relatively thin when compared with those of other forms. The optic cups soon become quite deep, so that a considerable space (the vitreous humor) exists at an early period between the floor of the cup and the lens. The origin of the latter from a thickened induplication of the epiblast may be very readily traced. Some of these and other features to be described later, are represented in figs. 22, 23, and 24, plate v. Immediately behind the auditory vesicles, and shortly after their invagination, the rudiments of the breast fins appear as a pair of low longitudinal folds. In the stickleback the breast or pectoral fins develop very rapidly and while the young fish is still in the egg.

Pigment is also rapidly developed on the embryo, as is shown in figs. 25 and 26, plate v, representing the young, 6^{mm} long, of *Apeltes* when it quits the egg. During still earlier stages and while still in the egg pigment is formed so rapidly over the embryo that it soon becomes impossible to see the outlines of the viscera through the mantle of crowded pigment cells; such is the case with a still older stage represented by fig. 27, plate vi. About the time of hatching, a second kind of pigment cells, brown in color instead of black, and much larger than the latter, make their appearance. These brown pigment cells blotch the embryo symmetrically on the sides and along the median dorsal line, being confined to sharply circumscribed areas in those regions, as may be gathered from figs. 25 and 26. The style of pigmentation prevalent at the time of hatching foreshadows that of the adult.

The heart appears about the fourth day as a heap of mesoblastic cells just below the hinder part of the head, and is at first a simple sinus. It does not begin to pulsate vigorously until the seventh day, when its pulsations are nearly if not quite 100 per minute. Its venous end rapidly elongates until it extends fully the diameter of the body beyond the right side of the embryo; a large pericardial space is developed below the head at this point for its lodgment; this space dips down deeply into the amber-colored vitellus. It continues to pulsate from this time onwards, but there are as yet no blood corpuscles. A wide space now appears on the right side of the embryo and underneath the latter. This latter we may consider as a vascular sinus or channel of definite outline. The floor of this space, as far as I have been able to observe, seems to consist of the periblast (hypoblast), from which knobbed cells project upward, and which appear to be budding off portions of themselves, which will apparently become blood corpuscles. The sinus, at any rate, becomes much crowded with what are evidently blood corpuscles. Now follow what seem to be amœboid contractions of the yelk, or its periblastic investment, as a result of which this sinus is pushed out more to the right and over the vitellus. This sinus, as it is further extended, in a girdle-like manner, over the vitellus, as in figs. 22, 23, and 24, is seen to be obviously homologous with the edge of the *area vasculosa* of Avian embryology or to the *sinus terminalis* of the mammalian embryo. Smaller vessels are soon formed which lead from the under side of the posterior end of the embryo and join the great marginal trunk anteriorly which leads to the heart. The asymmetry of the vessels which spread over the yelk and take up its substance is very striking during the first few days of development. By the time the young fish is about to hatch the marginal sinus or trunk has gradually assumed a median position on the under side of the yelk, and small vessels pass out on either side of the body on the upper surface of the yelk in a quite symmetrical manner, as shown in figs. 25 and 26.

When the great vascular sinus or first trace of a vascular system is developed, it can scarcely be said that there is a circulation; the blood corpuscles now present are merely swayed back and forth by the pulsations of the heart. As soon as the aortic channel, underneath the chorda dorsalis, is forced through, the blood commences to pour through the sinus from the tail end of the embryo headward over the yelk, as there is now a complete and open vascular cycle of vessels developed. The cardinal and caudal veins are formed about the same time. From them the feeders of the sinus, now the vitelline vessels, are soon developed, and they are rapidly spread out over the yelk as narrow channels, becoming more and more numerous. They at first spread out over the aboral pole of the yelk, and a great common venous channel, derived from the sinus first mentioned, begins on the left side of the embryo and goes round to the right side over the yelk, like a girdle, to feed the heart. Into this somewhat tortuous, equatorial, vascular girdle the blood pours from the small veins traversing the yelk. The main vessel is symmetrically disposed in reference to the median plane of the embryo, and is gradually swung round over the yelk in front of the head as in fig. 24. Eventually the venous end of the heart is also swung round, and is pushed out under the front of the head instead of extending outwards over the yelk at one side of the head. The arrangement and changes undergone by the omphalomeseraic vessels of the embryo stickleback are characteristic, and have not been met with, as far as I am aware, in the embryos of any other Teleosts.

Kupffer's vesicle was found to be present. The urinary bladder occupies the usual position; it is large and inclosed by a proper cellular wall. The course of the intestine, when the embryo is nearly ready to hatch, is marked by a greenish color. The hind gut, during the earlier stages of development, is decidedly swollen and has a spacious lumen.

The blood becomes red in color before the embryo leaves the egg. The vascular system is better developed in this species at the time of hatching than in any other known to me, as well-defined vascular loops already exist in the dorsal and ventral median fin-folds. The branchial vessels, arches, and opercula are also in an advanced condition of development at this period, unusually so when compared with the embryos of most other forms at the same stage.

Lateral sensory or segmental sense organs are developed on the skin at the time of hatching. If the young fish is allowed to assume its normal position in a live-box, and the microscope applied, looking down past the sides of the body from above, certain thickenings of the epiblast or integument will be noticed. These thickenings are surmounted by transparent cells which project freely for a little distance from the general level of the surface. The outer ends of these cells, ten or twelve in number, are somewhat separated from one another, and have blunt truncated tips which are not surmounted with sensory hairs or filaments. The segmental sense organs of the lateral line in the young stickleback, therefore, differ very widely from those of the cod. Fig. 27 represents an older larva in which the lower lobe of the tail is beginning to develop.

THE SPINNING HABITS OF THE ADULT MALE DURING THE BREEDING SEASON.

It has been known for a long time that the males of the different species of sticklebacks build a nest in which they place the eggs laid by the females. The water is continually forced through the mass of eggs by the male fish, which moves his fins for the purpose, and also draws or pumps the water through the clump of eggs with his mouth in executing the movements of the jaws, gills, and opercula incident to respiration. Just how the nest was built, however, never seems to have been observed until about 1879 or 1880, when Mr. W. P. Seal noticed that the nest was built of threads drawn out through an opening near the vent of the male, and that the latter wound these threads round the cluster of weeds chosen to support the nest in a wonderfully intelligent manner. Specimens with which this gentleman kindly supplied me in 1881, upon dissection, showed that there was present, lying on the right side of the rectum, a large sack filled with a viscid secretion, and that this was the source of the material of which the threads were formed. These observations, which were published four years since, have apparently been overlooked by Möbius,[42] who has recently given an account of his observations on the spinning organs of *Spinachia vulgaris* Flem., though his observations are far more complete than were my own.

On the habits of the male *Apeltes*, I wrote as follows in 1881: "The male binds the nest together by means of a compound thread which he

[42] K. Möbius. Ueber die Eigenschaften und den Ursprung der Schleimfäden des Seestichlingsnestes. Arch. f. mikr. Anat., xxv, 1885, 1 plate. Also, Die Niere des männlichen Seestichlings, eine Spinndrüse. Biolog. Centralbl., v, 1886, pp. 647–648.

spins from a pore or pores behind the vent, while he uses his bobbin-shaped body to insinuate himself through the interstices through which he carries his thread with which he binds a few stalks of *Anacharis* or other water-weeds together, bringing in his mouth every now and then a contribution of some sort in the shape of a bit of a dead plant or other object, which he binds into the little cradle in which the young are to be hatched. The thread is spun fitfully, not continuously. He will go round and round the nest for perhaps a dozen times, when he will rest awhile and begin again, or turn suddenly round and force his snout into its top with a vigorous plunging motion, as if to get it into the proper shape. Its shape is somewhat like an inverted truncated cone; an opening is left at the top through which it is supposed that he introduces the eggs. The thread is wound round and round the nest in a horizontal direction in the case we are describing, and if this thread is placed under the microscope when freshly spun it is found to be composed of very thin transparent fibers to the number of six or eight; where they are broken off or terminate they have attenuated tapering ends, as though the material of which they were made had been exhausted when the spinning ceased. Very soon after the thread is spun particles of dirt adhere to it and render it difficult to interpret its character. I have seen the thread being drawn out from the abdomen repeatedly, but not from the vent; it appeared to me more probable that it came from the openings of a special spinning gland. Its glass-like transparency shows that it is not made up of ingested food, the particles of which would exhibit themselves were that the case. The nest measures half an inch in height and three-eighths in diameter.

"Upon opening the male I find a large vesicle filled with a clear, extremely viscid secretion which coagulates into threads upon contact with water. This vesicle appears to open directly behind* the vent, separately from the latter. It measures one-fifth inch in length and an eighth in diameter. As soon as it is ruptured it loses its transparency, and whatever secretion escapes becomes whitish after being in contact with water for a short time. This has the same tough, elastic qualities as when spun by the animal itself, and is also composed of numerous fibers, as when a portion is taken which has been recently spun upon the nest. The nature of the opening was not learned with precision, as I possessed only a single specimen. The vesicle lies to the right side of the intestine, and there is very little doubt that it opens behind the anus. The testes are two ovoid glands, the ducts of which unite into a common canal, both glands and ducts being covered with black pigment cells; the testes, during the breeding season, measure somewhat less than an eighth of an inch in length. As to the origin of the secretion I have

* By mistake it is stated, in this paragraph of my original account, that the sac opens "in front of the vent." I make the needed correction here, as I find that the sketches which I made at the time show that it opened behind the vent, as stated in the first paragraph.

no suggestion to make, but there are certain glandular structures lying close by, the significance of which I am at a loss to understand."

Since the above was written the inspection of additional material enables me to state that the secretion is present only during the breeding season.

Möbius has investigated the subject much more thoroughly in the larger European stickleback, *Spinachia vulgaris*, and he finds that the sac, found by me in *Apeltes* to be filled with a viscid secretion, is really the urinary bladder. And, further, that the sources of the viscid secretion are the kidneys, the secretion being poured out from the epithelial cells of the uriniferous tubules. The bladder acts simply as a reservoir in which it accumulates. In *Spinachia* the threads measure 0.12 to 0.13^{mm} in diameter, the male winding them around weeds to form a nest, in the same manner as the male of *Apeltes*. The secretion or viscid spinning material belongs, according to Möbius, to the mucines. Boiling hydrochloric acid stains it a violet color and then dissolves it. Nitric acid stains it yellow but does not dissolve it. It is insoluble in acetic acid; soluble in caustic potash solution, and when in solution in the latter, if acetic acid is added drop by drop, a white precipitate is formed, which is again dissolved if acetic acid is added in excess. Boiling baryta-water dissolves it, but boiling lime-water does not.

Möbius traced the secretion to the epithelial cells lining the urinary tubules of the kidneys or wolffian bodies. After the breeding season the volume of the kidneys and urinary bladder diminishes, and they then contain urine only, while during the breeding season they are principally filled with the slimy secretion, the thread being spun from the genito-urinary opening just behind the vent.

X.—Esox reticulatus Le Sueur. (*Common Eastern Pickerel; Green Pike.*)

From material supplied by Mr. W. P. Seal, I am enabled to give figures of two stages of this type; the youngest 9^{mm} long and the most advanced 11.5^{mm} in length. These are represented by figs. 28 and 29.

The young of this species become pigmented rather soon. The gill arches remain exposed for a considerable time, as is shown in fig. 29, in which the depressed, produced snout characteristic of the pike family is also already evident. Caudal metamorphosis is also beginning to manifest itself in this older stage, the tail having become lancet-shaped, and proportionately narrower than in the younger stage preceding. There is a well-developed vitelline circulation which has been figured by Truman[43] in the embryo of *Esox lucius*. The same species has also been investigated by 'Swirski,[44] who has worked out the devel-

[43] E. B. Truman. Observations on the development of the ovum of the pike, Monthly Mic. Journ., Oct., 1869, pp. 185–203, pls. 27–29 and part of 30.

[44] Georg 'Swirski. Untersuchungen über die Entwickelung des Schultergürtels und des Skelets der Brustflosse des Hechts. Inaug. Diss., Dorpat, 1880, pp. 60, pls. 2.

opment of the skeleton of the shoulder-girdle and pectoral fins of this type. The most important contribution to our knowledge of the development of fishes of this type, however, is a paper by Walther.[45]

It is interesting to note that 'Swirski found no less than fifteen cartilaginous nodules at the distal ends of the still cartilaginous actinosts or basipterygial pieces, of which he finds four, but the distal end of the fifth and most dorsal in position is bifurcated, showing that it is probably compound, having doubtless originated by the proximal coalescence of two parallel bars. Some of the distal nodules or actinophores were transitory. The sixteen or seventeen rays of the pectoral developed as do those of the rays of the median fins, viz, by the proximal concrescence or blending of horn fibers or actinotrichia. The large number of pectoral actinophores found at various stages would indicate, even if two rays must be reckoned to a segment, that at least eight metameres have thrust processes of tissue into the pectoral fold during its development. These data seem to indicate, in fact, that considerable reduction has occurred in the number of metameric elements in the paired fins of Teleosts, since certain of these elements are transitory.

Walther's paper discusses especially the chondrocranium and the relation of the cementum plates, at the bases of the conical enamel-crowns of the teeth, to the formation of the membrane bones of the jaws and mouth.

X.—Species No. 1.

This fresh water species, which I cannot identify, has a very adhesive egg, 1.6^{mm} by 1^{mm} in diameter, as shown in fig. 31, plate vii. The blastoderm constricts the yelk in a very remarkable way during its growth over the yelk-globe, as shown in figs. 30 and 31. A very large refringent oil-drop is embedded in the yelk; the larger oil-drop is also surrounded by a wreath of much smaller ones. Kupffer's vesicle is developed under the tail end of the embryonic axis in the stage represented by fig. 33. Fig. 32 represents nearly the same stage in profile, and shows the oil-sphere pushed quite to the ventral and anterior pole of the yelk, where it remains until absorbed, as shown in fig. 34.

Three days after hatching, the embryo measures about 4^{mm} in length, has a well-marked vitelline circulation developed, and a row of dark pigment spots are developed along the side of the body, while a very singular and peculiar arrangement of pigment is found on the yelk-sack. On the latter, as may be seen in fig. 34, the pigment spots are confined to the points where the minute vessels join each other.

These eggs were found adherent to a piece of leather in a single layer at Havre de Grace, Md., in the early part of May, 1881. The adhesive

[45] Johannes Walther. Die Entwickelung der Deckknochen am Kopfskelett des Hechtes (Esox lucius). Jenaische Zeitschr., xvi, n. f., ix, 1. und 2. Heft, Jena, 1882, pp. 59–87, pls. iii–iv.

agglutinating matter which covered the zona radiata seemed to have flowed down over the egg and hardened into a kind of flat disk at one side, as shown in fig. 31. The yelk is quite transparent, but the disk and blastoderm are rather thick; these characters lead me to think that it is the egg either of a Cyprinoid or a Centrarchid, most probably the latter, as the yelk of the Cyprinoids is generally very granular.

XI.—PERCA AMERICANA SCHRANCK. (*Yellow Perch; American or Ringed Perch.*)

I have not yet had an opportunity to study the development of this valuable fresh-water species, which spawns in April and May. Like the European *P. fluviatilis*, it lays its eggs in flat bands consisting of a single layer, agglutinated together by an adhesive material. These flat bands of eggs somewhat resemble those of the goose-fish or *Lophius*, but they are not as large and do not float on the surface as do the egg-ribbons of the latter; on the contrary, in this species, they are quite heavy and sink to the bottom, and are suspended by the female in all probability upon submerged objects where they are left to hatch out.

The envelopes of the eggs of the yellow perch are, however, so complex in structure that they may be recognized with the greatest readiness. The vitellus measures 1.75^{mm} in diameter. It contains a large oil-sphere which occupies an eccentric position. The oil-sphere is not represented in fig. 35, plate viii, representing the egg of the American perch, which measures, including the spacious and thick-walled egg-membrane, 3.5^{mm} in total diameter.

The egg-membrane is exceedingly complex, and consists apparently of an internal layer, *z*, which is homologous with the zona radiata of other types. Immediately overlying the zona there is a very thick, highly elastic layer, *g*, which is traversed radially by fibers or canals which widen perceptibly at the outer surface. A third thin investment, *a*, overlies this thick elastic layer, and it consists of the hardened mucine-like material which agglutinates the eggs together. At one point on the surface of the egg there is a wider pore canal which leads to the micropyle *m*. The outer layer, *a*, serves to agglutinate the egg to the outer layer of adjacent eggs, as shown in fig. 35.

XII.—ROCCUS AMERICANUS (GMEL.) J. & G. (*White Perch.*)

The eggs of this species are quite small and measure only about .73^{mm} or one thirty-fourth of an inch in diameter, are very adhesive and stick together in masses or in thin layers over fixed objects in the water. The zona radiata is quite thick and is traversed by fine pore-canals. The micropyle is a minute opening measuring .0075^{mm} in diameter. Externally the zona radiata is at first covered by a thick layer of adhesive matter, which flows toward the points where the eggs come into contact with a foreign body or with each other. At such points disk-like hardened accumulations of the adhesive investment of the egg are developed, as shown in figs. 36 and 37, plate viii. The oil-drop in the vitellus is relatively quite large, as an inspection of the figures named will show.

The blastodisk is also quite bulky in comparison with the bulk of the yelk, as is indicated by the stippled areas, showing the blastodisk in optical section, in figs. 36 and 37. When the blastoderm is developed and has spead over one-half of the yelk, as shown in fig. 38, it is characterized by its great thickness and its much swollen rim. The yelk is also more or less constricted at a later stage by the rim of the growing blastoderm, in the same way as shown in figs. 30 and 31. The embryo, before the tail begins to grow out, embraces considerably more than half the circumference of the yelk. Kupffer's vesicle is also developed at this stage, or by the time the condition shown in fig. 39 is reached.

In six days, with the water at a temperature ranging from 51° to 53° Fahr., the young fish leaves the egg. Viewed as a transparent object, the young White perch at the time of hatching presents the appearance represented in fig. 40, when it measures 2.3^{mm} in length. No fin-folds have as yet appeared and the head seems as if it almost formed a continuum with the yelk-sack below it. On the first day after hatching considerable growth is made by the embryo, since it now measures somewhat over 3^{mm} in length. This stage is represented by fig. 41, plate ix. At the end of three days but little more growth has been made, as is shown in fig. 42, but after the young fish has been hatched five or six days, as shown in figs. 43 and 44, the head begins to project forward. The oil-drop now occupies the forward part of the yelk-sack and is covered by cells derived from the periblast. Stellate pigment cells also begin to make their appearance at this time over the oil-drop, and a few scattered ones develop on the sides of the tail and back part of the yelk-sack.

During the later stages the yelk-sack becomes more elongated, and the liver develops as a bud-like outgrowth from the ventral wall of the mesenteron. The rudiments of the pectoral fins appear as a pair of low horizontal folds of the larval integument some distance behind the ear-capsules. The mouth is barely more than indicated at this stage of development. The spawning season of this species is in April and May.

XIII.—STIZOSTEDIUM VITREUM (MITCH.) JORDAN AND COPELAND.
(*Wall-eyed Pike.*)

The eggs of this species measure nearly a line in diameter or nearly 2^{mm}. Shortly after hatching, the embryo measures 5.8^{mm} (see fig. 45). The pectoral fin is already developed and the oil-drop is anterior in position as in the embryos of the preceding species. The eggs and embryos observed by the writer came from Northville, Mich., and were hatched on the 15th of June, 1885, at the Central Station, Washington.

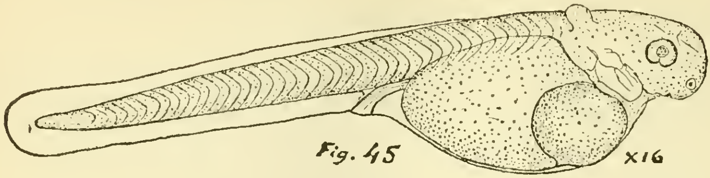


Fig. 45 ×16

XIV.—Scomberomorus maculatus (Mitch.) J. & G. (*Spanish Mackerel.*)

Figs. 46 to 56, plate x, relate to this species and give a few details of structure which it was not possible to work out by the methods of study which I was obliged to pursue at the time my first paper was written.

Fig. 46 represents a transverse section through the first cerebral vesicle; the nasal pit is also cut through at *na*. Fig. 47 represents a section through the mid-brain and the origin of the optic nerves. A segmental sense organ is also cut through just above the front portion of the eye. Fig. 48 is from a section a little farther back than the preceding. Fig. 49 is a very much enlarged representation of a section through one of the segmental sense organs, showing the columnar character of the cells of the lower layer of the integument in these structures. Fig. 50 is a representation of a section cutting transversely through the hinder region of the mid-brain and shows the course of the fibers of the optic nerves through the retinal walls. Fig. 51 represents a cross-section through the fore part of the medulla oblongata; a segmental sense organ is also shown in section. Fig. 52 represents a cross-section cutting through the auditory capsule *au*, with a segmental sense organ, *ss*, below it; below the pharyngeal region, in the middle line, the bulbus arteriosus and ventricle is cut through. Fig. 53 represents a longitudinal section of a young Spanish mackerel somewhat off the median line. Above the pericardial cavity *pc* the branchial and hyomandibular arches are cut across. The heart *h* opens directly, as in fig. 56, into the space surrounding the periblast *p*, as I have elsewhere described in the embryo of *Clupea*. The trabeculæ cranii *tr* are seen to be feebly developed at this stage, as shown in both figs. 53 and 56. Fig. 54 represents a cross-section through the pectoral fin-fold *p′*, the yelk-sack, and segmental ducts *sd*. The periblast in this section is seen to be well developed and contains nuclei. Fig. 55 represents a cross-section through the tail of a young Spanish mackerel, a segmental sense organ having also been cut through. Fig. 56 shows that the oil-drop *o*, at the posterior end of the yelk, is mainly enveloped by the periblast. The intestine *i* is cut through at several points, and the segmental duct *sd* of one side is split lengthwise, the section passing through the urinary bladder *al* and the pronephric funnel *pn* anteriorly. The chorda *ch* is cut through at several points, and the floor of the pericardial cavity *pc* is shown to be very thin and continuous with the venous end of the heart *h*. The latter, therefore, opens directly into the body cavity behind it, the body cavity itself being directly continuous with the cleavage cavity of an earlier stage, the latter becoming the former in the course of development. These sections were prepared from Spanish mackerel embryos which had left the egg only about twenty-four hours, and measured about 3^{mm} in length.

XV.—Chætodipterus faber (Brouss.) J. & G. (*Angel-Fish; Porgee, or Moonfish.*)

The ova of this species are pelagic or floating in habit, in sea-water having a specific gravity of 1.014. They hatch out in twenty-four hours when the temperature of the water is 80° Fahr. This species spawns in the Chesapeake during the latter part of June and the early part of July. It is prodigiously fertile, the female probably discharging a million ova during a single season.

The egg measures somewhat over a millimeter in diameter. The blastodisk will develop independently of fertilization, as shown in fig. 57. Cleavage is very rapid and it requires only about one hour to pass from the condition shown in fig. 58 to the morula condition shown in fig. 60. Fig. 59 shows the form assumed by the cells of the morula stage, and traces are also present of the subquadrate form assumed by the blastodisk at the time of the completion of the second cleavage.

After the blastodisk begins to spread, the development of the marginal cells at its edge becomes very well marked, as shown in fig. 61. The oil-drop, shown in figs. 58, 60, and 61, remains for a time almost exactly opposite the center of the blastodisk, and later, when the embryo is formed, it occupies a median ventral position in the yelk-sack, as shown in figs. 62 and 63, and is not finally shoved to the posterior end of the latter, as in the embryo Spanish mackerel.

In thirteen hours the embryo fish is fairly outlined, as shown in fig. 62, and the oil-drop becomes covered by the periblast in which nuclei seem to be differentiated. At this stage faintly-colored pigment cells, mostly of a rounded form, become developed on the body of the embryo. At the under side of the tail Kupffer's vesicle is also distinctly developed. All over the blastoderm, enveloping the yelk at this stage, faintly-colored pigment cells are discernible.

At the end of twenty-four hours the young fish leave the egg, measuring about 2.5^{mm} in length. Sixteen hours later, as shown in fig. 63, the embryo has grown about half a millimeter in length, and the greater part of the yelk has been absorbed, so that an immense serous space is left in front of the yelk, between the periblast enveloping the latter and the outer somatopleural sack. This wide space has been derived directly from the cleavage cavity. By this time the pigment cells on the body and tail have begun to aggregate in definite groups, as shown in fig. 63, and the majority have also become distinctly stellate.

Fig. 64 represents the recently-hatched moonfish. The body cavity *sc*, formerly the cleavage cavity, is already very spacious, as the yelk is being absorbed more rapidly than the outer somatopleural envelope of the yelk is collapsing. This outer somatopleural covering of the yelk in this species, as in all young fishes, even Elasmobranchs, is quite free and is not fused with the periblast-splanchnopleure beneath it. The oil-drop, it will also be noticed, is now invested by distinct cells of periblastic origin, which have well-defined borders, and are more or less stellate. It also bulges outward, more or less distinctly, but it is easy to see that it is still invested by the yelk. The pectoral fin-fold appears far behind the auditory involution in the stage represented by fig. 64; it is somewhat more developed in the more advanced stage represented by fig. 63. The ventral fins appear quite late, as they were absent in the oldest stages observed by me.

Twenty-eight hours after hatching, the young moonfish measures 3.5^{mm} in length, and presents the appearance shown in fig. 65. Embryonic fin-rays have by this time made their appearance at the end of the tail; the pectoral fin is well developed, and the intestine is longer and the urinary bladder is larger. The yelk has also diminished greatly in size, and the mouth will soon be open. There is still no complete circulation, though all the principal subdivisions of the heart are developed and that organ is pulsating vigorously. By this time traces of a reddish pigment begin to appear on the upper and lateral portions of the abdomen.

Fifty-three hours after hatching the young moonfish has grown mainly in height of the body, as shown in fig. 66. The snout is very blunt and declivous and foreshadows the form of the blunt, rounded profile of the parent fish. The yelk is nearly absorbed and over the abdominal walls there is now developed a strongly-marked group of stellate red pigment cells. A flexure of the intestine is also developed and the urinary bladder is very large and distinct. The pectoral is strongly developed and a complete circulation is apparent, though the aorta bends upon itself and is continued forward against the caudal vein at a point less than half the distance between the vertical from the vent and the end of the tail. The pigment cells have also by this time been more definitely aggregated into a definite band on the tail and on the integument above the pectoral. The young fish by this time measures nearly 4^{mm} in length.

I have seen some of the post-larval stages of the young of this species in Chesapeake Bay measuring from one-half to one inch and a quarter in length. In these the transverse dusky bands seen in the adult are intensely bluish-black in color. It is, therefore, obvious that the coloration diminishes greatly in brilliancy with age. I have very strong reasons to suspect that the larvæ of this species are phosphorescent at night.

XVI.—Gadus tomcod Walb. (*Tom-cod; Frost-fish.*)

The eggs of this species of Gadoid are somewhat larger than those of the common codfish. The egg-membrane is rather thick and tough and is covered externally by an adhesive coating of a mucine-like substance which agglutinates the eggs together in masses, the latter being very frequently, if not usually, attached to sea-weeds and stones at the bottom of the littoral zone. The eggs are not pelagic, like those of the cod, though there is a very conspicuous oil-drop in the vitellus; as development progresses this oil-drop is pushed forward to the anterior pole of the yelk-sack.

When hatched the gape of the mouth is very much greater than that of the larva of the common cod. The intestine terminates at the margin of the ventral fin-fold, instead of some distance from it, as in the larval cod, as may be seen by comparing figs. 1 and 67. There is no integumentary vesicle or bulla developed over the head as in the young cod, so that the larval stages of this species differ very widely from its congener, though both spawn in winter or during the colder months of the year. The larvæ of the tom-cod are also more robust in build than those of the cod, and measure at the time of hatching very nearly, if not quite, 5^{mm} in length.

XVII.—Clupea sapidissima Wilson. (*The Common Shad.*)

The interest attaching to the development of this species is two-fold, namely, that which appeals to the economist and that which appeals to the biologist. While the description of the morphological changes which this species undergoes during development will be of immediate interest only to the latter, the former, if he be a fish-culturist, and not otherwise interested in the life-history of the type under consideration, may still perhaps derive useful information from what is to follow respecting the manner in which the perpetuation and development of this valuable food-fish is accomplished. With the invention of greatly improved appliances, the hatching of this form from artificially fertilized eggs is now accomplished to the number of perhaps fifty to seventy millions annually along the Atlantic slope, reckoning in this total the combined efforts of the United States and the different State fish commissions of the coastwise States. The species is anadromous and quite fertile, a single female yielding during the season, if unmolested, about 200,000 ova. These ova are probably discharged in shoal water and mainly after night-fall. Spawning occurs during the spring months of April and May, and as late as June and July in the latitude of Washington and Baltimore.

The freshly-extruded egg of the shad is of a very pale amber color, and is invested by a very much wrinkled zona radiata, as shown in fig. 68. At this time, if the egg is allowed to lie on a plane surface, its form is considerably flattened, and its outline from above is subquadrate and irregular. The freshly-laid egg, if examined with a low power of the microscope, is found to be very closely invested by the zona radiata *z*, fig. 69; immediately below the zona lies the cortical layer *cl*, in which numerous minute rounded bodies or corpuscles are imbedded. This cortical layer of plasma also sends down into the yelk thin laminar prolongations of itself which envelop the large yelk masses *y* into which the body of the vitellus is subdivided. Immediately after the ova are brought into contact with the sperm or milt of the male shad a great change in their appearance occurs. This change consists mainly of the distension of the wrinkled zona with water, as a result of which the egg becomes spherical, its bulk at the same time becoming about seven times greater than in the unimpregnated state. This change may occur in the presence of water without the agency of impregnation, but it is then not apt to affect all of the ova in this way. As a result of the distension of the zona radiata or egg-membrane, the latter is lifted up from contact with the surface of the vitellus so that it lies quite free in its spherical envelope with a wide space all around it, as shown in fig. 70, in which the vitellus is shown as an oval black dot and the contour of the egg-membrane as a simple circle. This figure represents the egg of the shad of the natural size with the vitellus lying in the lower half of its envelope. With the further progress of development no additional distension of the egg-membrane occurs, but during the whole of the time the space surrounding the egg or embryo remains the same, as may be seen by reference to fig. 101, plate xvi; figs. 126 and 127, plate xviii; and fig. 136, plate xix.

Upon the impregnation of the egg, which is effected by the entrance of a spermatozoön through the single minute pore or micropyle, which admits of the passage of the male element to the vitellus from the outside through the zona, a germinal thickening of the cortical layer or a blastodisk is rapidly developed. In its natural position in the zona, the vitellus of the shad, surrounded by its envelope of germinal matter, assumes the form of an oblate spheroid or that of a somewhat flattened sphere, when viewed in optic section, as shown in figs. 71, 72, and 73. At first there is no blastodisk present, but a few minutes after impregnation the cortical layer at one side of the ovum becomes perceptibly thicker over one pole of the vitellus by the concentration or aggregation of its substance at that point, as shown in profile in fig. 71, and from above in fig. 75. The substance of the cortical layer becomes slowly heaped up after impregnation into a depressed conical mass at one pole of the vitellus, as shown in figs. 71, 72, 73, 74, and 76. Normally, the blastodisk is lateral in position when the egg is at rest. From its inferior side strands of protoplasmic matter pass down between the large vitelline masses into which the yelk is subdivided. These strands of plasma radiate from the under side of the blastodisk into the yelk somewhat in the same way as the roots of a plant radiate from the base of its principal stem into the surrounding soil, as is shown in figs. 71 to 78, inclusive, plate xiv.

In the course of about fifteen minutes after fertilization, I have several times witnessed the expulsion of the polar cells from the developing blastodisk of the ovum of the shad. A distinct prominence is first developed near the center of the thickening of the cortical layer, as shown in fig. 74. At intervals of a minute or so apart, the changes which that prominence undergoes I have represented in fig. 79, *a*, *b*, *c*, *d*, *e*, *f*. The two polar cells at first lie close to the surface of the incipient disk; later, they remain adherent only by a slender filament of protoplasm, as shown at *c*. Finally, they are detached from the filament, as shown at *d*, and at last the filament itself is slowly withdrawn into the cortical layer, disappearing entirely at a stage a little more advanced than that shown at *f*. The polar cells in this species are finally detached, and seem to disintegrate in the large water space surrounded by the zona, and in which the egg lies. Such a detachment of the polar cells is not without precedent, for Bischoff represents them as detached in the segmenting ovum of Mammalia, and I have myself observed their detachment from the segmenting ova of Nudibranchiate mollusks, and saw them drop into the perivitelline space just as seems to be the case in *Clupea*.

At the end of about half an hour, with the water at a temperature of 75°, the blastodisk is formed, and at the end of one hour and twenty minutes the first cleavage furrow has been formed. This furrow divides the blastodisk into two equal conical masses, as shown in figs. 77, 78, and 80. These figures represent the cleavage in its most active phase, when the plasma of the disk is heaped up into two remarkably prominent blunt cones. The disk becomes much elongated as a result of the development of the first cleavage, nor does it lose its elongated squarish form for a considerable time after the second cleavage furrow is developed, as shown in fig. 81, from above, and in figs. 82 and 85 in profile. Certain irregularities of cleavage are sometimes apparent, such as the development of five cells in the disk at this stage, instead of four, or the normal number. An abnormal disk of this kind is represented in fig. 83. The second furrow is developed about two hours after fertilization.

Upon the advent of the third set of furrows, which divide the four cells of the last stage transversely, the blastodisk is subdivided into eight cells lying in two parallel rows of four each, as shown in figs. 86, 87, and 88. The third set of furrows appears about half an hour after the second cleavage has been completed. In the course of the next forty minutes the thirty-two celled stage of segmentation has been passed over, as represented in figs. 84, 89, and 90. The morula condition is now entered upon, but its development is not completed until about four to five hours after fertilization. Consequently, the next change which the blastodisk undergoes is the further subdivision of its component cells. Just after the stage represented in fig. 90, the blastodisk becomes divided into two layers of cells, as shown in fig. 91. At about this time the nuclei of the periblast become sundered from the nuclei of the cells at the edge of the blastodisk. The morula stage is finally completed when the segmented blastodisk assumes in section the lenticular form represented in figs. 92, 93, and 95; nuclei are already apparent in the periblast of the latter.

Immediately succeeding the morula stage comes the blastula condition, when, for the first time, the blastodisk becomes markedly lifted up at its center from the underlying periblast. As a result of this lifting up of the middle of the blastodisk, which at the same time becomes thinner in the center, a space appears under its central part, known as the cleavage cavity, as shown in figs. 137 and 138, plate xix. The duration of this phase of the blastula is brief and is almost immediately followed by the gastrula stage.

The advent of the gastrula stage is characterized by the inflection of the margin of the blastoderm. This becomes greatly thickened at one point at its margin, or where the future embryo will be formed, as shown in optic longitudinal section, in fig. 137, at *s*, as a swelling. Other views of this stage are also given in figs. 138 and 139. At this time the cleavage cavity has a kidney-shaped outline as viewed from above, but it soon becomes somewhat crescent-shaped, as in fig. 140, for the swelling *s* of the previous stages is extending inwards to form the embryonic shield *e*. In sagittal, optic section this same stage is represented in fig. 141, with the egg in another position. Both these last figures were carefully drawn from micro-photographs.

The gradual advance of the blastoderm over the vitellus is represented by figs. 140 and 141, plate xix; fig. 96, plate xv; figs. 118, 119, and 120, plate xvii; and in figs. 98, 101, and 102, when the yelk-blastopore or protostoma of the egg of the shad may be said to have closed, the margin of the spreading blastoderm being considered the margin of the gastrula mouth and the whole yelk as hypoblast, together with the formative hypoblast *h*, as shown in figs. 96 and 118. Such an arrangement causes the gastrula mouth from *o* to *o* to be greatly expanded or widened in order that it may embrace the greatly hypertrophied hypoblast with its inclusions of passive deutoplasm.

Before the blastoderm of *Clupea* begins to spread a well defined thin cuticle or epidermis is developed over its whole surface, composed of a single layer of squamous cells, as shown in fig. 95. This is the first differentiation of tissue layers which occurs in the blastodisk of the ovum, aside from the formation of the periblast. As a result of the inflection of the margin of the blastoderm, the hypoblast and epiblast are developed, the former from the inflected stratum of cells, *h*, and the latter, *e*, from the epithelial and immediately underlying cells of the disk. From these two primitive organs all those of the young shad are evolved by further differentiation, folding, expansion, invagination, &c.

The central nervous system is developed wholly from the epiblast. This will be rendered the more obvious from a glance at figs. 106 to 108, representing transverse sections through the embryonic axis of an embryo shad represented in fig. 101, plate xvi. The spinal cord *N* in these is shown to arise as a thickening of the layer *e*, and extends the entire length of the body at this stage, and is here characterized by its solidity, as in the embryos of all Osseous fishes and the Lampreys. During a later stage the cord *N* becomes separated from the layer *e*, as is shown in cross-sections (figs. 109 to 112) of a much later stage, viz, that shown in fig. 126, though the sundering of the embryonic spinal cord from the epiblast in reality occurs considerably earlier, or by the time the stage represented in fig. 103 is reached.

As the blastoderm spreads, the portion *e*, fig. 140, lengthens to form the embryo, the component layers of the latter, fig. 96, *e* and *h*, becoming much thickened in the vicinity of the median longitudinal plane. From the inferior thickened part of the inflected band of tissue *h*, the chorda *ch*, figs. 106, 107, and 108, is formed, together with the myoblasts or myotomes on either side of the chorda, as dorsal outgrowths, fig. 97, *M M M*, of the primitive hypoblast *h*. These rudiments of the musculature of the body in the embryo shad are not hollow, as in *Branchiostoma*, or composed of two layers forming the inner and outer walls of the series of myoblastic segments, as in *Elasmobranchii*. They are therefore not clearly defined paired archenteric diverticula or gut pouches, but their solid condition is probably due to an abbreviation of development like that which has affected and retarded the appearance of the cavity of the spinal cord and brain and that of the intestine. The inferior part of the layer *h*, in fig. 96, gives rise in the middle line to the intestine *i*, as shown in figs. 106 and 107. The lumen of the intestinal canal appears very slowly, and at first is a mere pore in cross-sections, as shown in figs. 109 to 112 at *i*. During the early stages the hypoblastic band which gives rise to the intestine is thickest at the posterior end of the embryo, and gradually thins out and widens as it extends toward the head. This is rendered obvious upon comparing a section near the tail end of the embryo, fig. 111, with a more anterior one, fig. 109, from the region of the back part of the medulla oblongata. The lumen of the intestine in this anterior region is also no longer pore-like, but flattened, cleft-like, and transverse.

At a slightly earlier stage than is shown by the sections represented in figs. 106 and 107, the chorda *ch* is found to be united inferiorly with the layer *i*, which gives rise to the intestine. The chorda, myotomes, and the intestine are therefore to be regarded as differentiations of the layer *h* in figs. 96 and 118.

The myotomes gradually increase in number, and at the time the blastopore closes but three or four are visible, as shown in fig. 120. Somewhat later more are added behind those already formed, as shown in figs. 98, 101, 102, 103, 123, 126, 127, until the full complement is developed, as shown in fig. 151.

Of the sense organs, the optic lobes, from which the eyes are formed, are the first to become developed. These appear as a pair of lateral elongated thickenings of the epiblast at the front end of the embryonic axis. Four stages of the differentiation of the optic lobes are shown, as viewed from the above, in figs. 114 to 117. These phases of the development of the eyes and head may be readily connected with the more advanced ones represented in figs. 113 and 128.

The gradual extension of the cleavage cavity *sc* under the growing blastodisk may be traced by reference to figs. 137, 138, 139, 140, 141, 118, 119, 120, 121, 98, 102, 103, 122, 126, and 127. After the entire yelk is covered by the blastoderm the only cellular membranous covering investing it externally is the extremely thin epiblastic membrane *e*, shown in section, fig. 121, and between this and the periblast *p* of the same figure the cleavage cavity *se* is included; this again being directly continuous with the body cavity *bc* on either side of the intestine *i*. This relation of the surrounding parts to the cleavage cavity demonstrates very conclusively that the membrane *e*, in fig. 121, must be the somatopleure, while the periblast *p* must undoubtedly be homologized with the splanchnopleure. The vascular network developed over the periblast and in intimate connection with it, in the ova of many species of fishes, is also splanchnopleural and homologous with the area vasculosa or omphalomeseraic meshwork developed over the yelk of higher forms. Of the correctness of this homology I think there can scarcely be any doubt whatever.

The yelk of *Clupea*, and of Teleost embryos generally, it may therefore be said, is intra-abdominal; it is excluded from direct connection with the intestine, but remains adherent to it for a considerable time by its inferior face, through the intermediation of the periblast immediately underlying the intestine. The yelk is almost naked were it not for the thin syncytium, known as the periblast, and which, on the lower and lateral portions of the yelk, can hardly be considered to rank as a true membrane on account of the widely-scattered or diffused nuclei it contains. The splanchnopleure (= periblast) of osseous fishes is therefore rudimentary or very feebly developed over the vitellus, so that the latter may be considered to be intra-abdominal, not only because there is no umbilical stalk developed, but also because it is very imperfectly inclosed by the splanchnopleure.

The chorda is unusually well developed in *Clupea* and forms a massive axial rod at the time of hatching, as shown in cross-section at *ch*, fig. 121, and for its whole length in fig. 148. Derived as already stated from the median dorsal part of the hypoblast, it retains its connection with the last-named layer longest at its posterior extremity, as shown in fig. 98. After the tail begins to bud out, however, its intimate connection with the hypoblastic layer is broken, and it then terminates after becoming somewhat enlarged in the cellular terminal mass in which the lateral myoblastic *m*, neural *N*, and post-anal section of the gut *i* terminate, as shown in cross-section in fig. 104, and in vertical and transverse optic section in figs. 103 and 113. The histological differentiation of the chorda has already been described by Kupffer, Kowalevsky, and others, so that there is no occasion for me to redescribe it, as it takes place in very nearly the same way in the embryos of all *Chordata*. The cells of the chorda of *Clupea* are, however, unusually large and contain very spacious cavities, in which no coagulable albumen is present.

The later stages of the development of *Clupea* involve mainly the completion of structures, the rudiments of which were laid down during the evolution of the stages already described.

The renal apparatus of the larval shad is extremely simple, and consists, at the time the tail begins to bud out, of a pair of parallel tubes differentiated from before backwards from the outer portions of the mesoblast at the time it splits into somatopleure and splanchnopleure. The segmental ducts *sd* finally lie just above the somatopleural peritoneum and extend from a little way behind the pectoral plate *pp*, fig. 113, or the pectoral fins, fig. 148, to a point just behind the vent where they debouch into a common cavity, the urinary bladder which opens outward behind the vent. At their anterior extremities the segmental ducts terminate in a single nephridial funnel which opens into the body cavity, the mouths of the pair of funnels being directed backward and inward, so that the anterior extremities of the ducts are bent upon themselves in the form of a shepherd's crook.

The development of the cranium is not precocious, and its primary cartilaginous elements are not very apparent until after hatching. The most obvious portions are the trabeculæ *Tr*, figs. 142, 143, and 144, the branchial bars *i*, *ii*, *iii*, *iv*, and *v*, and the hyomandibular arch, composed of the hyomandibular *Hm*, interhyal *Ih*, quadrate *Q*, symplectic *Sy*, Meckel's cartilage *Mk*, and the cerato- and glosso-hyal elements *Ch* and *Gh*. The auditory vesicles *Au* are quite large, but are not entirely invested by cartilage; only the outer and inferior aspects being closed in by chondrified tissue, as shown in cross-section in fig. 147, which was prepared from a larva about six days old. Fig. 144 represents a very nearly mesial longitudinal section through the head of a just-hatched larva, in which the positions of the cranial cartilages crossing the middle line are indicated. Fig. 143 represents the cranial cartilages of a slightly older larva constructed from a series of sections. Fig. 142 represents the cranial cartilages of a still more advanced larva, in which the antorbital process *Ao* and trabecular rostrum *R* are more strongly developed. The branchial and hyomandibular arches have also reached a considerably greater development than in the preceding stage, while the anterior end of the notochord has become more completely covered by the parachordal cartilages. This inclosure of the anterior extremity of the chorda by the parachordal elements *pa* is more distinctly displayed in figs. 146 and 147, plate xxi, drawn from cross-sections of the same stage as that represented by fig. 142. The tegmen cranii *Tc*, fig. 142, is not developed during the earlier stages, shown in figs. 143 and 144. The palatopterygoid is not present until the stage represented by fig. 142 is attained, or perhaps even later. An element which I identify as palatopterygoid is present in the cross-section represented in fig. 145, and has been cut through just below the eye at *pt*. This element, at any rate, seems to be developed quite independently of any connection with the hyomandibular.

The heart at the time of hatching opens directly into the cleavage cavity (=body cavity), as represented in fig. 144, and it is not until some days after hatching that connection is established between its venous end and the jugular and portal veins *j j'*, and *pv*, as shown in fig. 152. The yelk seems to be absorbed by the heart and portal vessels, which pass above it, and its anterior end is finally drawn out into a pointed process, which is directed toward the heart, as shown in fig. 152. I have witnessed the budding of free cells from the periblast *p* in the stage represented in fig. 144, and have, also, seen such cells pass directly into the cavity of the heart, though there was, as yet, no complete circulation.

The other visceral organs are differentiated as appendages of the alimentary canal. The first and most conspicuously developed is the liver *L*, figs. 133, 148, 150, and 152, it being formed as an outgrowth of the ventral wall of the intestine. Just a little distance behind the posterior extremity of the liver, the alimentary canal is constricted at *py;* this marks the point just behind which the pyloric appendages will grow out. Just in advance of the pyloric constriction, and on the dorsal side of the œsophageal portion of the alimentary canal, the air-bladder grows out as a saccular diverticulum of the intestinal wall at *ab*, fig. 133. The first traces of the air-bladder do not appear until some days after hatching, and the same may be said of the gall-bladder *Gb*, fig. 133, which is formed at the anterior end of the liver. In the course of about three weeks the metamorphosis of the visceral organs is nearly completed, as may be gathered from fig. 131, as this figure represents the pneumatic duct *pn*, posterior end of the œsophagus *oc*, the rudimentary stomach *st*, and the pylorus *py* of a young shad nearly an inch long and three weeks old, reared in confinement. There are still no pyloric cæca, but the permanent form of the alimentary tract of the Clupeoids is already very clearly apparent.

We may now review the principal and most striking changes in external form which the young shad undergoes within the egg. Starting with the phase represented in figs. 137, 138, 139, 140, and 141, when the first trace of the embryo becomes obvious at one side of the blastoderm the embryo is finally quite distinctly outlined when the stage represented in figs. 101 and 102 is reached. A little later the tail begins to bud out as shown in fig. 103. Later still, and usually by the end of the second day, the young fish has reached the condition represented in fig. 126. Somewhat later the stage represented in fig. 127 is attained. The yelk is still quite large at this time and the peritoneal or segmentation cavity *sc* is obvious. At this time the horizontal folds which give rise to the pectorals appear, as shown in fig. 128 from above and in diagrammatic section in figs. 129 and 130. A more advanced stage of the development of the pectoral fin is represented in fig. 134, at which time it begins to be rotated on its own base. As a result of this rotation, its posterior or metapterygial border becomes directed downward, while its anterior or propterygial border is directed upwards or dorsally. Shortly after the stage represented in fig. 136 is reached the young fish leaves the egg. By the time this stage is reached the mouth is open, but there is no open or free passage through the œsophagus. The gill and hyomandibular arches are obvious, though the branchial clefts are still very narrow. After hatching, as shown in fig. 149, the tail of the larva is perfectly lophocercal and shows no well-marked signs of heterocercality until some time after the absorption of the yelk. The larva now measures 10^{mm} in length. Fig. 148 represents a stage about two days older than that shown in fig. 149, and in which the gill-arches and jaws are more fully developed, so that the mouth is opened and closed voluntarily by the young fish. A feeble branchial respiration is established about this time. The auditory vesicles are now fully differentiated and the semi-circular canals, otoliths, and auditory end-organs of the seventh nerve are developed as shown in fig. 132. Two pairs of recurved teeth have also been developed in the lower jaw at this stage.

At the end of about the fifth day the yelk has been almost entirely absorbed; only a small fusiform mass of vitelline matter, *Y*, fig. 151, remains and causes the ventral wall of the abdomen to bulge downwards behind the pectoral fins. By this time the mesoblast begins to proliferate into the median dorsal fin-fold to form the foundation of the permanent dorsal, as indicated at the base of the widest portion of the dorsal fold in fig. 151. On the thirteenth day a decided notch at the posterior end of the future dorsal, as shown in fig. 133, marks the point in advance of which that fin will be formed. In the course of twenty-one to twenty-eight days the young shad has about completed its metamorphosis, when it is still much slenderer than the adult, though it has all of the fins developed, even the ventrals, which grow out quite late and about midway between a vertical passing through the pectorals and another passing through the anus. In six months the larvæ of the shad, if kept where they can find an abundance of small crustacea, insects, &c., will grow to a length of 4½ inches. By the time they reach that size they are readily recognizable by their external characters as appertaining to this species.

The gill-clefts remain uncovered for a long time, as shown in figs. 150, 151, and 153, but by the twenty-first to the twenty-eighth day the opercular folds have grown to such an extent that the clefts and gills are quite concealed from observation externally. When the fish reaches that stage of development it measures 22^{mm} in length, or not far from an inch, and has a heterocercal tail in which the permanent rays are well developed, as they are in all of the fins except the ventrals. The first obvious intimation of heterocercality in the larval shad appears on the seventeenth day, as shown in fig. 150, representing a rather stunted larva measuring 14^{mm} in length. The food during the later larval stages does not accumulate in the stomach, but accumulates in the intestine *I*, just behind the pylorus, as shown in fig. 150. It is only after the young fish acquires mobility of its jaws that it begins to feed, and after the small teeth already mentioned have appeared; indeed, the larvæ about this time occasionally become so ravenous that they have been known to attempt to eat each other, and finally strangle in their efforts at consummating cannibalism.

The temperature at which the ova of the shad develop normally ranges from about 55°, or perhaps slightly less, up to about 80° Fahr. Experiments made to determine the lowest temperature at which normal development would take place gave some very interesting results. It was found that at a little below 52° Fahr. abnormalities of various kinds were sure to appear. Some of these I have figured from micro-photographs on plate xviii. Figs. 122 and 123 show how the development of the tail and notochord was impaired when the embryos were subjected to a temperature ranging from 45° to 48° Fahr. Fig. 124 shows how the development of the blastodisk became impaired when subjected to the same low temperature.

A great variation in the period of hatching of this species is caused by variations in the temperature of the water during the hatching season; for example, at 74° Fahr. hatching occurs in about seventy hours; at 64.5° Fahr. in one hundred and nine hours; at 57.2° Fahr. in one hundred and forty-eight hours or over six days. I have known it to require seventeen days for the ova of the shad to hatch when the average temperature of the water was 53.75° Fahr. In ordinary pleasant spring weather the eggs usually hatch during the third or fourth day after fertilization.

The first paper of note on the development of the shad was published by the late Prof. H. J. Rice[46] in 1878. Since then the writer has published additional observations[47] on the development and the retardation of the development of the eggs and on the feeding[48] of this species.

[46] H. J. Rice. Notes upon the development of the shad (Alosa sapidissima ?). Report of a Commissioner of Fisheries of Maryland, January, 1878, pp. 95–106, pl. vi.

[47] J. A. Ryder. On the retardation of the development of the ova of the shad. Bull. U. S. Fish Com., i, 1881, pp. 177–190 and 422–424.

[48] J. A. Ryder. Observations on the absorption of the yelk, the food, feeding, and development of embryo fishes. Bull. U. S. Fish Com., ii, 1882, pp. 179–205. One figure in text.

The illustrations accompanying the present note on the development of *Clupea sapidissima* have been drawn in part with the camera lucida at various times during the last five years; a number are redrawn from a series of very successful micro-photographs made by Mr. T. W. Smillie, under the direction of the author.

XVIII.—ICTALURUS ALBIDUS (LE SUEUR) J. & G. (*White Cat-fish; Channel Cat of the Potomac.*)

I have already given a short account of the development of this species elsewhere,[49] but as the many remarkable phases presented by its larval growth cannot be understood without illustrations, I will now give a fuller and more detailed description, with such figures as are ready for publication.

A number of individuals of this Siluroid were brought from the Potomac River to the Armory Building in the spring of 1883, and deposited in the large aquaria in that institution at about the close of the shad-hatching season of that year. One pair of these fishes afterward spawned while in confinement, and thus afforded the writer the opportunity of observing and describing some of the more interesting phases of development of this singular family of fishes. There has hitherto been little attention paid to the development of this type, probably from the lack of opportunity; and these notes may therefore prove of interest to naturalists. The literature of the subject is scanty; and, besides a paper by Jeffries Wyman[50] on the development of *Aspredo lævis* and *Bagrus*, I know of no separate essays on the development of this group, except some remarks in Günther's Introduction to the Study of Fishes, and in his article Ichthyology, ninth edition of the Encyclopædia Britannica, on the development of *Arius*. An egg of this genus is there figured in an advanced state of development, from which it appears that this form is very similar in its embryological features to *Ælurichthys*, some ova of which are in my possession, measuring three-fourths of an inch in their longest and five-eighths of an inch in their shortest diameter. *Arius* and *Ælurichthys* are marine forms, and the males have the habit of carrying the ova in the hinder part of the oral cavity or branchial region until the young are hatched. These marine species, however, have only a few very large ova so concealed in the mouth of the male at one time. They are probably far less prolific than the species the development of which is about to be described.

The adults were kindly identified for me by Professor Gill. Its habits of spawning and care of the young are probably characteristic of all of the species of the genus, of which there are said to be eight found within the limits of North America.

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[49] J. A. Ryder. Preliminary notice of the development and breeding habits of the Potomac cat-fish, Amiurus albidus (Le Sueur) Gill. Bull. U. S. Fish. Com., iii, 1883, pp. 225–230.

[50] J. Wyman. On some unusual modes of gestation. Am. Journ. Arts and Sciences, xxvii, 1859, pp. 5–13.

On the morning of the 13th of July, a little after 10 o'clock, we noticed a mass of whitish eggs in one of our aquaria inhabited by three adult specimens of *Ictalurus albidus*, two of which were unmistakably the parents of the brood, for the reason that they did not permit the third one to approach near the mass of eggs which one of them was watching vigilantly. One of the individuals remained constantly over the eggs, agitating the water over them with its anal, ventral, and pectoral fins. This one subsequently proved to be the male and not the female, as was at first supposed. The female, after the eggs were laid, seemed to take no further interest in them, the whole duty of renewing and forcing the water through the mass of adherent ova devolving upon the male, who was most assiduous in this duty until the young had escaped from the egg-membranes. During all of this time, or for a period of about a week, the male was never seen to abandon his post, nor did it seem that he much cared even afterwards to leave the scene where he had so faithfully labored to bring forth from the eggs the brood left in his charge by his apparently careless spouse. The male measured 15 inches in length, the female a fourth of an inch more.

On the 30th of June, or when the young were seventeen days old, it was determined to make an examination of the internal organs of both parents, which was done in the presence of Professor Gill, to learn which one of the parent fishes it was that had acted as nurse. Fortunately there was considerable difference between the two in color; the female had also lost a part of one maxillary barbel, so that it was easy to distinguish the two fishes apart. The darker specimen, with the broader head, we found was the male, which, as already stated, had acted as the nurse. Upon cutting him open and removing a portion of the milt or testes they were found as a lobulated pair of organs, lying one on either side of the mesentery and depending from the dorsal wall of the abdominal cavity. The lobes of the testes were digitate. Upon compressing fragments of the testes under the microscope, active spermatozoa were passed out. The spent roe or ovary of the female was a paired organ, the right and left sacs of which were joined together posteriorly. The ovarian lobes or leaflets were disposed transversely in the sacs.

The mass of ova deposited by the female on the 13th of July in one corner and at one end of the slate bottom of the aquarium measured about 8 inches in length and nearly 4 inches in width, and was nowhere much over one-half to three-fourths of an inch in thickness. There were probably 2,000 ova in the whole mass, as nearly as could be estimated. The single ova measured about one-sixth of an inch in diameter a short time after oviposition.

The ova were covered with an adhesive but not gelatinous envelope, so that they were adherent to the bottom of the aquarium and to each other where their spherical surfaces came in contact, and consequently had intervening spaces for the free passage of water, such as would be found in a submerged pile of shot or other spherical bodies which had been piled in a heap. It was evident that the male was forcing fresh water through the interstices in this mass of eggs by hovering over it and vibrating the anal, ventral, and pectoral fins rapidly.

All of the ova left in the care of the male hatched, while about one-half of the mass which he had detached from the bottom of the aquarium on the third day, during some of his vigorous efforts at changing the water, were transferred to another aquarium, supplied with running water, and left to themselves. Those which were hatched by the artificial means just described did not come out as well as those left to hatch under natural conditions. Nearly one-half of the former failed to hatch, apparently because they were not agitated so as to force fresh water through them and kept clean by the assiduous attentions of the male parent.

The eggs measure about one-sixth of an inch after the large water space is formed, which is normally developed in this, as in the ova of other fishes, after fertilization, the zona radiata being lifted up somewhat from the vitellus. The vitellus measures one-eighth of an inch in diameter. The egg-membrane is double, that is, there is a thin inner membrane representing the zona radiata, external to the latter and supported on columnar processes of itself which rest upon the inner membrane; there is a second one composed entirely of a highly elastic adhesive substance. The columns supporting the outer elastic layer rest on the zona and cause the outer layer to be separated very distinctly from the inner one. It is these elastic columns and the elastic outer adhesive membrane which permits the adult fish to shake and move the mass of ova so violently without injury to the embryos in process of development within. This peculiar double egg-membrane, with a well defined space between its inner and outer layers, is highly characteristic, and bears no resemblance to the thick, simple zona investing the egg of *Ælurichthys*, nor has anything resembling it ever been described, as far as I am aware, in the ova of any other Teleostean.

The germinal disk was formed at the upper pole of the vitellus immediately after oviposition and gradually spread in the usual manner over the lower pole of the opaque, whitish, granular, vitelline globe. In the early part of the second day the body of the young fish was distinctly outlined and the tail had grown out to a considerable length, and before the body of the embryo had encircled much more than one-fourth of the circumference of the vitellus, as shown in figs. 154 and 155—the first figure being drawn from a hardened embryo of the second day, viewed as an opaque object and the second from a living embryo of the same age, viewed as a transparent object. On the third day, the tail of the embryo had acquired considerable length, as shown in fig. 159, and its free extremity was moved from side to side grace-fully and rhythmically through the contents of the water space surrounded by the zona.

The water space from the first was filled with an immense number of free refringent but very minute corpuscles, which made it difficult to make out the form of the embryo during the early stages, unless the zona was first removed. These corpuscles were not of the nature of blood cells, and seemed to become less abundant toward the close of the period of development within the egg. So abundant were these corpuscles at first, coupled with the opacity of the vitellus and the peculiar whiteness of the germinal matter, that even an experienced observer would be led to suppose at first that all of the eggs were bad, having the "rice-grain" appearance of blasted shad ova. The corpuscles mentioned are visible in sections of the entire egg of *Ictalurus*, and are very abundant in the water space forming adherent masses. In life the movements of the tail of the embryo cat-fish whirl these corpuscles about in the water space in clouds, so that it seems as if a whitish sediment was being constantly stirred up within the egg-membrane. The presence of vast numbers of such bodies of plasmic origin within the egg-membranes of Teleosts it seems had not been observed in any other form up to the time that the writer had published his observations on the development of the cat-fish. Recently, however, it has been found by Solger[51] that they are present in the water space of the ova of other species, especially of *Leuciscus rutilus*. These corpuscles becoming less abundant toward the close of the hatching period is very probably to be accounted for on the supposition that they are taken up and appropriated by the epiblastic tissues of the embryo by a process of intracellular digestion.

On the third day the vascular system begins to be evident, and the heart *h*, figs. 156 and 157, is extended forward beneath and in advance of the head over the anterior end of the yelk. A pair of vascular arches (Cuvierian ducts) are soon formed just in advance of the rudiments of the pectorals. These vessels grow outward and split up into vitelline capillaries and eventually join a median ventral vitelline vessel which empties into the venous end of the heart, as shown in figs. 163 and 164.

The mouth is not yet open on the second day, fig. 155, but at this stage if the embryo be removed from its envelope and viewed as an opaque object, the rudimentary branchial arches and clefts, fig. 154, *b*, are visible. The first traces of the pectoral thickenings or outgrowths *p*, in advance of the lateral extensions of the muscular somites of the body, are evident at this stage. The eyes *e*, fig. 154, are unusually small for young fishes at this stage, and remind one of the comparatively small eyes of embryo sturgeons, bony gars, and amphibians. The choroid fissure is prolonged obliquely downward and forward on the second day, as shown in fig. 155.

[51] B. Solger. Dottertropfen in der intracapsulären Flüssigkeit von Fischeiern. Arch. f. mik. Anat. xxvi, 1885 pp. 321–334.

On the third day the mouth is wide open, figs. 156 and 157, and the branchial clefts *b*, fig. 158, are developed with a free circulation through the arches. The opercular folds *op*, fig. 159, which lead to the formation of the opercles of the adults, are also beginning to be quite obvious. The caudal part of the aorta and caudal vein are also developed at this stage, and the intersegmental vessels are formed a little later, from which loops run out into the mesoblast of the median fin-folds.

The pectoral fin is formed as a lateral outgrowth *p*, figs. 158 and 159, just in advance of the inferior and lateral extension of the muscular segments *m m*, which eventually form the muscular portions of the lateral body-walls. In this early condition the pectoral is a mere flat, immobile lobe, into which muscular and other mesoblast has proliferated; it also begins to show evidences of a slight rotation or torsion on its own base. At its base and a little way toward the middle line of the embryo there is a patch of thickened epiblastic tissue composed of very large cells. This is the rudiment of a peculiar integumentary organ, situated in the adult above the base of the pectoral and behind or upon the shoulder girdle, and is composed of a series of vesicular cavities which contain particles of calcareous matter.

The development of the median fins is very similar in character to that usually observed in other forms. On the second day the median natatory fold began to grow out on the dorsal and ventral sides of the embryo and over the end of the tail. By the end of the third day the median fin-fold was well developed, and the tail had not yet exhibited any inclination to become heterocercal.

The remarkably developed barbels of the embryos of this species make their appearance very early, especially the maxillary pair; these appear on the second day as a pair of bosses or thickenings of the epiblast at points near where the future angles of the mouth will be situated. On the third day this pair of barbels is developed as flat prominent lobes *bl* at the angles of the mouth, as shown in figs. 156, 157, and 158. The barbels on the lower jaw do not appear till the fourth day of development is completed, as shown in fig. 152. The last of all to be developed is the nasal pair, which grow out at the anterior side of the posterior nareal openings, as shown in fig. 164; this pair does not appear until the seventh day. The development of a cartilaginous axis in the barbels takes place as early as the formation of the other portions of the chondro-skeleton, but the fuller description of these supports of the barbels will be postponed until I come to the account of the cartilaginous cranium, with which the cartilages found in the barbels are in intimate relation.

The nasal pits, or the first traces of the olfactory organs of *Ictalurus*, appear on the second day as a pair of thickenings of the epiblast, just in advance of the eyes. On the third day they are visible as a pair of much antero-posteriorly elongated depressions or pits, in the same location, as shown in fig. 160. On the fourth day the edges of the elongated olfactory depressions begin to grow toward each other in the middle, and by the fifth day a bridge is formed across the nasal sack, so that an anterior and posterior opening is left, corresponding to the anterior and posterior nostril of the adult.

Hatching occurs on the sixth day, at which time the embryo presents the appearance shown in fig. 163, when viewed as a transparent object. It now measures 9^{mm} in length, or somewhat over a third of an inch. The heart is now prolonged downward over the anterior pole of the yelk. The branchial arches are quite hidden by the downward and backward extension of the opercular folds. The tail has also become decidedly heterocercal, and distinct indications of the future permanent caudal rays are developed. The anterior dorsal fin is also becoming evident, just behind the head, where mesoblast has begun to proliferate into the median dorsal fin-fold.

On the seventh day, as shown in fig. 164, the fins have undergone still further development. The pectoral has completed its rotation, and the anterior dorsal and the anal fins are outlined. The caudal lobe is wider and its rays more evident. The entire set of four pairs of barbels is also now evident, and a more intricate meshwork of vessels traverses the surface of the yelk.

On the eighth day, as shown in fig. 165, the yelk has diminshed somewhat in size. The anterior dorsal is now also sharply defined, and some distance behind it the dorsal fin-fold is widening at the point where the second or soft dorsal will be formed. The ventral fins have also appeared as a low horizontal fold at the ventral side, between the vent and the yelk-sack. The rudiments of permanent rays are also evident in the pectoral.

On the ninth day, as shown in fig. 166, the ventral is a more pronounced lobe than on the preceding day, but no rays have yet made their appearance. The upper or first ray of the pectoral is also now developed as a spine, and the position of the soft dorsal is indicated by a decided notch at its posterior extremity.

On the tenth day the permanent rays of the dorsal become clearly defined, as shown in fig. 167, and the ventral has become somewhat more prominent. The yelk is now rapidly disappearing, and by the eleventh day comparatively little is left to distend the abdomen, as may be noted in fig. 168, representing a young *Ictalurus* of that age. At this stage the rays of the ventral begin to be apparent, while those of the pectoral, dorsal, anal, and caudal are clearly differentiated; accessory caudal rays are also beginning to be formed, and the nasal barbel is conspicuous.

On the fifteenth day all of the fins are well developed and permanently outlined, but the lower lobe of the caudal is still shortest, as shown in fig. 169. Five days later the lower lobe of the caudal is somewhat longer, as shown in fig. 170. The anterior spinous ray of the first dorsal and of the pectoral is now developed, and the latter has assumed a nearly horizontal position. The young *Ictalurus* is now twenty days old and would be readily recognized as possibly belonging to one of several American genera, though at this stage it resembles most nearly the adult of the genus *Noturus*, indicating that the latter is a less specialized type than the one here under consideration.

When the young *Ictalurus* is eighty-eight days old, as shown in figs. 171 and 172, from the side and from above, its external generic features become distinctly apparent. The anterior dorsal spine and the pectoral spines, armed posteriorly with recurved hooks, are now developed. The post-scapular process is evident beneath the skin and the air bladder forms a strongly marked rounded prominence just behind the shoulder-girdle, where it presses the body-wall outwards. The soft dorsal is now quite free and sharply defined posteriorly, and the pigmentation, which has gradually increased in depth since the time of hatching, is now very nearly that of the adult. At this stage of development the young fish measures 19.5^{mm} in length. At the end of one hundred and twelve days the young of *Ictalurus*, measures 25^{mm} in length, or about 1 inch. When one hundred and seventy days old the young fish measures 35^{mm} in length. These two stages I have not figured, since the resemblance to the adults is sufficiently obvious in fig. 171, representing a much younger individual. The young of *Ictalurus* therefore more than double their length in eighty-two days, and nearly quadruple it in one hundred and sixty-four days after hatching, as the foregoing data demonstrate.

On the fifteenth day after oviposition it was found that the young fishes would feed. While discussing with the writer what should be provided for them Mr. J. E. Brown threw some pieces of fresh liver into the aquarium, which they devoured with avidity. It was now evident that they were provided with teeth, as they would pull and tug at the fragments of liver with the most dogged perseverance and apparent ferocity. This experiment showed that the right kind of food had been supplied, and as they were then fed, up to August 1, with nothing else without our losing a single one of the brood, nothing more in the way of food seemed to be required.

It is worthy of note that when pieces of liver were thrown into the aquarium the parent fish would apparently often swallow them, with numbers of his offspring eating at and hanging to such fragments. I was soon agreeably surprised to find that the parent fish swallowed only the meat, and that he invariably ejected the young fish from the mouth uninjured, as he seemed to be able to discriminate, instinctively and before deglutition occurred, between what was his proper food and what were his own young. As soon as the young began to feed they commenced to disperse through the water and to all parts of the aquarium, and to manifest less desire to congregate in schools near the male, who also abated his habit of fanning the young with his fins, as was his wont during the early phases of development, The air-bladder became perceptible through the semi-transparent bodies of the young on the tenth day, as a dorsal outgrowth of the back part of the œsophagus, and is placed far forward, a little above and behind the level of the insertion of the pectoral fins, and as it grew more capacious the young fish commenced to swim higher in the aquarium. When first hatched, and for some days afterwards, the young fish exhibited a great tendency to gather together in a dense school.

Of the development of the viscera I shall have but little to say at present. The intestine is not prolonged backwards very far beyond the posterior end of the yelk-sack. On the thirteenth day the greenish secretion of the liver can be seen in its cavity.

The liver is developed on the ventral side of the intestine and very soon displaces, more or less extensively, the coarsely granular yelk below it. It is crowded into the anterior end of the yelk-sack close to the heart, at first growing downward and outward on the left side as a rather elongated structure lying between a vertical traversing the hinder part of the opercles anteriorly and a vertical cutting through the shoulder girdle posteriorly. A capillary network of vessels traverse the liver and pour their contents directly into the vitelline or portal system of vessels which convey the blood back to the heart.

Behind the vent a distinct urinary duct could be seen by the sixth day, and by the tenth day the urinary bladder was developed in the usual position in the extreme hinder portion of the body cavity and just behind the posterior section of the gut. The renal apparatus was present and had reached an advanced stage of development on the tenth day, urinary tubules and glomeruli being found in advance of the air-bladder, and also behind it.

In the upper posterior part of the gill-cavity of either side a large glandular organ is found on the tenth day, which is undoubtedly the thymus gland; it is embedded only in the posterior part of the upper wall of the gill-chamber.

The air-bladder is formed as an outgrowth of the dorsal wall of the fore-gut. The saccular diverticulum, from which this organ is formed, acquires a lumen about the fifth day after the commencement of development, and on the tenth day the organ presents the form of a depressed oval sack. By the twentieth day the hinder end of the air-bladder becomes emarginate and shows traces of the bilobed character which it presents in the adult. By this time also the muscle plates overlying its exterior right and left aspects have aborted more or less completely, so that its walls come into close juxtaposition with the integument just behind the shoulder girdle.

The cranium of *Ictalurus albidus* when ten days old I have figured on plate XXX. At this time its principal elements are represented by cartilage, though the membranous representatives of parostoses are rapidly developing external to the chondrified parts. None of these have been represented in fig. 173. This drawing was made from a series of superimposed outlines of the cartilages of the skull, as cut at successive levels in a series of sections of uniform thickness, extending from the outer side of the head to the middle line. Stereograms of this character may be readily constructed with the aid of the camera lucida from a series of sections, if a uniform amplification is employed and patience and care is exercised in drawing the outlines.

It will at once be noticed that, as compared with the chondrocranium of *Salmo*, as figured by Parker,[52] or of *Gambusia*, as figured by myself,[53] the cartilaginous cranium of *Ictalurus* presents some very important modifications. These involve mainly the structure of the palatopterygoid arch *Pl Pt*, which is composed in *Ictalurus* of two pieces instead of one. The narrow bar *T Cr*, representing the tegmen cranii in *Ictalurus*, is much wider in both the other types named, and the build of the skull in the type here described is complicated by the presence of no less than three pairs of cartilaginous appendages for the support of the barbels, representing chondrified elements which are probably not found in the skulls of young fishes of any other type. The skulls of the *Nematognathi* are therefore distinguishable from those of other ordinal groups of fishes at a very early period of development.

The chondrocranium of the young *Ictalurus*, as a whole, is depressed, but relatively far less so than in the adult. The auditory apparatus is quite completely covered in laterally and inferiorly by a cartilaginous investment in the region marked *Au*. Below and mesially, the parachordal elements *Pa C* are found, although now quite completely fused with the auditory capsules laterally and the trabecular bars *Tr* anteriorly. The cartilaginous brain box is perforated laterally on either side in the exoccipital region to give passage to the ninth and tenth pairs of nerves at IX and X. In advance of the articulation of the hyomandibular bar, *Hm*, there is a large lateral fenestra in the cranial box through which the second or optic, the fifth or trigeminal, and the seventh or facial nerves pass at II, V, and VII. Just in front of this is the orbit *O*, and forming its lower inner walls is seen the chondrified plate *Ps* destined to form the presphenoid. In front of the orbit there is a high ectethmoidal ridge, *EE*, in advance of which lies the olfactory fossa *Ol*. Anteriorly the skull terminates in the trabecular rostrum *R*. There is a wide fontanelle behind the tegmen cranii or frontal bridge, and a smaller one in front of it. These fontanelles persist in the median line as narrow clefts, partly separating the frontals in the ossified cranium of the adult. At the posterior end of the cranial box and in the median line, the supraoccipital, *so*, is developed as a separate block of cartilage. The extent to which the chorda is prolonged into the base of the skull is indicated by the dotted line below the auditory capsule *Au*.

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[52] W. K. Parker and G. T. Bettany. Morphology of the skull, London, 1877, p. 59, fig. 17.

[53] J. A. Ryder. Development of Viviparous Oss. Fishes. Proc. U. S. Nat. Mus., 1885, pl. x, pp. 150–151.

The appendicular skeleton of the cranium, or the cranial visceral arches possessing endoskeletal supports, are apposed to the infero-lateral parts of the skull at the anterior part of the auditory region.

The most important of these arches is the compound hyoid and mandibular, supported by a common hyomandibular element, *Hm*, which abuts with its upper end upon the anterior wall of the auditory capsule. Inferiorly the hyomandibular gives support (1) to the mandible, now entirely constituted of Meckel's cartilage, *Mk*, but around which articular, angular, and dentary parostoses are subsequently laid down in membrane; and (2) to the hyoid arch, through the intermediation of a short cylindrical element, the interhyal *I Hy*, which in its turn supports a series of elements consisting of the ceratohyal *C Hy*, hypohyal *H Hy*, and urohyal *G Hy*.

The changes which the hyomandibular has undergone in the course of further development are quite complex. The principal portion of the upper half becomes the ossified hyomandibular element of the adult, an articular knob being formed on its posterior border, which supports the operculum. Its inferior half represents the quadrate of authors. Between the quadrate and hyomandibular portion the cartilage representing the symplectic does not seem to be well distinguished. The inner, upper, anterior part of the hyomandibular bar takes part in the formation of the hinder part of the pterygoid, *i. e.*, the metapterygoid of the adult. The ecto- and entopterygoid are apparently differentiations of the posterior separate element of the palatopterygoid arch *Pl Pt.*

The branchial arches are five in number; the posterior is imperfectly developed above. At the inner ends of the posterior branchial bars are placed a pair of epipharyngeal plates, *Phb*, bearing teeth even at this early stage. The branchial bars are not yet definitely segmented into their lateral elements. Cartilaginous copulæ or basibranchials, *B B*, are present in the floor of the branchial region, as shown in section in fig. 174.

A very remarkable series of cephalic appendages now remains to be described. These are the maxillary, nasal, and mental barbels. Of these the nasal pair only is not represented in cartilage at the stage of development here under consideration, but even this one develops a chondrified axial support at a later stage.

Whether the endoskeletal part of the upper end of the so called maxillary barbel in reality represents the maxillary bone of other fishes seems somewhat open to doubt, as the proximal ossification of the cartilaginous support of this barbel would give this element in the catfishes a cartilaginous origin, which is at variance with what is known of the development of its homologue in all other forms of Teleosts, in which it arises as a membrane bone. True, it ossifies on the surface of the cartilaginous support of the barbel, even in *Ictalurus*, yet it is barely possible that the so-called adnasal of McMurrich,[54] may, if not actually a part of the suborbital chain, as he surmises, in reality represent the maxillary of other fishes, since this adnasal element is clearly a membrane bone, while it is not altogether certain that the so-called "maxillary" of the *Nematognathi* can be considered such. While the ossification of the upper end of the cartilaginous bar *Mxb* is superficial, old specimens of *Ictalurus* show that the cartilage is invaded and replaced by the process, so that its terminal portion only remains cartilaginous. The other barbels, viz, the nasal and the mental, are also occasionally ossified at the base, especially in old specimens. Both the internal pair of mental barbels *Ib* and the external pair *Eb* are at first laid down in cartilage in the embryo. The strongest argument in favor of regarding the ossified basal parts of the lateral barbels as maxillary elements is derived from a study of the distribution of the branches of the fifth group of nerves as worked out by Wright,[55] though it must not be forgotten that these organs in Siluroids are specialized as tactile organs, and that they may therefore be richly supplied with nerves, in correspondence with their high degree of specialization.

A longitudinal, median, vertical section through the head of *Ictalurus* is represented in fig. 174, prepared from an embryo of the same age as that used in working out the cranium represented in the preceding figure. The brain is shown in mesial section and illustrates the relations of the cerebrum *Cer* anteriorly to the pineal body *Pn* just behind it. The narrow midbrain *mb* is also shown, and upon which the remarkably voluminous cerebellum *Cb* encroaches from behind. At an earlier stage the great antero-posterior width of the cerebellum is far less obvious, so that it is quite clear that the excessive anterior extension of the cerebellum in the Siluroids is a result of the exaggerated development or specialization of this portion of the brain of the ordinary Teleostean type. The medulla oblongata *mo* is massive. The infundibulum *Inf* departs but little in its form from that usually met with in the embryos of osseous fishes. The cranial nerves and brain of *Amiurus* has been so carefully described by Wright (*op. cit.*) that no further discussion of this part of the subject will be entered upon here, except to call attention to the disposition of the sacculus vasculosus *S* and the hypophysis *Hy*.

A mesial section of the heart is also displayed in fig. 174. The thin-walled sinus venosus *S V*, the muscular ventricle *Vc*, and the bulbus aortæ *Ba*, have been cut through. The tip of the liver *L*, crowded into a cavity in the coarsely granular yelk *Y*, is also shown, together with the more homogeneous periblast *P*, which invests the mass of granular deutoplasm. The granules of deutoplasm in the yelk-sack are characteris-

[54] J. P. McMurrich. Osteology of Amiurus, Proc. Canadian Inst. Toronto. N. S., ii, No. 3, p. 278, pl. ii, fig. 1, *An*.

[55] R. R. Wright. On the nervous system and sense organs of Amiurus. Proc. Canadian Inst. Toronto. N. S., ii, No. 3, pp. 366–368, pl. iv.

tically firm in character, but globular instead of flattened and oval or elongated, as in the ova of Ganoids, Amphibians, and Elasmobranchs.

The muscular bundles *M M*, cut through at several points, actuate or belong to the pharyngeal, branchial, submaxillary, and hyoid regions of the head. The intestine *I*, œsophagus *Oe*, and air-bladder *Ab*, are cut through in the middle line in the section here represented. The anterior part of the chorda *Ch* has also been divided in the middle line, and the rudiments of the three anterior centra *x x x* are seen to be shorter than those which follow. Two of these centra eventually coalesce with each other, and with the fourth and fifth form the co-ossified anterior segment composed of four vertebral bodies in the spinal column of the adult. Some of the lateral processes and parts of the neural arches of these co-ossified vertebræ, especially the first, second, and third, give rise, according to McMurrich, to the series of ossicles by which the air-bladder and auditory apparatus are brought into intimate physiological relations with each other.

The development of the shoulder girdle is remarkable from the circumstance that the coracoid portion originally laid down in cartilage is excessively developed, extending downward as a great flat cartilaginous blade, *Cor*, from the base of the pectoral fin, as shown in fig. 173. In front of the coracoid the membranous basis of a parostosis is already formed; this is clearly the rudiment of the element termed the clavicle by Huxley and Parker in other osseous fishes. The scapular portion *Sc* of this cartilage is small, and is prolonged anteriorly into two cornua, between which there is a well-marked glenal fossa in which the basal ends of the pectoral rays are lodged; two nodules of cartilage, 1, 2, represent with some doubt the actinosts. The metapterygial actinost, if it be such, is the larger of the two and the most anterior, forming, in fact, the basal part of the first pectoral ray which eventually becomes developed as a strong spine. This relation of these nodules to the rays would indicate that they were actinophores and that therefore true actinosts are not developed in *Ictalurus*.

The nomenclature followed above in naming the chondrified parts of the shoulder girdle is that used by Huxley. Dr. Gill, however, regards the whole cartilaginous plate *Sc* and *Cor* as scapula, but there is no subdivision of this plate into hypercoracoid and hypocoracoid elements, but it forms a solid piece, the upper part of which alone gives support to the pectoral and the reduced actinosts, or perhaps rather actinophores, already described.

EXPLANATION OF PLATE I.

GADUS MORRHUA. (*The Cod.*)

FIG. 1. Young cod 5^{mm} long showing the large supracephalic integumentary sinus *ss* over the head and body; *i*, intestine; *y*, yelk. Viewed from the side. x 32.

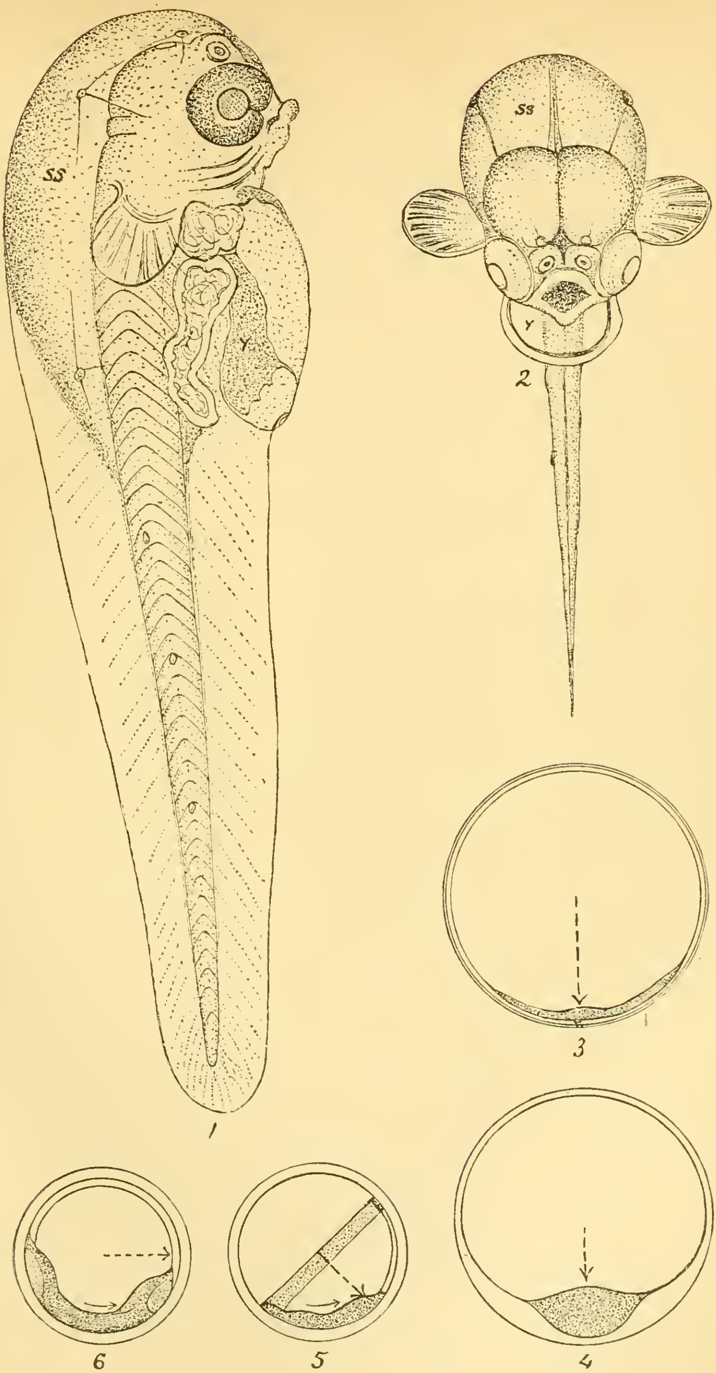
FIG. 2. Same, viewed obliquely from in front to show the size of the sinus *ss*.

FIG. 3. Position of cod's egg in the water shortly after impregnation, showing the polar cells, germinal plasma, and micropyle at inferior pole.

FIG. 4. Illustrating the inferior position of the blastodisk when the egg of the cod is at rest at the surface of the water.

FIG. 5. Illustrating the slight rotation of the egg as the embryo is gradually lengthened.

FIG. 6. Illustrating the quarter-rotation of the egg when the blastopore is about to close, bringing the embryo into an inferior position.


SS
Y
1
Ss
Y
2
3
4
5
6

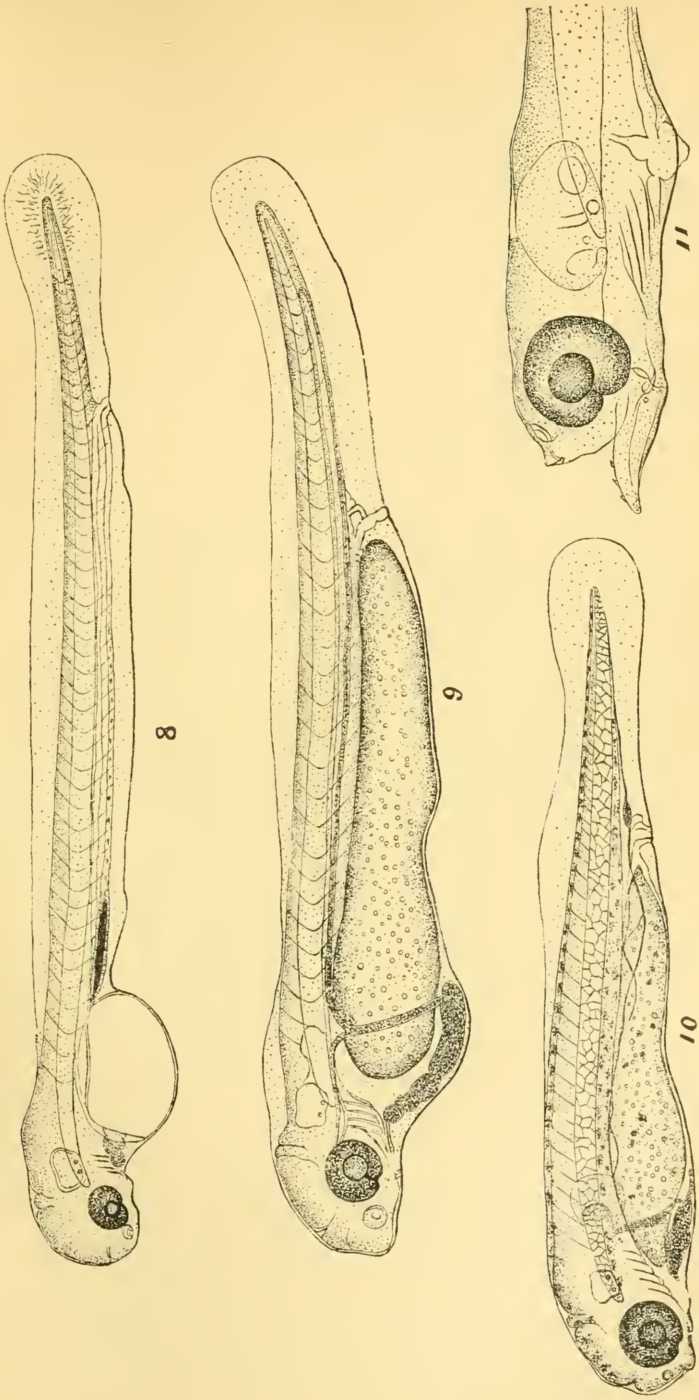
EXPLANATION OF PLATE II.

FIG. 8. Embryo *Clupea vernalis* on the second day after hatching. x 32.

FIG. 9. Embryo golden ide, *Idus melanotus*, just hatched. 6.6^{mm} long. x 20.

FIG. 10. Embryo gold-fish, *Carassius auratus*. Five and one-half days after hatching. x 21.

FIG. 11. Head of a larval fish; a hybrid between the shad and rock-fish, the former being the female and the latter the male parent. x 32.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EXPLANATION OF PLATE III.

Fig. 12. Head of young *Siphostoma fuscum.*

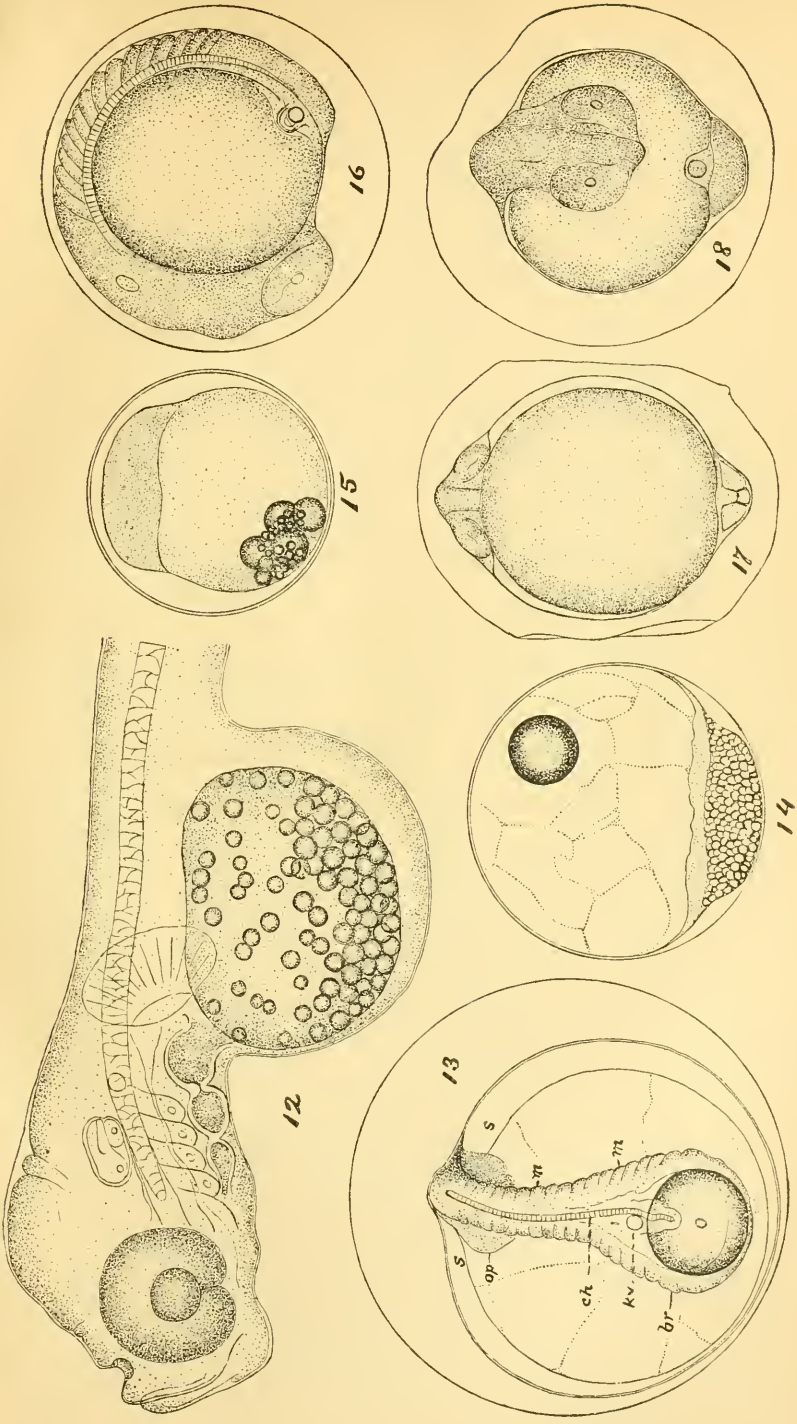
Fig. 13. Developing egg of *Elacate canada,* showing the spacious cleavage cavity *s s,* Kupffer's vesicle *kv*, the chorda *ch*, the segments *m m* of the embryo, and the limbs *br* of the concrescing blastopore, the oil-drop *o*, and the optic vesicles *op*.

Fig. 14. An earlier phase of the development of an egg of the same species.

Fig. 15. The unimpregnated ovum of the file-fish, *Monacanthus broccus,* showing the position of the oil-drops and the form of the blastodisk.

Fig. 16. The developing ovum of the gold-fish *Carassius auratus,* showing the extent to which the embryo embraces the circumference of the vitellus. x 32.

Figs. 17 and 18. Other views of a similar stage of the same species.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m
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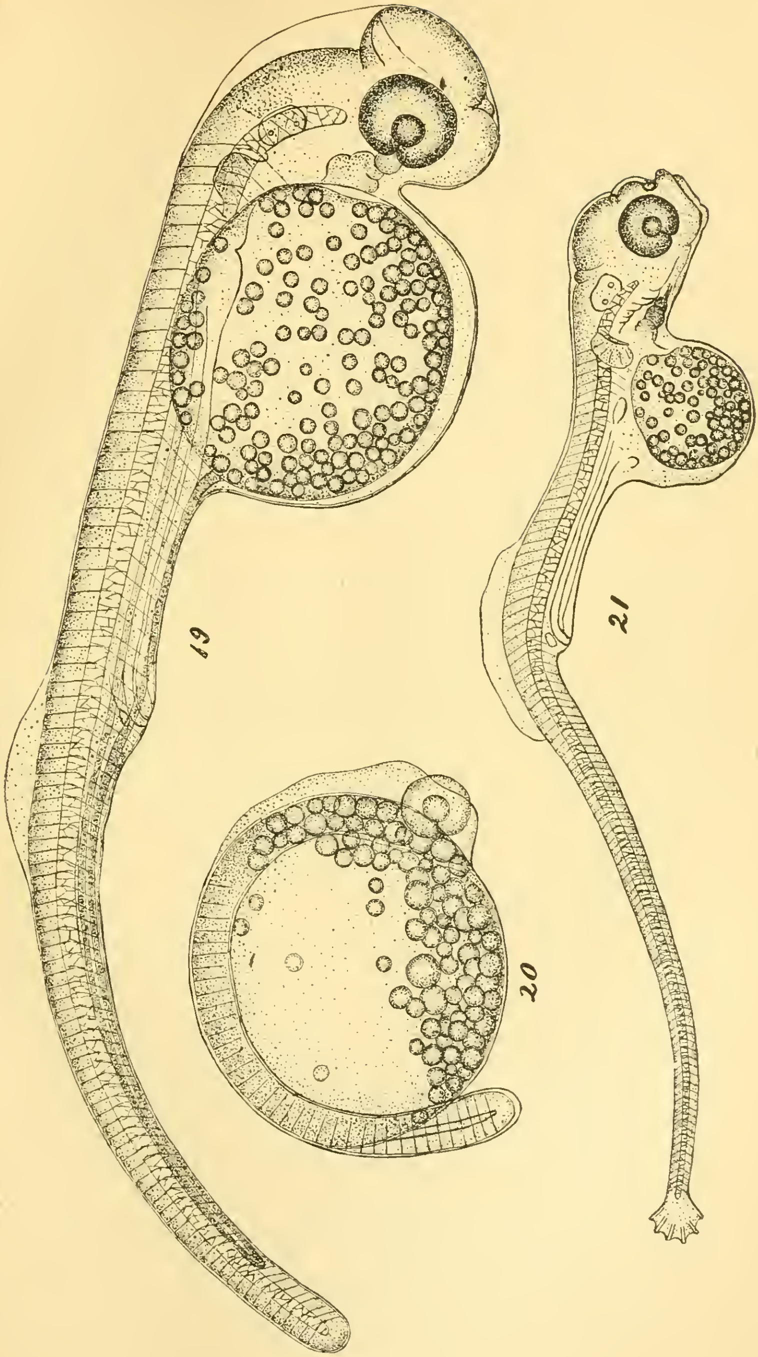
EXPLANATION OF PLATE IV.

SIPHOSTOMA FUSCUM. (*The Pipe-fish.*)

FIG. 19. A young embryo, in which the tail is still archicercal and the dorsal and pectoral fins are just developing.

FIG. 20. A still younger stage, in which the tail is just beginning to grow out.

FIG. 21. An older stage, in which the caudal fin is beginning to be formed.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EXPLANATION OF PLATE V.

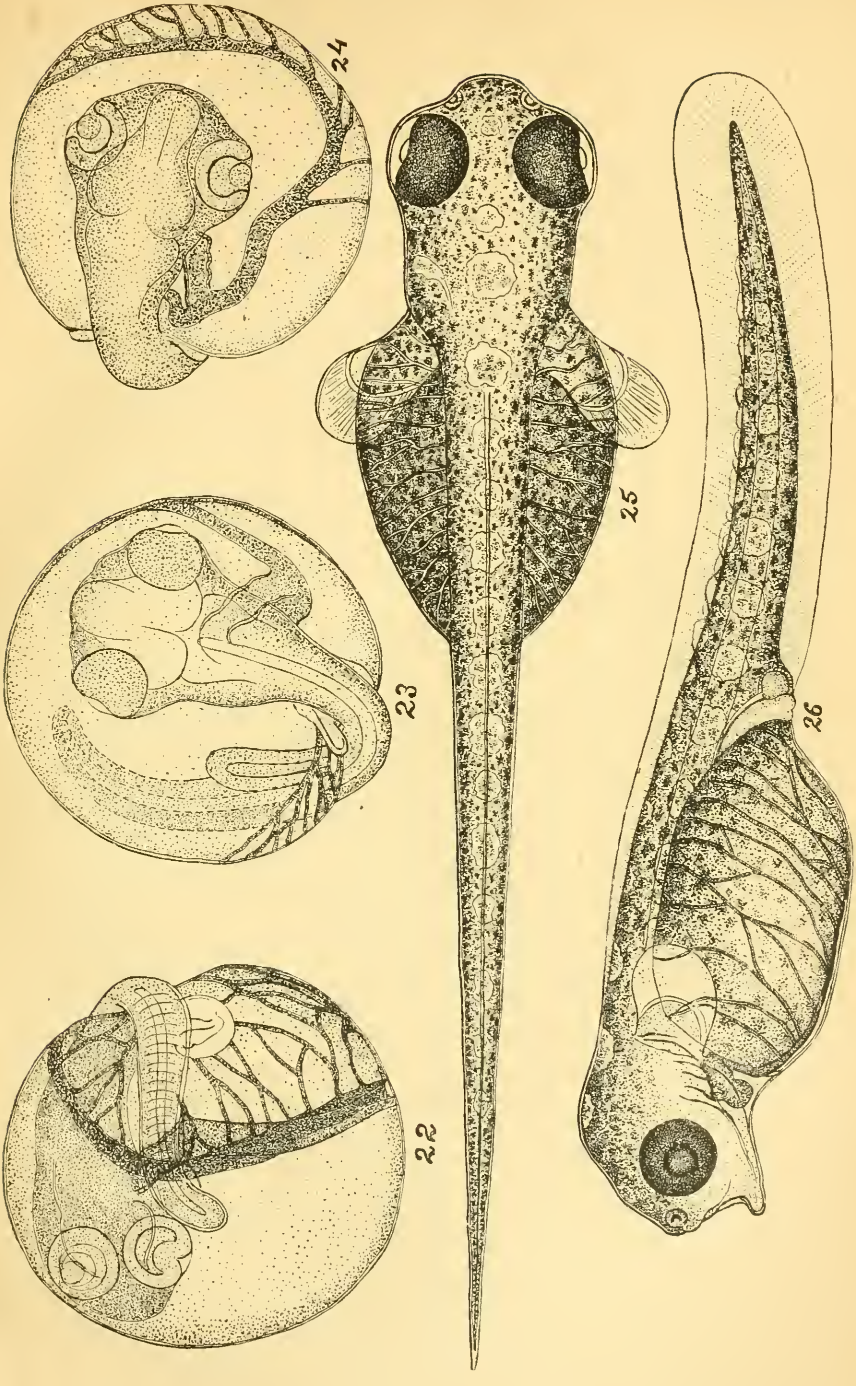
APELTES QUADRACUS. (*Four-spined Stickleback.*)

FIG. 22. Embryo in the egg, showing the asymmetrically disposed vitelline vessels.

FIGS. 23 and 24. Other views of the same stage, showing the lateral position of the heart.

FIG. 25. Dorsal view of a recently hatched embryo, showing the distribution of the brown pigment blotches on the median line and the symmetry in the distribution of the vascular channels on the dorsal side of the yelk.

FIG. 26. Side view of the same stage, showing the pigmentation and vascular loops in the dorsal fin-fold.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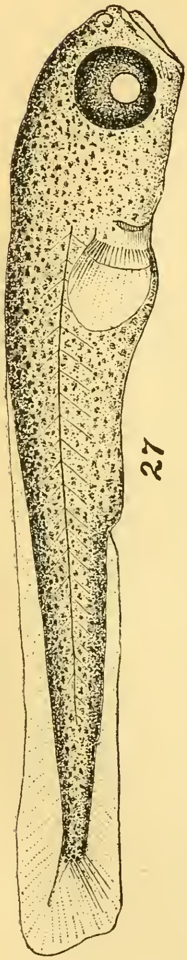
EXPLANATION OF PLATE VI.

FIG. 27. Young *Apeltes* one week old, with the lower lobe of the caudal developing and becoming heterocercal.

FIG. 28. Recently hatched embryo of *Esox reticulatus*, showing the wide median fin-folds, the distribution of vitelline vessels, and the course of the caudal and subintestinal veins.

FIG. 29. A much older stage of *Esox reticulatus*, in which the flat snout is becoming apparent and the rudiments of the caudal, anal, and dorsal fins are becoming evident.



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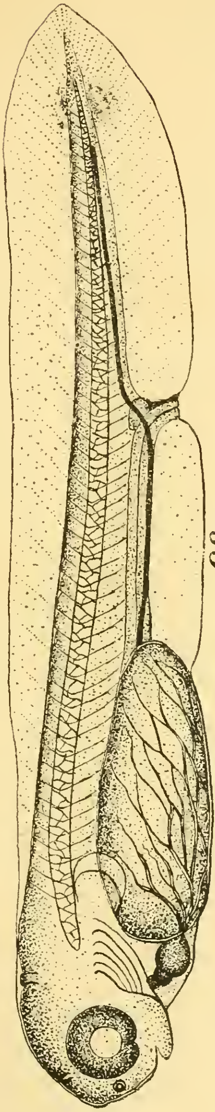

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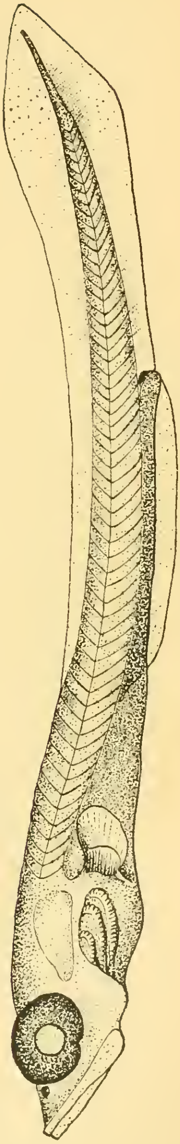


29

EXPLANATION OF PLATE VII.

(Species No. 1.)

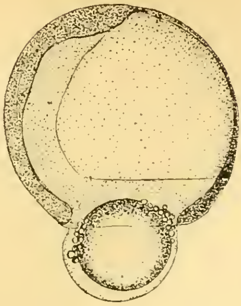
FIG. 30. Showing developing egg removed from its membrane. The spreading blastoderm has greatly constricted the yelk.

FIG. 31. A somewhat earlier stage of the same in its membrane, over a part of which the adhesive covering of the latter has collected and formed a disk-like mass, by which it adhered to a piece of leather.

FIG. 32. A more advanced stage of the same.

FIG. 33. A still more advanced stage, in which the distribution of the oil-drops is evident and Kupffer's vesicle is developed under the posterior end of the embryo.

FIG. 34. A larva which was developed from this same lot of eggs, three days after hatching, showing the distribution of the pigment on the body, tail, and at the junctions of the vessels of the yelk-sack.



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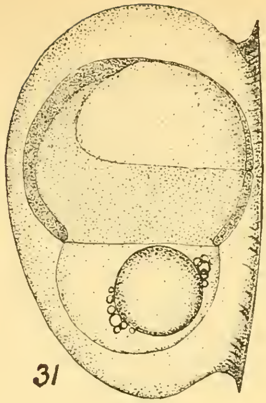

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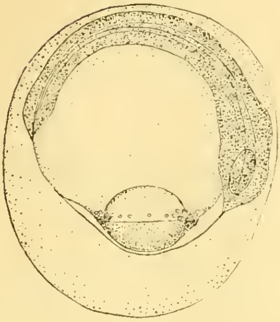

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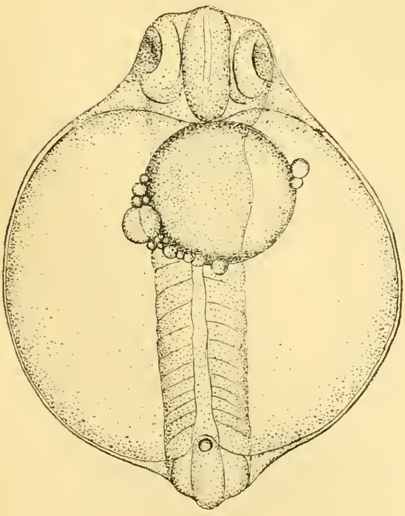

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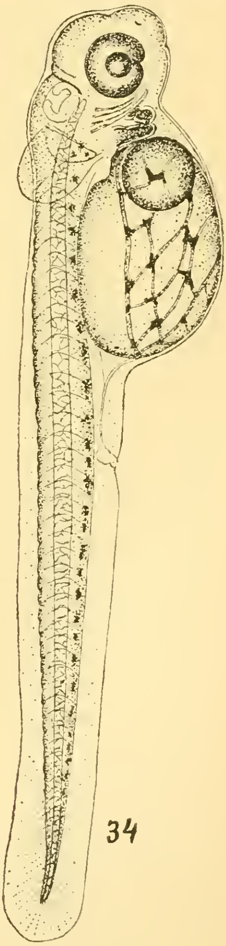

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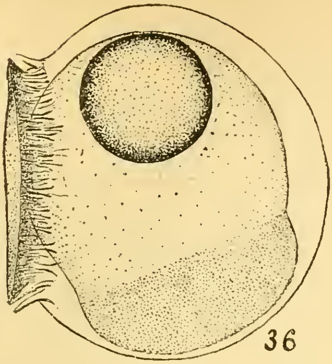
EXPLANATION OF PLATE VIII.

FIG. 35. Magnified view of an egg of the common yellow perch, showing the micropyle *m*, the thin zona radiata *z*, the thick, elastic, canaliculated or fibrillated layer *g*, and the outer adhesive layer *a*.

FIGS. 36 and 37. Views of ova of the white perch, in which the large blastodisk is formed; also showing the way in which the adhesive covering of the egg forms disk-like accumulations where they come in contact with each other or with flat surfaces.

FIG. 38. A more advanced stage of the development of the same species, showing the very thick blastoderm in optic section.

FIG. 39. A still more advanced stage of the same species.



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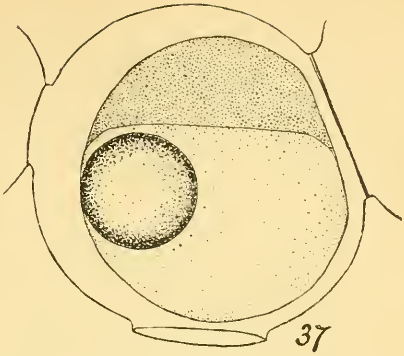

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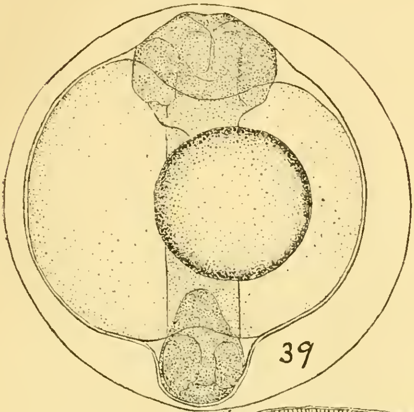

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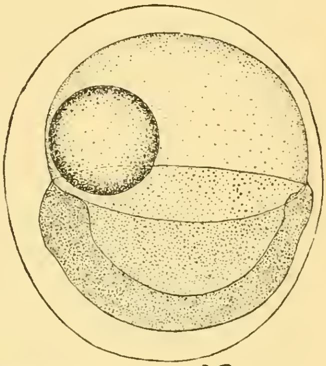

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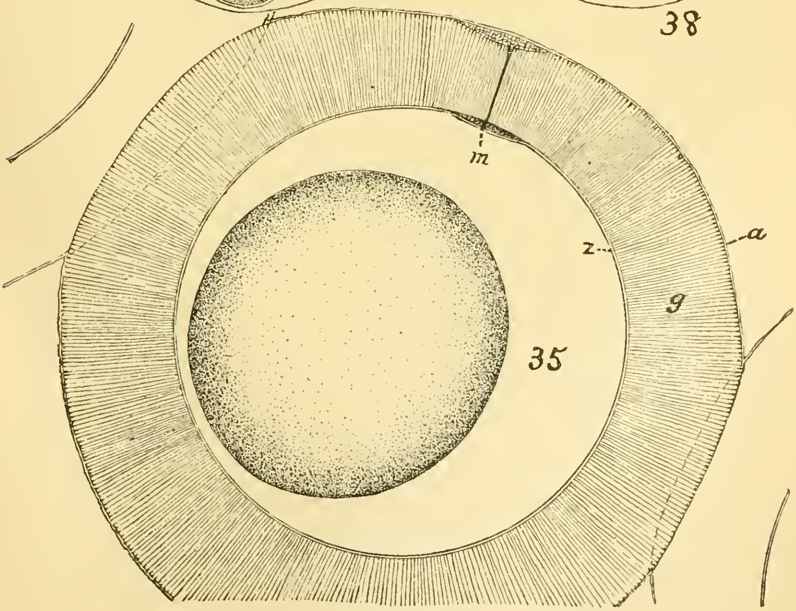

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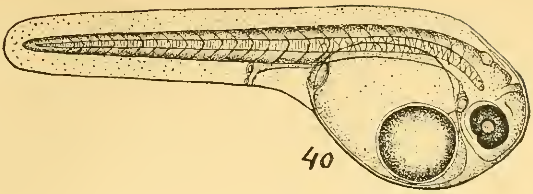
EXPLANATION OF PLATE IX.

ROCCUS AMERICANUS. (*The White Perch.*)

FIG. 40. The just hatched embryo. x 32.
FIG. 41. The young white perch one day old. x 32.
FIG. 42. The same, three days old. x 32.
FIG. 43. The same, five days old. x 35.
FIG. 44. The same, six days old. x 32.



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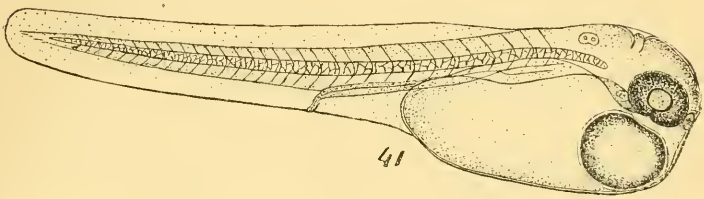

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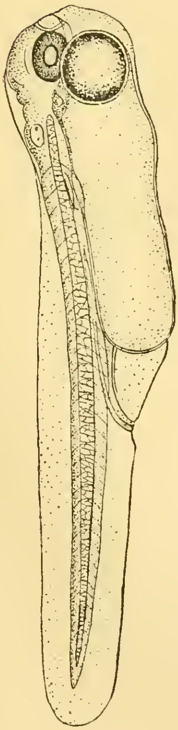

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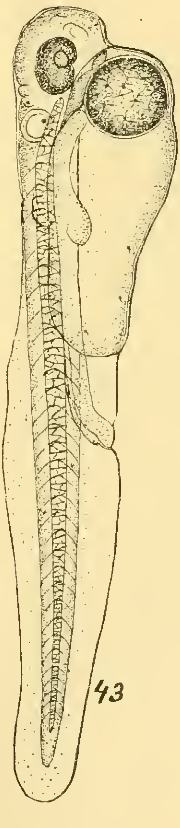

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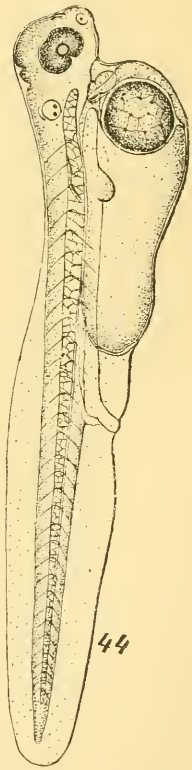

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EXPLANATION OF PLATE X.

SCOMBEROMORUS MACULATUS. (*Spanish Mackerel.*)

FIG. 46. Cross-section through nasal region of young embryo; *na*, nasal pit. x 65.

FIG. 47. Cross-section through region of the optic crus. x 65.

FIG. 48. Cross-section through mid-brain, trabeculæ cranii *tr*, and eyes. x 65.

FIG. 49. Section through a segmental sense-organ of the lateral line. x 250.

FIG. 50. Cross-section through back part of mid-brain, infundibulum, eyes, and optic nerves. x 65.

FIG. 51. Cross-section through fore part of medulla oblongata. x 65.

FIG. 52. Cross-section through the auditory vesicle *au*, a segmental sense-organ *ss*, front end of chorda, heart, and branchial region. x 65.

FIG. 53. Longitudinal vertical section through the head of an embryo near the median line; *h*, heart; *p*, periblast; *pc*, pericardiac cavity; *tr*, cranial trabecula; *o*, space of oil-drop. x 65.

FIG. 54. Cross-section through the pectoral region; *sd*, segmental duct; *p*, periblast; *p'*, pectoral fin. x 65.

FIG. 55. Cross-section through the tail. A segmental sense-organ has been cut through at one side. x 65.

FIG. 56. Longitudinal nearly median vertical section through the head, trunk, and yelk-sack of an embryo; *ch*, chorda; *m*, myotomes; *sd*, segmental duct; *al*, urinary bladder; *pn*, pronephric funnel; *i*, intestine; *p*, periblast; *o*, space occupied by oil-drop; *h*, heart; *pc*, pericardiac cavity; *tr*, cranial trabecula. x 65.

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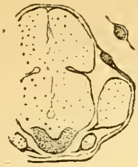

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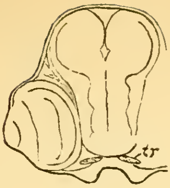

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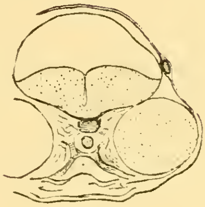

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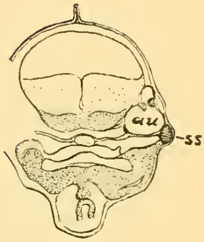

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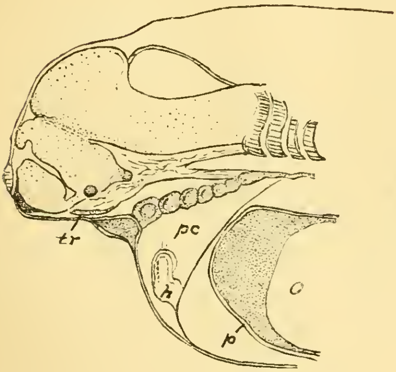

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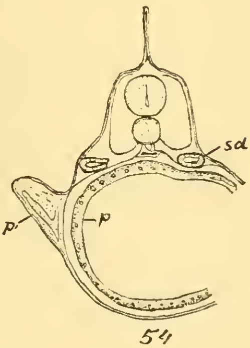

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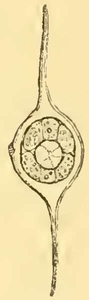

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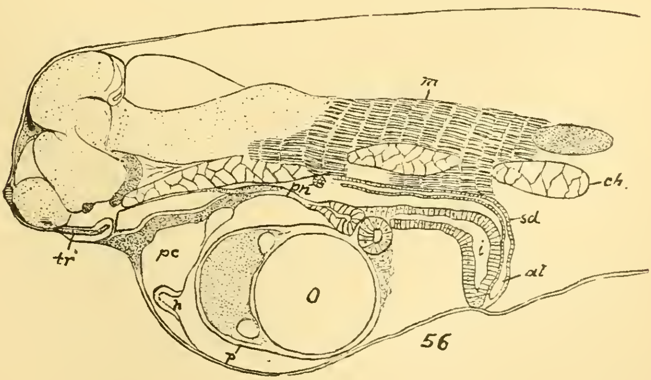

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EXPLANATION OF PLATE XI.

CHÆTODIPTERUS FABER. (*The Moonfish.*)

FIG. 57. Blastodisk of an unimpregnated egg, viewed from the side.

FIG. 58. Mature egg, showing the position of the oil-drop, and with the blastodisk formed.

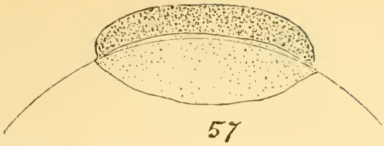
FIG. 59. Blastodisk, with about 32 cells, viewed from above, and showing the subquadrate form usually assumed at this stage.

FIG. 60. Entire egg, with the blastodisk developed to about the condition represented in the preceding figure.

FIG. 61. The blastodisk of *Chætodipterus* more advanced in development, with the large marginal, flattened cells very apparent.

FIG. 62. An egg in which the embryo is apparent, the oil-drop covered by periblast cells, pigment cells developed, and Kupffer's vesicle formed.

FIG. 63. An embryo sixteen hours after hatching, showing the increased capacity of the cleavage space *sc*, due to the rapid absorption of the yelk; the pigment cells aggregated at definite points.



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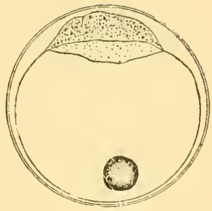

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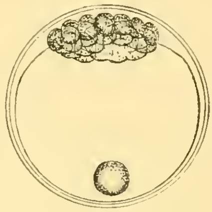

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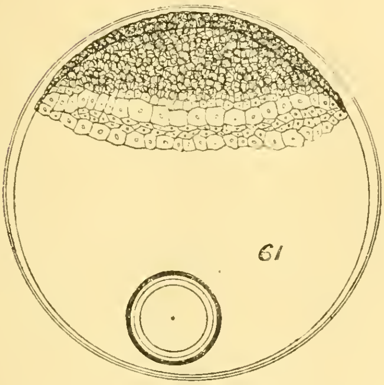

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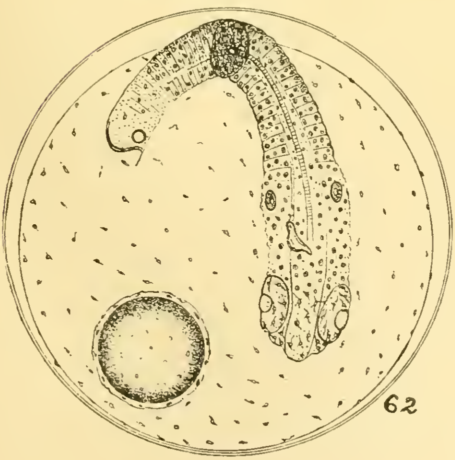

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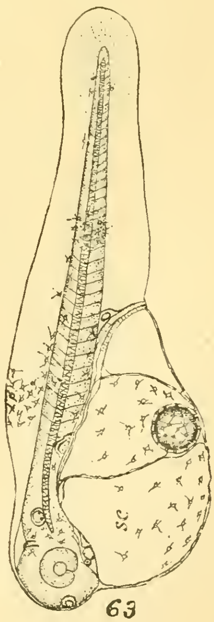

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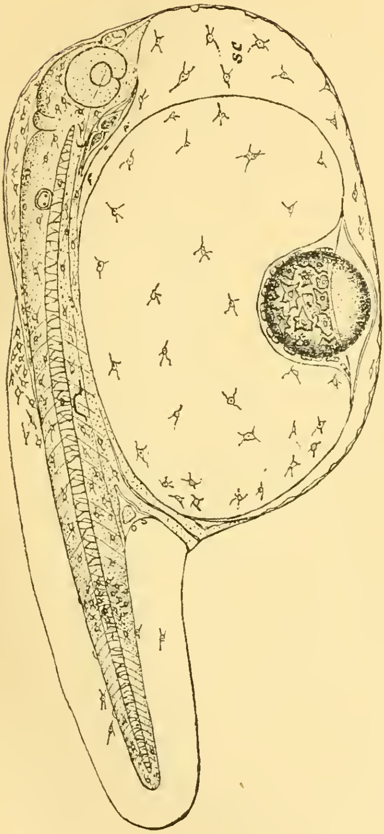
EXPLANATION OF PLATE XII.

CHÆTODIPTERUS FABER. (*The Moonfish.*)

FIG. 64. Young fish just hatched, with the oil-drop lying at the inferior side of the yelk, partly invested by cells derived from the periblast.

FIG. 65. Young fish twenty-eight hours after hatching, showing the yelk nearly absorbed.



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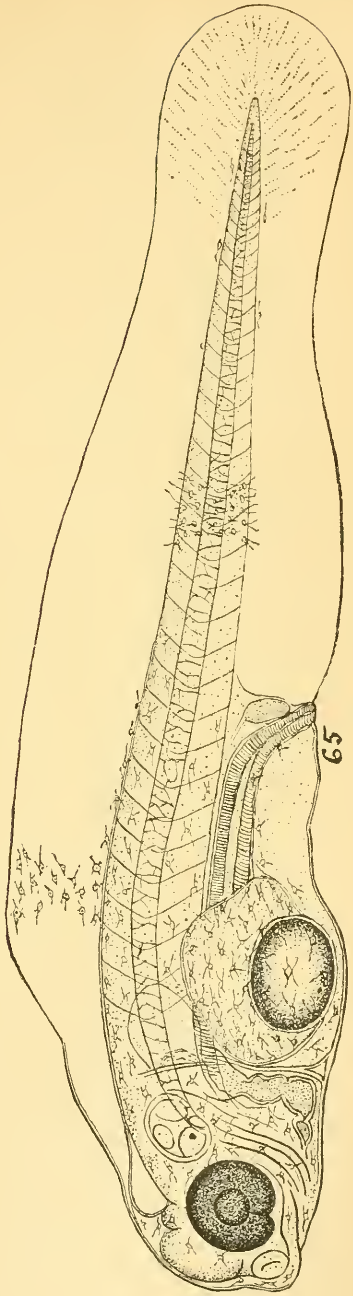

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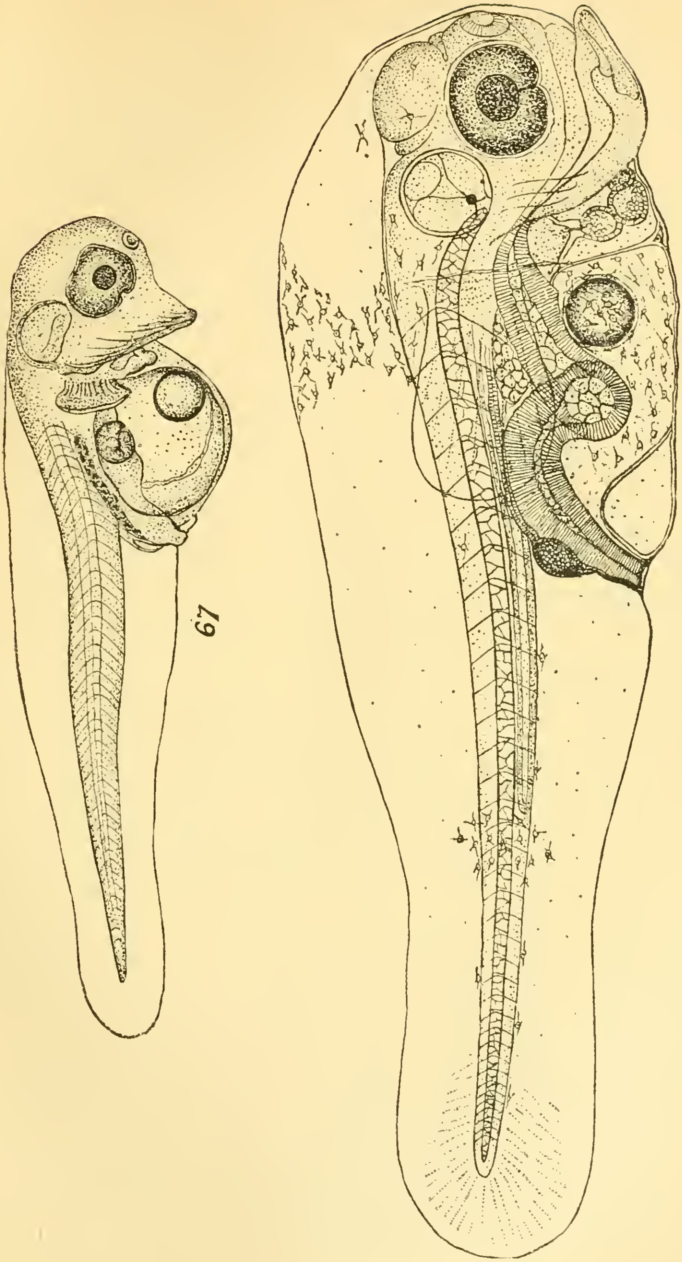
EXPLANATION OF PLATE XIII.

FIG. 66. Young *Chætodipterus faber*, sixty-three hours after hatching.

FIG. 67. Young tom-cod, *Gadus tomcod*, just after hatching, drawn from a dead specimen, the mouth being thrown wide open. x 24.



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EXPLANATION OF PLATE XIV.

CLUPEA SAPIDISSIMA. (*The Common Shad.*)

FIG. 68. The freshly extruded egg enlarged, showing its envelope much wrinkled and its surface covered with small round vesicles.

FIG. 69. An optic section of the periphery of the preceding more enlarged, showing the zona *z*, the cortical layer *cl*, with its embedded vesicles, and the large yelk-spheres *y* surrounded by their films of protoplasm.

FIG. 70. A shad's egg, showing the vitellus and distended egg-membrane, natural size.

FIGS. 71, 72, and 73. Represent three stages in the development of the blastodisk of the shad's egg at the lateral pole of the vitellus.

FIG. 74. Shows the gradual accumulation of the germinal matter at one pole of the egg, the polar prominence externally, and the presence of plasmic processes extending down through the vitellus.

FIG. 75. Shad ovum with the blastodisk just forming, viewed from above.

FIG. 76. Shad ovum with the blastodisk formed and with protoplasmic processes passing from its under surface down into the vitellus.

FIGS. 77 and 78. Views in optic section of shad ova at the time the first cleavage furrow is developed.

FIG. 79, *a*, *b*, *c*, *d*, *e*, *f*. The changes which the polar prominence shown in fig. 74, underwent at short intervals of time, during half an hour, till the polar cells were detached.

FIG. 80. Surface view from above of the blastodisk of the shad, at the time of the first cleavage.

FIG. 81. A similar view of an older blastodisk at the time of the completion of the second cleavage.

FIG. 82. Side view of a similar stage.

FIG. 83. Side view of blastodisk which has abnormally segmented into five cells.

FIG. 84. Blastodisk actively segmenting, and rapidly approaching the sixteen-celled stage. The irregularities in the form of the cells is due to the unequal contractractions of their plasma.

FIG. 85. Blastodisk composed of four cells at the time of the second cleavage; side view.

FIGS. 86 and 87. Oblique views of two different blastodisks at the end of the third cleavage after eight cells have been developed.

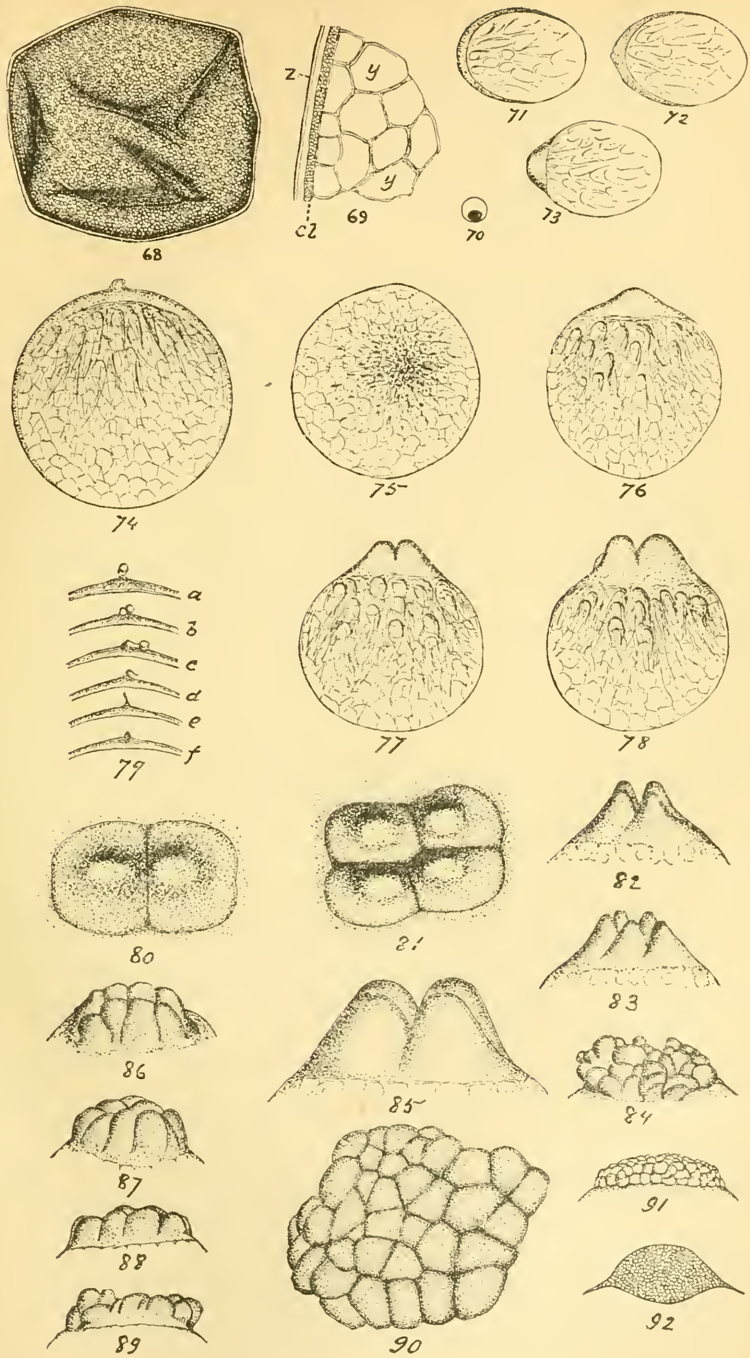
FIG. 88. Side view of a blastodisk at the same stage as the preced

FIG. 89. Side view of a blastodisk during the active stage of the fourth cleavage.

FIG. 90. Surface view of a blastodisk which has advanced somewhat beyond the fifth cleavage, or thirty-two celled stage.

FIG. 91. Optic section through a still more advanced stage of the development of the blastodisk, when the latter is composed of three to four layers of cells.

FIG. 92. Blastodisk at the time it has assumed the lenticular form, and is composed of very small cells, just before it begins to spread over the yelk. Optic section.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EXPLANATION OF PLATE XV.

CLUPEA SAPIDISSIMA. (*The Common Shad.*)

FIG. 93. Section through the blastodisk of an egg at a stage intermediate between those represented in figs. 91 and 92.

FIG. 94. A section of the germinal pole, same egg, near the edge of the blastodisk, showing the thick layer of periblast just under its margin.

FIG. 95. Section through a blastodisk somewhat older than that shown in fig. 92, showing the epidermal layer differentiated and with large nuclei at one side embedded in the periblast.

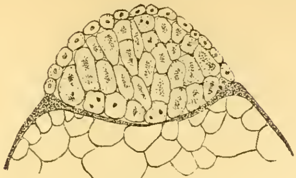
FIG. 96. Sagittal section through a more advanced stage, showing the cleavage cavity *sc* beneath the central portion of the epiblast *e*, and the inflected hypoblastic layer *h* just within the lips *o o* of the blastopore.

FIG. 97. Portion of a longitudinal vertical section of the side of the body of an embryo at the stage represented in fig. 98, to show that the solid myotomes *M M M* are more intimately united to the hypoblast *h* than to the epiblast *e*. Very much enlarged.

FIG. 98. Semidiagrammatic longitudinal median section through an embryo after the blastopore has closed, to show the position of the first myotomes and the continuity of the chorda *ch* posteriorly with the lower or hypoblastic layer; *sc*, cleavage cavity.

FIG. 99. Median longitudinal section through the head of a more advanced embryo, through the nasal pit, eye, gill-arches, brain, and chorda, and showing the relations of the periblast *p*.

FIG. 100. A similar section of the same stage somewhat off of the median line. The auditory capsule *au* is cut through, also the gill-arches, the heart *h*, and the oral cavity *b* above the latter.



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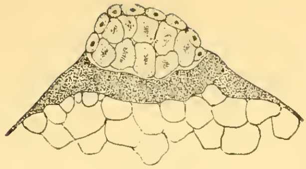

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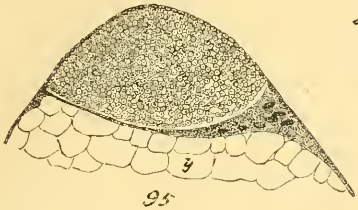

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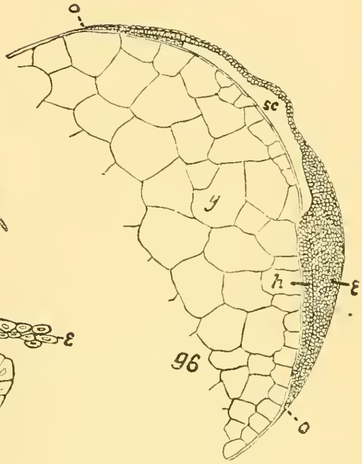

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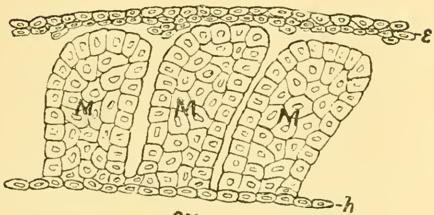

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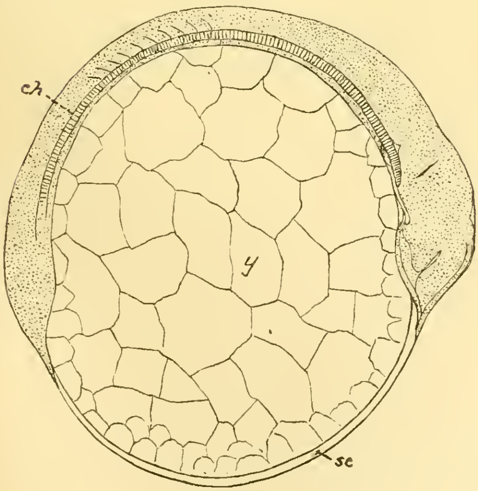

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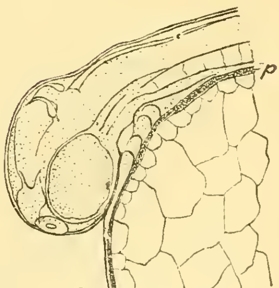
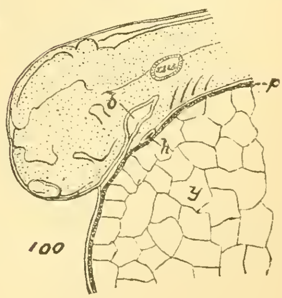


99



100

EXPLANATION OF PLATE XVI.

CLUPEA SAPIDISSIMA. (*The Common Shad.*)

FIG. 101. An embryo shad, somewhat older than the stage represented in section in fig. 98, in its natural position in its spacious enveloping membrane. From a photograph.

FIG. 102. An embryo of the same age drawn without details, and showing the position of Kupffer's vesicle at *kv*, and the heart *h*.

FIG. 103. A still more advanced embryo, showing the hind gut *hg* just under the outgrowing tail.

FIG. 104. Cross-section through the budding tail of an embryo of the preceding stage, showing the relations of the muscle plates *m m* to the nervous cord *N*, the chorda *ch*, and the post-anal section of the intestine *i*. The median fin-folds are still quite rudimentary, and are developed as very slight, ridge-like folds of the skin above and below in the median line.

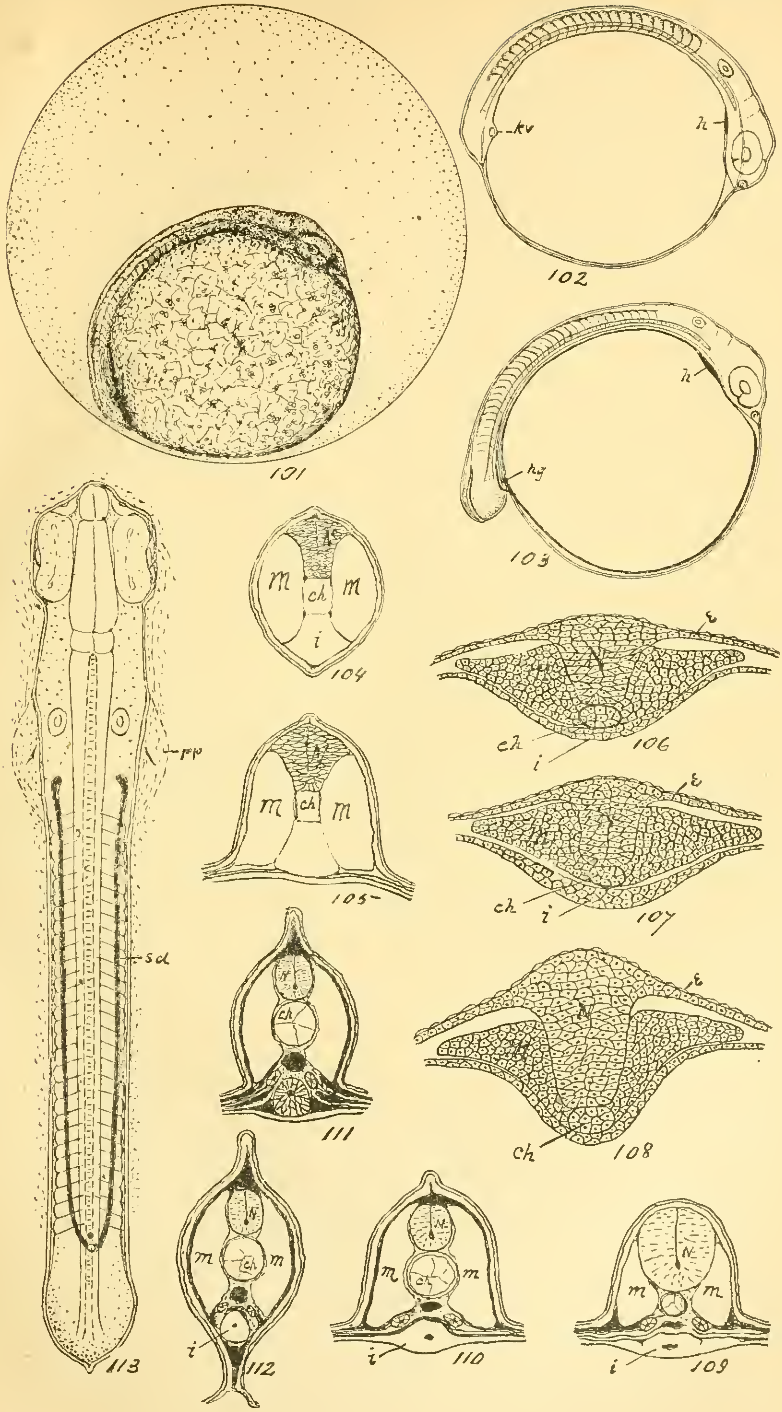
FIG. 105. A similar cross-section of an embryo of the same age, somewhat farther forward.

FIGS. 106 and 107. Cross-sections through the body of an embryo somewhat younger than that represented in fig. 102. The hypoblastic layer has not yet been differentiated into the intestine at *i*. The nervous cord *N* is still continuous with the epiblast *e* of the embryo. The chorda *ch* and muscle plates have been differentiated.

FIG. 108. A similar cross-section through the anterior part of the trunk of an embryo of the same age as that from which the preceding sections were prepared.

FIGS. 109, 110, 111, and 112. Four cross-sections through different regions of the body cavity of a much more advanced embryo, the first being the most anterior. The nervous cord *N* is detached from the skin, the segmental ducts are well defined, and the intestine *i* has a narrow lumen.

FIG. 113. Diagrammatic representation of an embryo of about the age of the one represented in fig. 103, but unrolled from the vitellus, to show the course of the segmental ducts *sd* and the extension outward of the pectoral plates *pp*, which are intimately concerned in the development of the pectoral fins.


101
102
kv
h
103
h
hy
104
m
ch
m
i
105
m
ch
m
106
ε
ch
i
107
ε
ch
i
108
ε
ch
111
112
m
ch
m
i
110
m
m
i
109
N
m
m
i
113
pp
sd

EXPLANATION OF PLATE XVII.

CLUPEA SAPIDISSIMA. (*The Common Shad.*)

FIGS. 114, 115, 116, and 117. Four views of successive stages of the development of the head and optic lobes of the embryo shad, commencing with the stage when the front end of the head of the embryo is visibly differentiated when viewed as a transparent object with transmitted light.

FIG. 118. Section through the spreading blastoderm of the shad at a somewhat earlier stage than that shown in fig. 96; *h*, hypoblast; *e*, epiblast; *sc*, segmentation cavity; *o o*, lips of the blastopore.

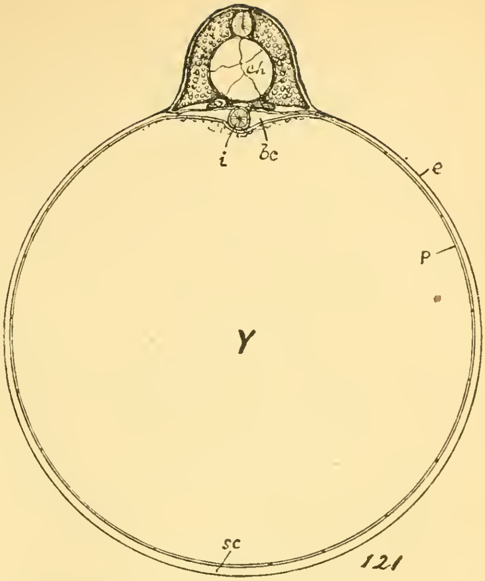
FIG. 119. Diagrammatic sagittal section through the embryonic axis *e* of a shad egg, the blastoderm of which has enveloped one-half of the vitellus. The jagged line represents the lateral limit of the cleavage cavity *sc*.

FIG. 120. Egg of the shad in which the blastopore has just closed. Only four myotomes have been developed in the mid-region of the embryonic axis.

FIG. 121. Cross-section through the body and yelk-sack of a young shad in about the condition of development represented in fig. 127; *ch*, the thick chorda; *i*, intestine; *bc*, body cavity; *p*, periblast or splanchnopleure investing the yelk *y*; *sc*, cleavage cavity; *e*, thin outer epiblastic investment of the yelk.

114

115



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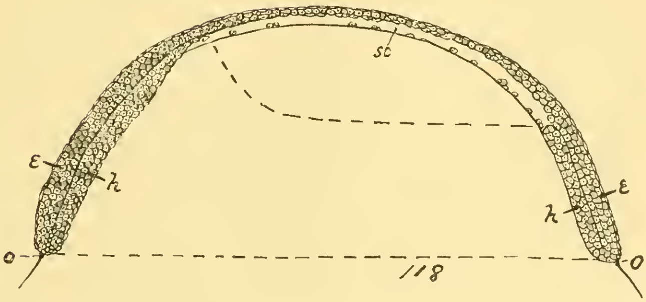

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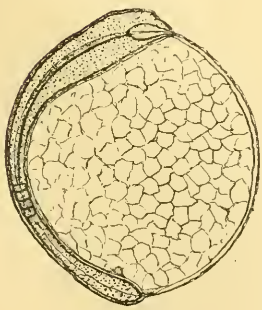

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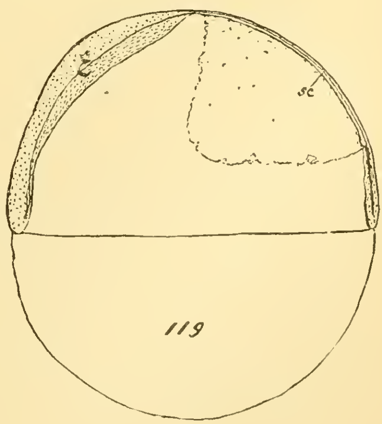


119

EXPLANATION OF PLATE XVIII.

CLUPEA SAPIDISSIMA. (*The Common Shad.*)

FIGS. 122 and 123. Two views of unhatched embryos of nearly the same age, which developed in a temperature of 45° F., producing distortions of the tail and notochord. From photographs.

FIG. 124. Egg which was impregnated at a normal temperature and which developed the blastodisk in a normal way, but subsequently, exposed to a temperature of 45° F., the blastodisk was distorted as here shown. From a photograph.

FIG. 125. Transparent view from below of front end of an embryo at about the time the mouth is formed.

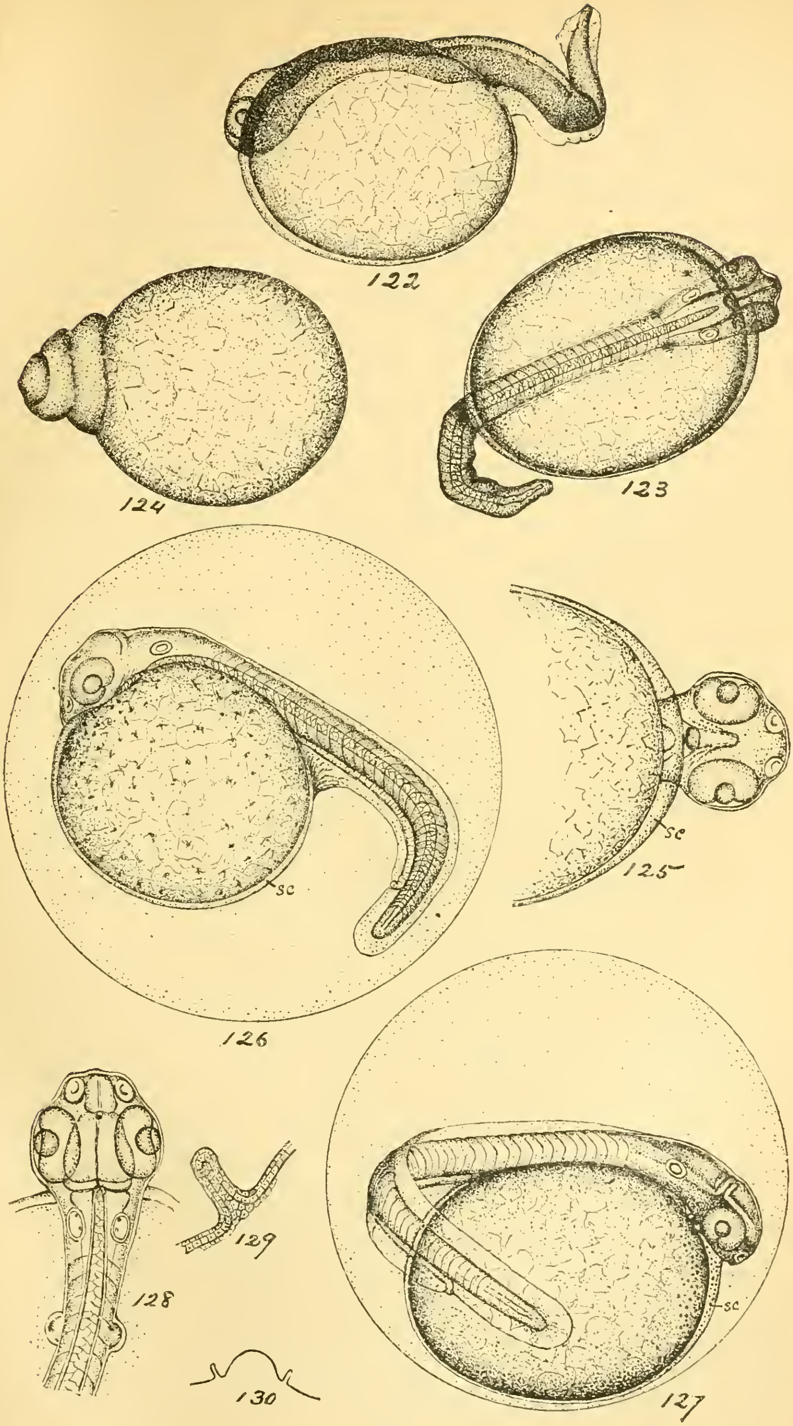
FIG. 126. An egg-envelope with its contained embryo, forty-four hours after impregnation, viewed as a transparent object.

FIG. 127. An egg-envelope with its contained embryo at the beginning of the third day of development. From a photograph.

FIG. 128. Dorsal view of the front part of an embryo at the time the pectoral fins are beginning to appear as lateral folds.

FIG. 129. Diagrammatic cross-section through the pectoral fin of an embryo, to illustrate the way in which the mesoblast is proliferated into the integumentary fin-fold.

FIG. 130. Transverse profile view of the dorsal pectoral region of an embryo in the stage represented in fig. 128.


122
124
123
sc
sc
125
126
128
129
sc
130
127

EXPLANATION OF PLATE XIX.

CLUPEA SAPIDISSIMA. (*The Common Shad.*)

FIG. 131. Pneumatic duct *pn*, rudimentary stomach *st*, pylorus *py*, and swollen anterior part of hind gut *I*, and back part of œsophagus *oe*, of a young shad 22^{mm} long, which had acquired ventral fins. From a specimen three weeks old reared in confinement.

FIG. 132. View from above of the head of a young shad fourteen days old, showing the relations of the auditory capsules, brain, and eyes.

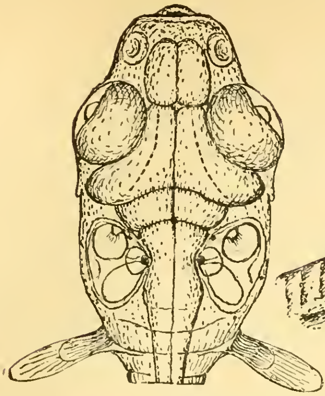
FIG. 133. Side view of a young shad thirteen days old, viewed as a transparent object. *ab* rudimentary air-bladder, *L* liver, *Gb* gall-bladder.

FIGS. 134 and 135. Two views of the heads of embryos nearly ready to hatch, showing the rudimentary gill-arches and pectoral fin, nasal pits, wide oral fossa, and short lower jaw. Drawn from opaque specimens hardened in chromic acid.

FIG. 136. An embryo in its envelope, on the third day of development, nearly ready to hatch.

FIGS. 137, 138, and 139. A lateral, a posterior, and a view from above of the blastoderm of the shad, just at the time the cleavage cavity, *sc*, is beginning to be evident, the tail swelling, *s*, formed, and the hypoblast developed by inflection of the edge of the blastoderm.

FIGS. 140 and 141. Two views of an egg after the blastoderm has spread considerably and the embryonic area *e* is well defined. From photographs.



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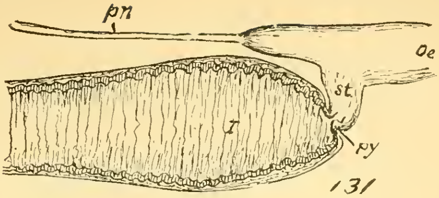

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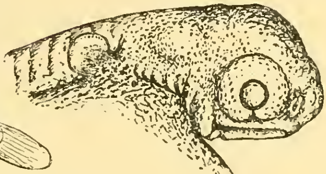

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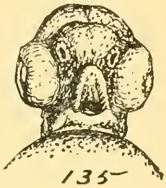

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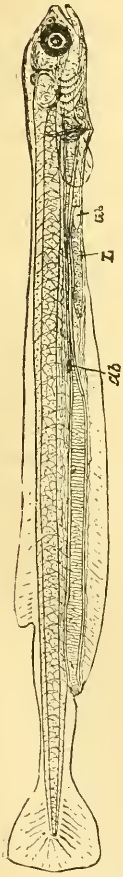

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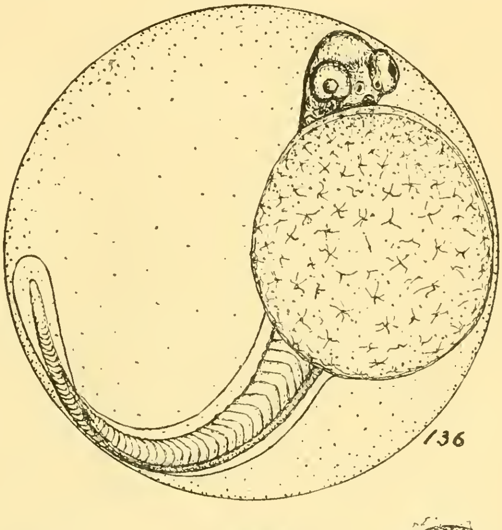

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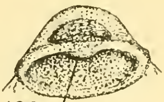

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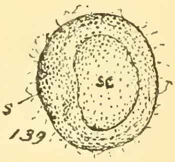

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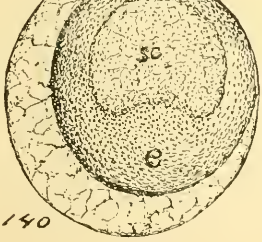

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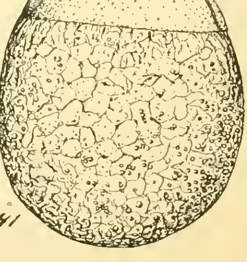

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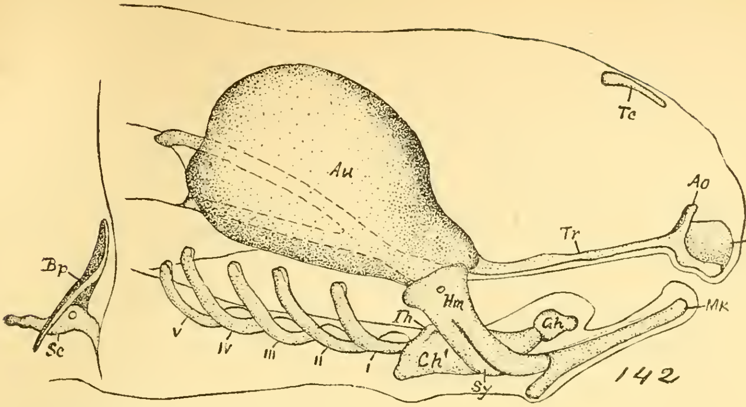
EXPLANATION OF PLATE XX.

CLUPEA SAPIDISSIMA. (*The Common Shad.*)

FIG. 142. Cartilaginous cranium of the larval shad on the sixth day after hatching. *Au* auditory capsule, *Hm* hyomandibular, *Ch'* ceratohyal, *Gh* glossohyal, *Mk* Meckel's cartilage, *Ih* interhyal, *Tr* cranial trabecula, *Ao* antorbital process, *R* rostrum, i, ii, iii, iv, v, branchial arches; *Tc* tegmen cranii, *Sy* symplectic, *Bp* basipterygial plate from which the actinosts are developed, *Sc* coraco-scapular plate perforated by a foramen.

FIG. 143. Cartilaginous cranium of a young shad shortly after hatching. Lettering as before, except *Ch*, which in this figure indicates the chorda; *Q* the quadrate, a continuation of the hyomandibular.

FIG. 144. Mesial section through the head of a young shad shortly after hatching. *mo* medulla oblongata, *Cb* cerebellum, *mb* mid-brain, *Pn* pineal body, *Cer* cerebrum, *Inf* infundibulum, *Hy* hypophysis, *bb* basibranchial, *Ch'* basihyal, *Gh* glossohyal, *Tr* anterior prolongation of the trabeculæ as the rostral plate, *Mk* Meckel's cartilage, i, ii, iii, iv, v, the open lumina of the branchial clefts, *M M M* anterior myotomes, *ba* bulbus aortæ, *ve* ventricle, *sv* sinus venosus, *pc* pericardia cavity, *Y* yelk, *p* periblast, *sc* cleavage cavity.


Tc
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Ao
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R
Bp
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Mk
Th
Ch
Sc
v
IV
III
II
I
Ch'
Sy

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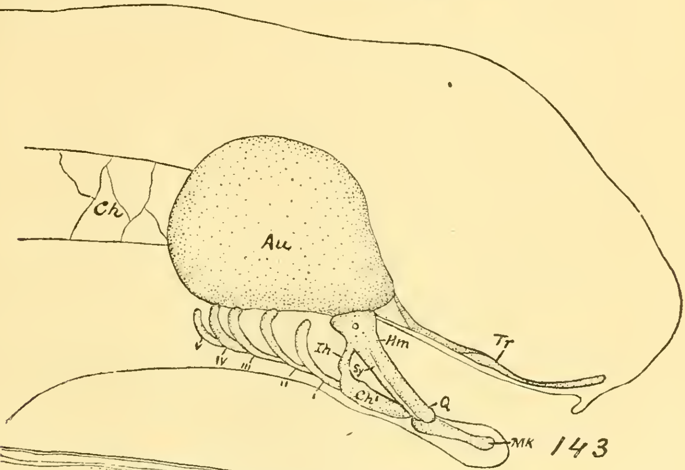
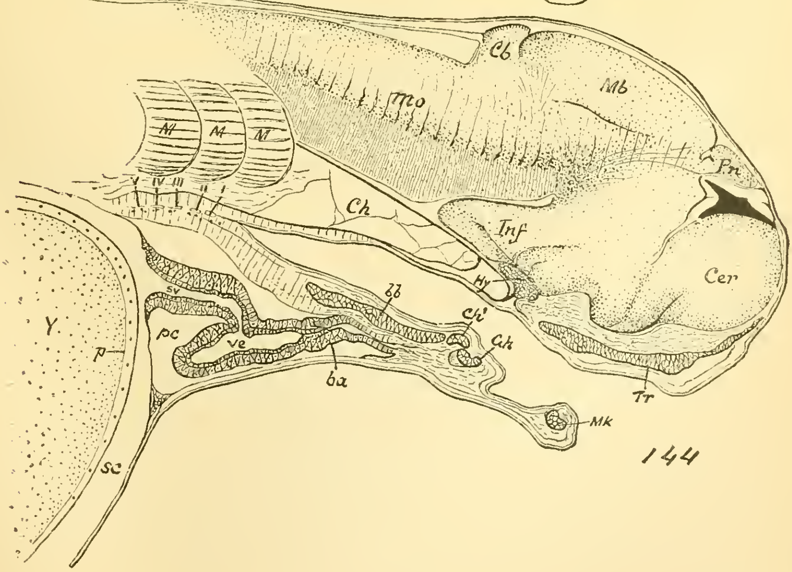

Ch
Au
Hm
Tr
Th
Sy
Ch'
Q
Mk

143


Cb
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Mo
M
Pn
Ch
Inf
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Hy
Y
sv
pc
ve
bb
ba
Ch'
Ch
Tr
Mk
p
sc

144

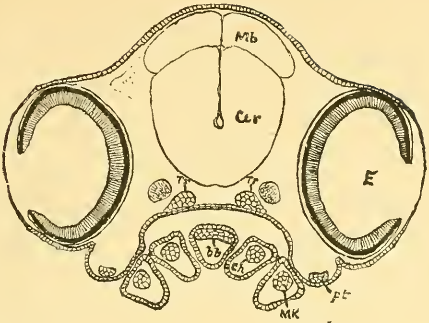
EXPLANATION OF PLATE XXI.

CLUPEA SAPIDISSIMA. (*The Common Shad.*)

FIG. 145. Cross-section through the region of the eyes of an embryo ten days old; *bb* basibranchial, *ch* ceratohyal, *MK* Meckel's cartilage, *pt* palatine, *Tr* trabeculæ cranii, *E* eye, *Mb* mid-brain, *Cer* cerebrum.

FIG. 146. Cross-section through the anterior part of the auditory region of the same embryo; *au* auditory vesicle with acoustic macula or end organ in its lower wall, *Mo* medulla oblongata, *Ch* chorda, *Hm* upper end of hyomandibular, *i, ii, iii,* and *iv* branchial arches, *pa* parachordal cartilages.

FIG. 147. Cross-section through the posterior part of the auditory region of the same; lettering the same, except that the basibranchial bar *bb* is cut through, as well as the whole five branchial arches, also the auditory canals and vestibule of the membranous labyrinth.


Mb
Cer
E
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bb
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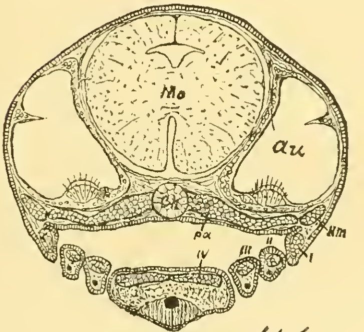
145


Mo
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Hm
I
II
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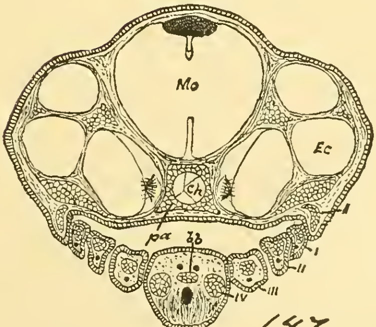
IV

146


Mo
Ec
ch
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bb
I
II
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IV

147

EXPLANATIONS OF PLATE XXII.

CLUPEA SAPIDISSIMA. (*The Common Shad.*)

FIG. 148. Young fish on the third day after hatching, viewed as a transparent object to show the extension of the segmental duct forward; the chorda *ch*, and liver *L*.

FIG. 149. Young fish immediately after hatching, viewed as an opaque object and somewhat obliquely from one side, so as to display the relations of branchial and hyomandibular arches, and the position of the pectoral fin.

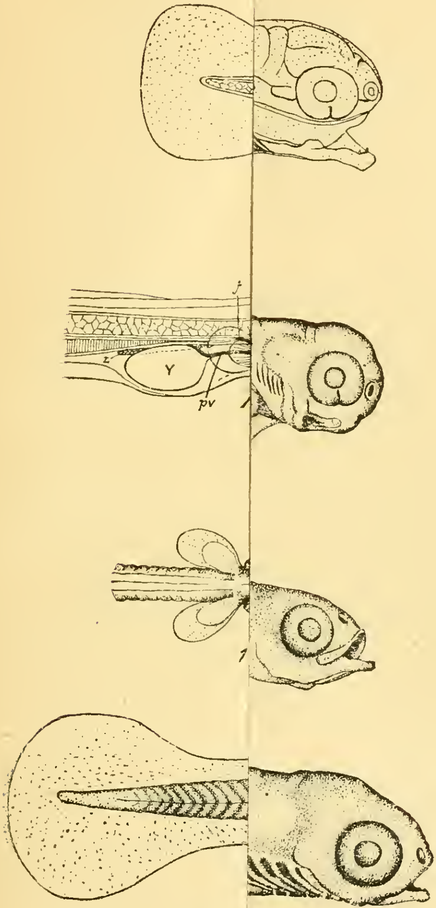
FIG. 150. Young fish seventeen days after hatching, viewed partly as an opaque and partly as a transparent object; *py* pylorus and rudimentary air-bladder above it; *I* intestine, filled with the remains of ingested food. The opercula are already so far developed as partly to conceal the branchiæ.

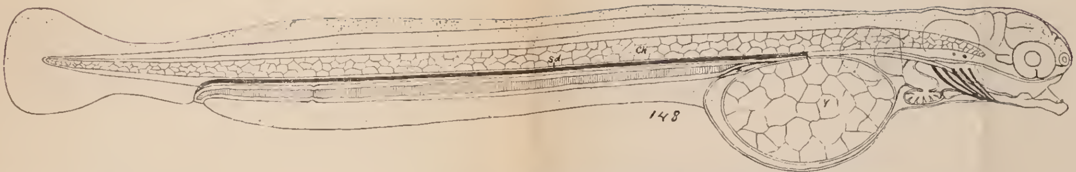
FIG. 151. Young fish five days after hatching, very much enlarged, and viewed as an opaque object. Only a slight remnant of the yelk-sack *Y* remains.

FIG. 152. Anterior portion of a young fish on the fourth day. To show the relations of the liver *L* to the yelk *Y*, over which the portal vessel *pv* passes forward to empty into the venous sinus, in common with the anterior and posterior jugulars *j'* and *j*, *ba* bulbus aortæ, *ve* ventricle.

FIG. 153. View of the fore part of a young fish seventeen days old, from the ventral side.

PLATE XXII.





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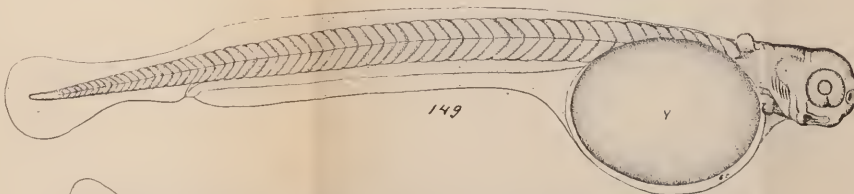

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151

EXPLANATION OF PLATE XXIII.

ICTALURUS ALBIDUS. (*White Cat-fish.*)

FIG. 154. Embryo of the second day removed from its envelope; *b* rudimentary branchial arches and clefts, *e* eye, *m m* myotomes, *p* pectoral plate or thickening. Drawn from a hardened specimen. x 24.

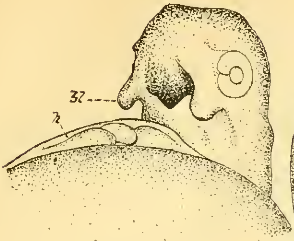
FIG. 155. Living embryo of the second day freed from its envelope, and viewed as a transparent object. x 16.

FIG. 156. Head of embryo on the third day, viewed from in front and somewhat obliquely; *h* heart, *bl* maxillary barbel. x 16.

FIG. 157. Head of embryo on the third, from in front, viewed as an opaque object; *bl* maxillary barbels, *h* heart, *n* nasal grooves. x 24.

FIG. 158. Head of embryo on the third day, from the side, viewed as an opaque object; *b* branchiæ, *bl* barbels, *m* myotomes, *p* pectoral. x 24.

FIG. 159. Embryo of third day freed from its envelope, and viewed from above, as an opaque object; *op* opercular fold, *p* pectoral, *m m* myotomes. x 24.



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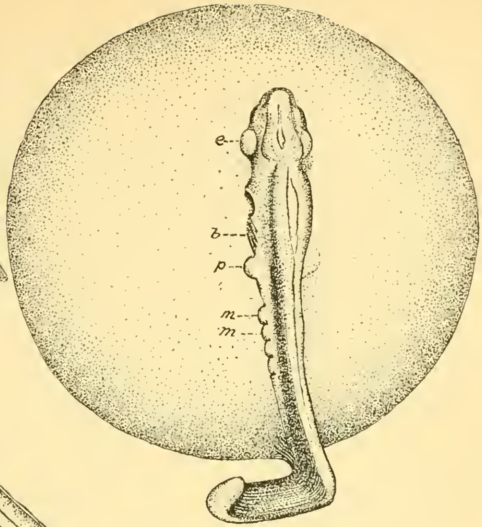

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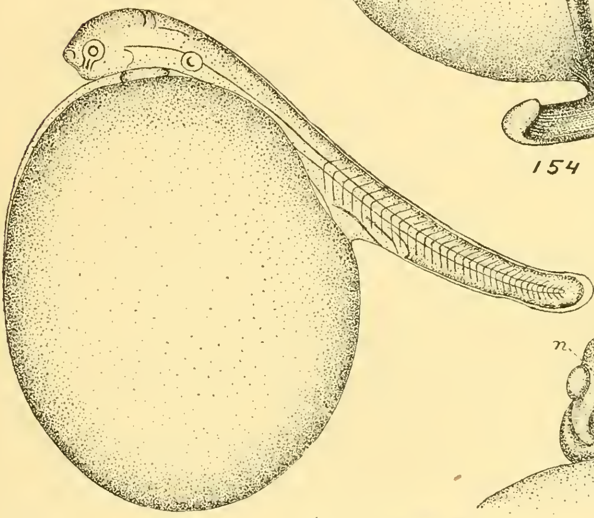

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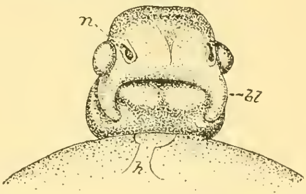

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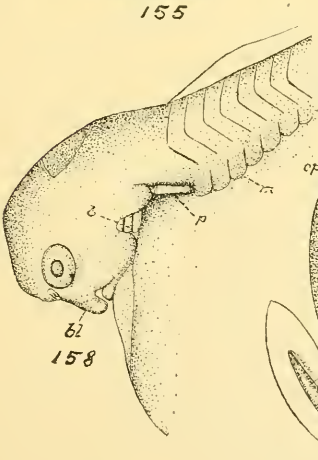

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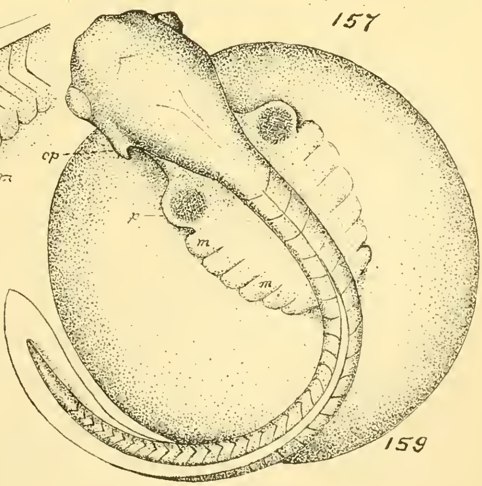

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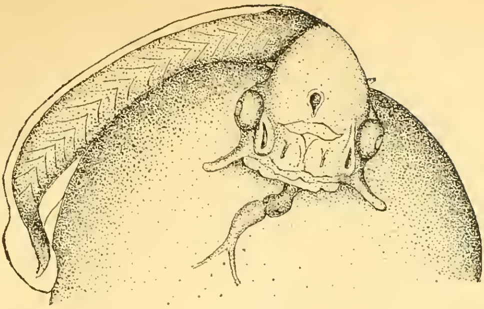
EXPLANATION OF PLATE XXIV.

ICTALURUS ALBIDUS. (*White Cat-fish.*)

FIG. 160. Embryo on the fourth day, viewed as an opaque object from the front. x 24.
FIG. 161. The same, viewed from the side. x 24.
FIG. 162. Head and yelk-sack of embryo on the fifth day, viewed from in front. x 24.



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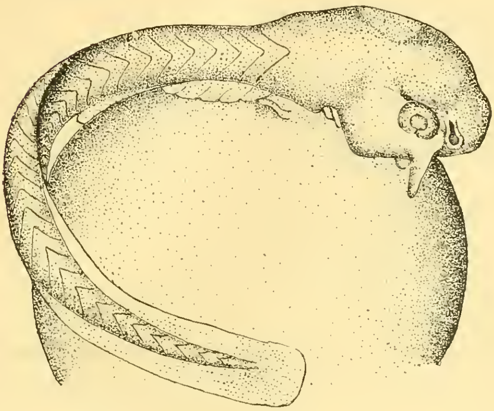

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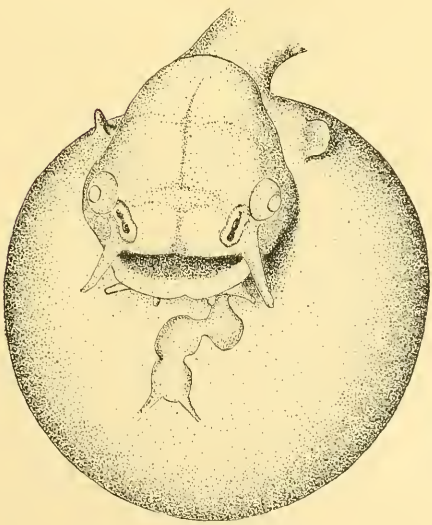


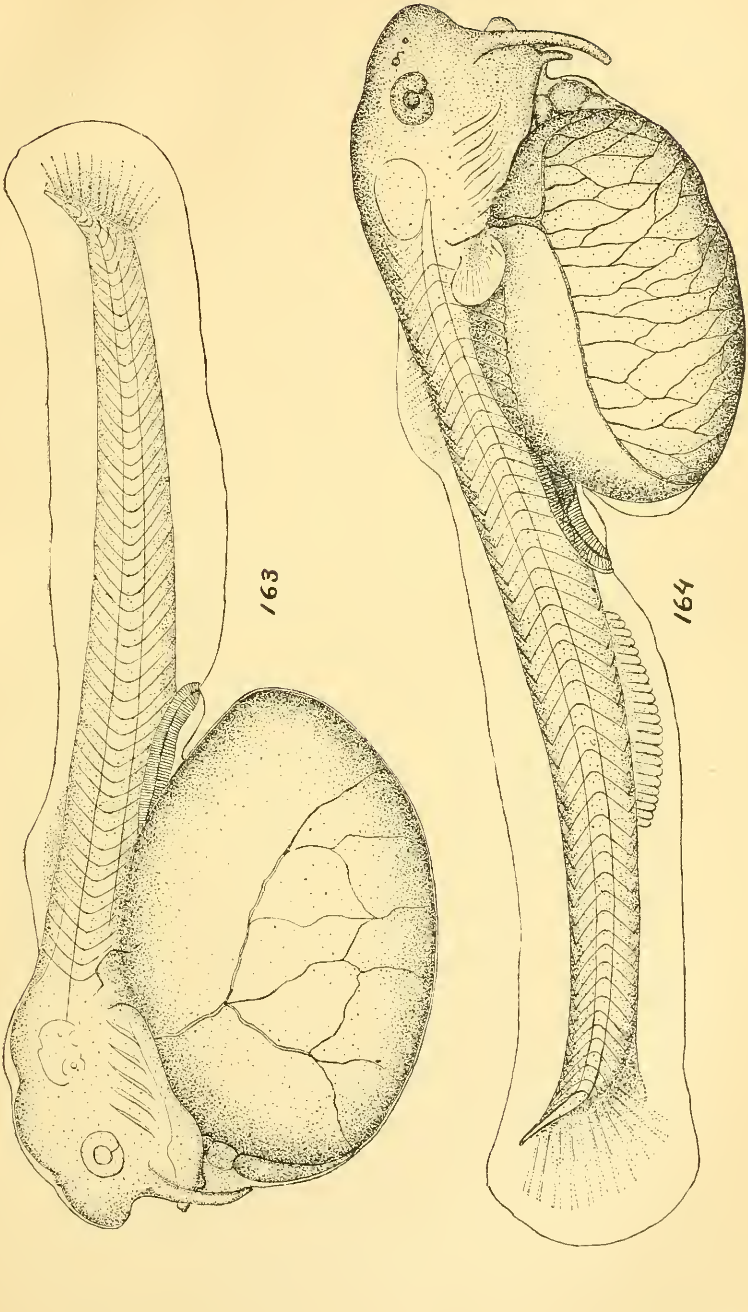
162

EXPLANATION OF PLATE XXV.

ICTALURUS ALBIDUS. (*White Cat-fish.*)

FIG. 163. Young cat-fish of the sixth day, just hatched, viewed as a transparent object. x 16.

FIG. 164. Young cat-fish of the seventh day, viewed as a transparent object. x 16.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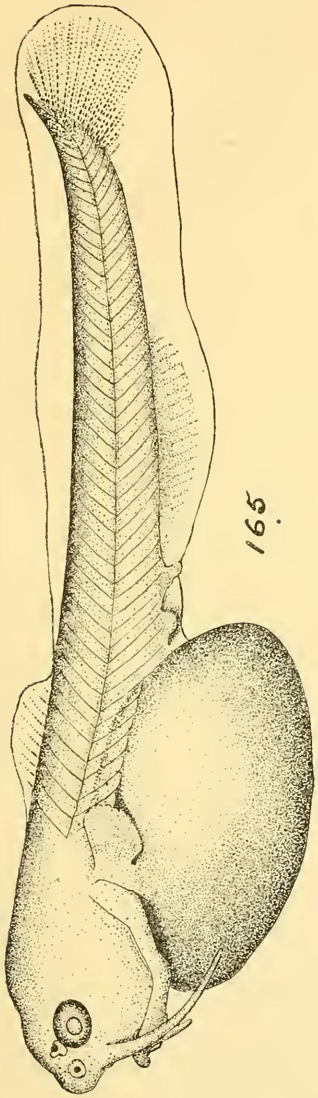
164

EXPLANATION OF PLATE XXVI.

ICTALURUS ALBIDUS. (*White Cat-fish.*)

FIG. 165. Young cat-fish, eight days old, viewed as an opaque object. x 16.
FIG. 166. Young cat-fish, nine days old, viewed as an opaque object. x 16.



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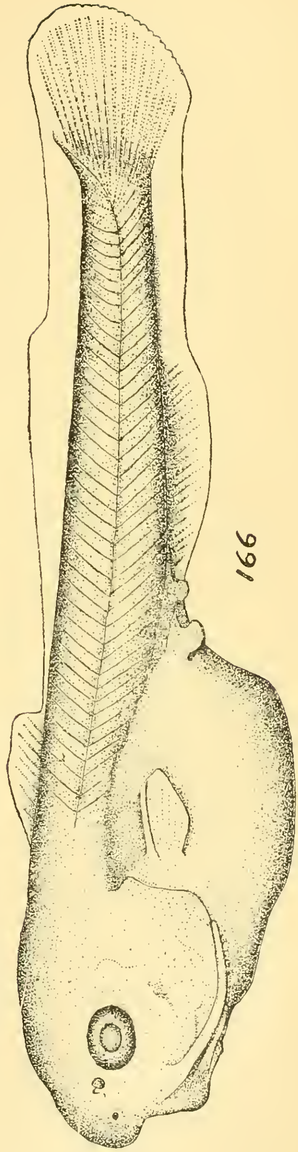
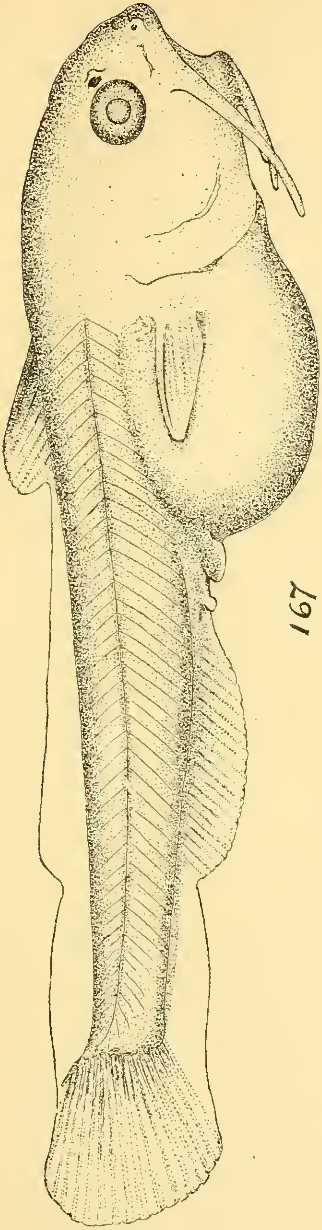


166

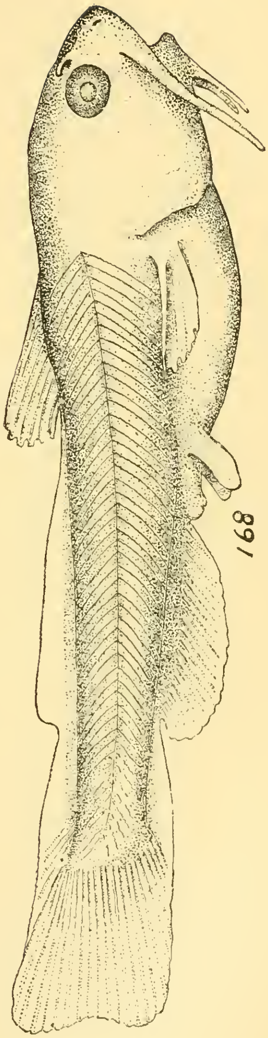
EXPLANATION OF PLATE XXVII.

ICTALURUS ALBIDUS. (*White Cat-fish.*)

FIG. 167. Young cat-fish, ten days old, viewed as an opaque object. x 16.
FIG. 168. Young cat-fish, eleven days old, viewed as an opaque object. x 10.



167

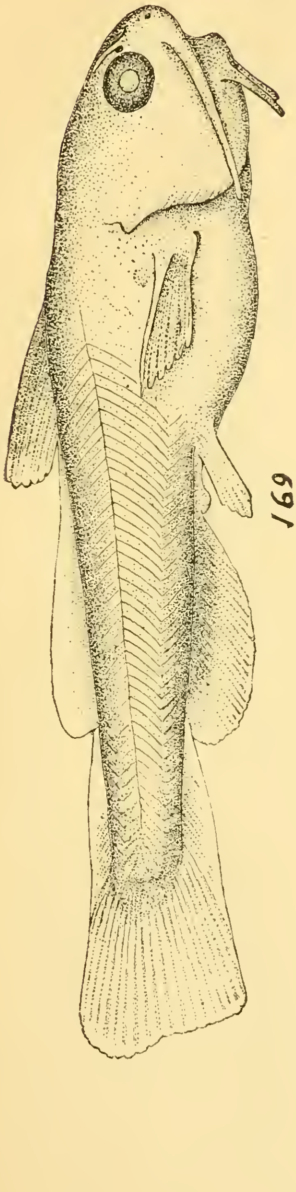


168

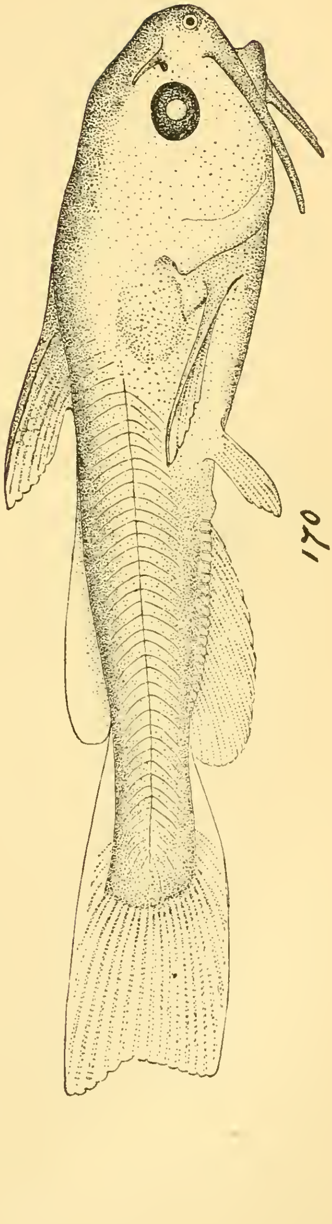
EXPLANATION OF PLATE XXVIII.

ICTALURUS ALBIDUS. (*White Cat-fish.*)

FIG. 169. Young cat-fish, twelve days old, viewed as an opaque object. x 10.
FIG. 170. Young cat-fish, twenty days old, viewed as an opaque object. x 10.



169

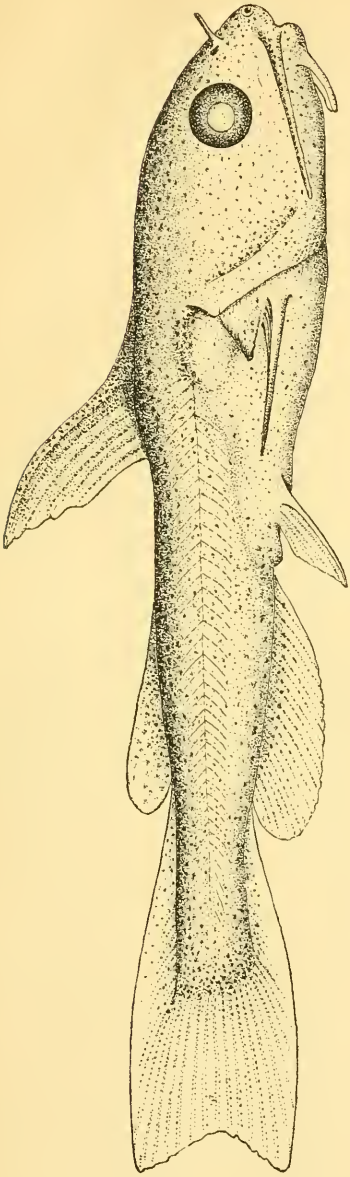


170

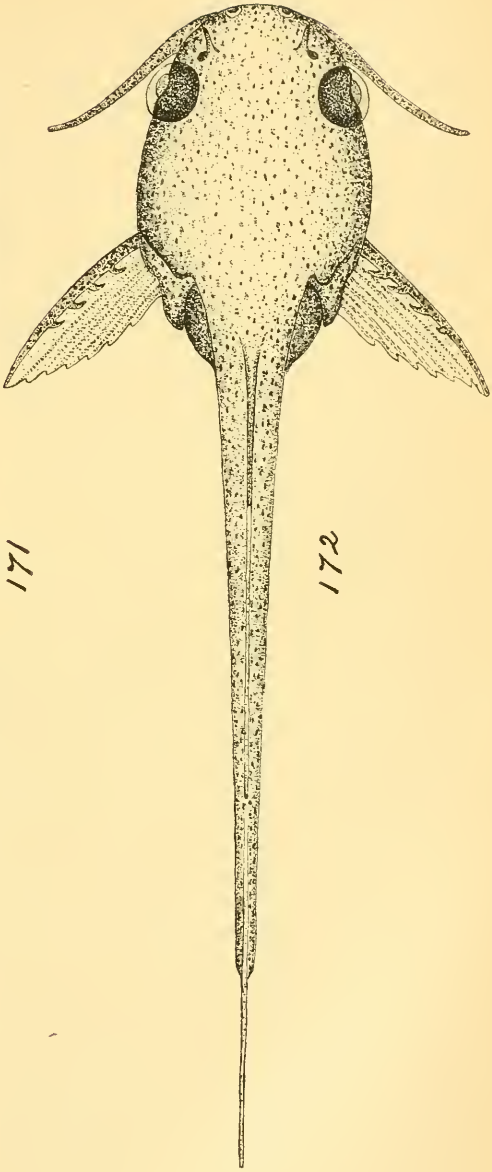
EXPLANATION OF PLATE XXIX.

ICTALURUS ALBIDUS. (*White Cat-fish.*)

FIG. 171. Young cat-fish, eighty-eight days old, viewed as an opaque object. x 8.
FIG. 172. The same, viewed from above. x 8.



171



172

EXPLANATION OF PLATE XXX.

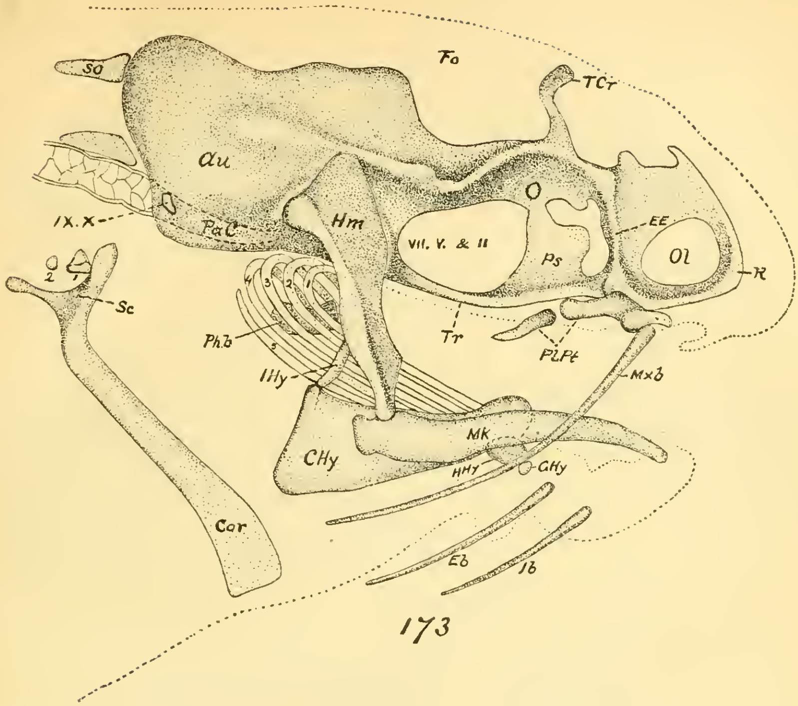
ICTALURUS ALBIDUS. (*White Cat-fish.*)

FIG. 173. Cartilaginous cranium of young fish, ten days old, constructed from a series of longitudinal vertical sections. x 35.

Au, auditory vesicle; *CHy*, ceratohyal; *Cor*, coracoid; *EE*, ectethmoid ridge; *Eb*, cartilage of external chin barbel; *Fo*, fontanelle; *GHy*, urohyal; *Ib*, cartilage of internal chin barbel; *IHy*, interhyal; *Hm*, hyomandibular; *HHy*, hypohyal; *Mk*, Meckel's cartilage; *Mxb*, cartilage of maxillary barbel; *O*, orbit; *Ol*, olfactory fossa; *PaC*, parachordal region; *Phb*, pharyngobranchials; *Ps*, presphenoid lamina; *PlPt*, palatopterygoid elements; *R*, rostrum; *Sc*, scapular portion of shoulder-girdle; *so*, supraoccipital; *TCr*, tegmen cranii; *Tr*, trabecula; II, V, VII, IX, X, foramina for cranial nerves.

FIG. 174. Median longitudinal vertical section of the head of a young fish, ten days old. x 35.

Ab, air-bladder; *BB*, basibranchials; *Ba*, bulbus aortæ; *Cb*, cerebellum; *Cer*, cerebrum; *Ch*, chorda; *ES*, erector spinæ; *Hy*, hypophysis; *I*, intestine; *Inf*, infundibulum; *L*, liver; *M*, pharyngeal and œsophageal muscles; *mb*, mid-brain; *MK*, Meckel's cartilage; *mo*, medulla oblongata; *Oe*, œsophagus; *Ot*, optic tract; *P*, periblast; *Pc*, pericardiac cavity; *Pn*, pineal body; *R*, rostrum; *S*, sacculus vasculosus; *SV*, sinus venosus; *Tr*, trabecula; *Ve*, ventricle; *x x x*, rudiments of anterior co-ossified vertebræ; *Y*, yelk.


Fo
SO
TCr
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IX.X
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MK
CHy
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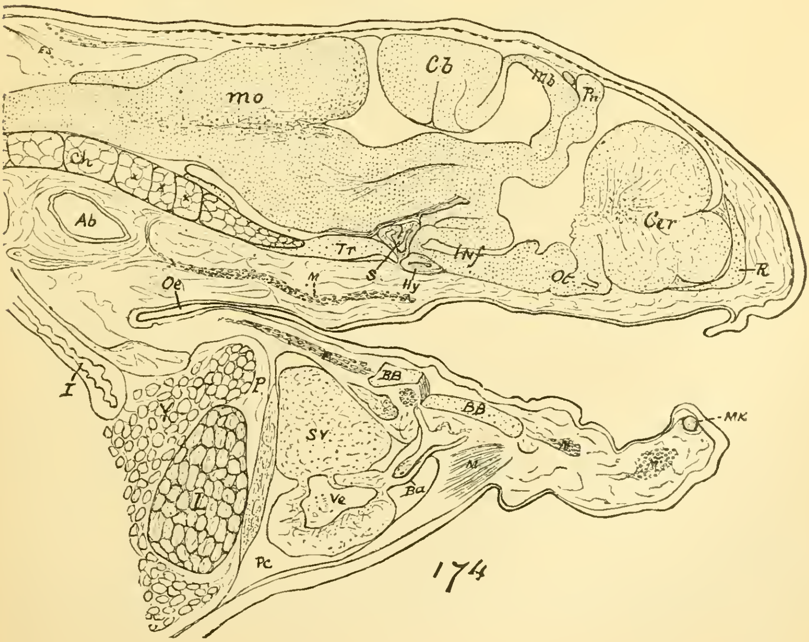
CHy
Cor
Eb
Ib

173


Cb
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BB
BB
MK
SV
Ve
Ba
Pc

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XXI.—REPORT ON THE DECAPOD CRUSTACEA OF THE ALBATROSS DREDGINGS OFF THE EAST COAST OF THE UNITED STATES DURING THE SUMMER AND AUTUMN OF 1884.

By Sidney I. Smith.

In addition to all the true Decapoda which have been submitted to me for examination from Albatross dredgings during the summer and autumn of 1884, this report includes a few specimens taken in 1883, but omitted from the report for that year.

In the tables of specimens examined the following abbreviations are used to indicate the nature of the bottom:

Materials.	Colors.	Other qualities.
C. for clay.	bk. for black.	brk. for broken.
Cr. for corals.	bn. for brown.	crs. for coarse.
F. for foraminifera.	bu. for blue.	fne. for fine.
G. for gravel.	dk. for dark.	glb. for globigerina.
M. for mud.	gn. for green.	hrd. for hard.
O. for ooze.	gy. for gray.	rky. for rocky.
P. for pebbles.	lt. for light.	sft. for soft.
R. for rocks.	rd. for red.	sml. for small.
S. for sand.	wh. for white.	
Sh. for shells.	yl. for yellow.	
Spg. for sponges.		
St. for stones.		

In the column of temperatures the degrees are given in whole numbers; fractions of half a degree or less are omitted, and when the fraction is more than half a degree the next higher whole number is used. In the column for the number of specimens examined, *l* is used to indicate large specimens; *s*, small specimens; *y*, young; and *f*, fragments or very imperfect specimens. In a few cases specimens which I have not seen are recorded, but the numbers of all such specimens are inclosed in brackets. When the sexes were not counted separately the whole number of specimens examined is placed in the middle of the column; when the sexes were counted separately the number of males is put on the right, the number of females on the left, and the number of young, whose sex was indeterminable, in the middle, followed by the letter *y*. When the number of egg-bearing females was counted it is entered in the appropriate column; when specimens carrying eggs were found, but not counted, a plus sign (+) is used; and when none of the specimens examined were carrying eggs a zero (0) is used. The National Museum Crustacea Catalogue numbers are given in the tables of specimens examined, or are simply placed in parentheses after the mention of the specimens. In a few cases among the Paguroidea, specimens selected for their carcinœcia, were catalogued among Actinozoa, in a different catalogue from the crustacea, and such catalogue numbers are preceded by an A, to distinguish them from the Crustacea catalogue numbers.

In the first report on the crustacea of the Albatross collections, I gave no general statement of results, but confined myself strictly to the enumeration of the specimens taken and the description of the many new forms discovered. Here, however, I propose to discuss some of the results of the examination of the Decapoda of the two seasons' work. The collections made in the West Indian region by the Albatross, during the winters of 1884 and 1885, have not yet been fully examined, and are not referred to in the following statements, which apply exclusively to the region north of Cape Hatteras; but some of the results, in regard to bathymetrical range, &c., of a partial examination of the collection of the summer of 1885 are included.

The most interesting feature of the crustacea collected by the Albatross is the great number of very deep-water, or abyssal, species of Decapoda which it contains. The whole number of species of true Decapoda dredged by the Albatross north of Cape Hatteras is over 130, but nearly one-half of these are from shallow or comparatively shallow water. None of the shallow-water species were taken below 1,000 fathoms, and it is, perhaps, best to limit the abyssal fauna to species occurring in depths greater than this, although some true deep-water species are probably excluded by adopting so great a depth. Taking this limit strictly, however, we have 43 abyssal species, of which 22 have been taken below 2,000 fathoms, as shown in the following list:

LIST OF DECAPODA TAKEN NORTH OF CAPE HATTERAS, BELOW 1,000 FATHOMS, BY THE ALBATROSS IN 1883–'84–'85, WITH THE BATHYMETRICAL RANGE OF EACH SPECIES AND A BRIEF STATEMENT OF THE CHARACTER OF THE EYES.

BRACHYURA.

CANCROIDEA.

1. *Geryon quinquedens.* 105 to 1,081 fathoms.
   Eyes well developed, black.

DORIPPOIDEA.

2. **Ethusina abyssicola.** 1,497 to 2,221.
   Eye-stalks very small, immovably imbedded in the orbits, and tipped with minute, distinctly faceted, black eyes, much smaller than the diameter of the stalks.

LITHODOIDEA.

3. *Lithodes Agassizii.* 410 to 1,255.
   Eyes well developed, black.

PAGUROIDEA.

4. **Parapagurus pilosimanus.** 250 to 2,221.
   Eyes very small, no larger than the diameter of the stalks, distinctly faceted, black.

GALATHEOIDEA.

5. *Munidopsis curvirostra.* 75 to 1,290.
   Eye-stalk very short, capable of considerable motion, and its whole terminal portion covered with an ovoid, unfaceted cornea; pigment white.

6. **Munidopsis crassa.** 1,742 to 2,620.
   Eye-stalks short, capable of very little motion, bearing the small hemispherical cornea partially imbedded near the distal end, which projects in a spine; cornea unfaceted; pigment white.

7. *Munidopsis similis.* 1,060.
   Eyes as in the last species.

8. *Munidopsis Bairdii.* 1,497 to 1,742.
   Eyes nearly as in 6 and 7.

9. *Munidopsis rostrata.* 1,098 to 1,356.
   Eye-stalks short, capable of some motion, cornea terminal, large, swollen, reniform, unfaceted; pigment white.

MACRURA.

ERYONTIDÆ.

10. *Pentacheles sculptus.* 250 to 1,081.
    Eyes reduced to lobes of the ocular somite imbedded in sinuses in the front of the carapax; each lobe with a small cornea-like area above and a smaller one below tipping a projecting process; no colored pigment nor faceted surface.

11. *Pentacheles nanus.* 705 to 1,917.
    Eyes as in the last species.

12. *Pentacheles debilis.* 1,290 to 1,309.
    Eyes nearly as in 10 and 11.

CRANGONIDÆ.

13. **Pontophilus abyssi.** 1,917 to 2,221.
    Eye-stalks very short; eyes about as large as in most species of the genus, but much smaller than in the closely allied species (*P. gracilis*) inhabiting 200 to 500 fathoms; cornea rather indistinctly hexagonally faceted; pigment almost colorless except over an area on the outer dorsal side (which is apparently of somewhat different structure from the rest of the eye), where there are many points of dark pigment.

GLYPHOCRANGONIDÆ.

14. *Glyphocrangon sculptus.* 1,006 to 1,434.
Eyes very large, almost spherical, and mounted on very short stalks; cornea distinctly faceted; pigment purplish brown; a minute papilla on the mesial side of the stalk, but perhaps not of the same nature as that in the Miersiidæ and Penæidæ.

15. *Glyphocrangon longirostris.* 828 to 1,081.
Eyes similar to those of the last species.

ALPHEIDÆ.

16. *Bythocaris gracilis.* 888 to 1,043.
Eyes hemispherical, small, little larger than the diameter of the stalks; cornea distinctly faceted; pigment black.

17. *Heterocarpus oryx* A. M.-Edwards.* 1,081.
Eyes well developed, black, but smaller than in the species of the closely allied genus *Pandalus.* †

NEMATOCARCINIDÆ.

18. **Nematocarcinus ensiferus.** 588 to 2,033.
Eyes rather small, but well developed, black; papilla minute and very obscure; no dorsal area.

MIERSIIDÆ.

19. **Acanthephyra Agassizii.** Surface and 105 to 2,949.
Eyes rather small, but highly developed; stalks expanded distally and capable of great mobility; pigment black and abundant: papilla well developed, prominent; dorsal area present.

20. **Acanthephyra,** sp.‡ 2,069.
Eyes imperfect in the single specimen seen, but apparently nearly as in the last species; pigment black; papilla prominent; dorsal area present.

21. **Acanthephyra microphthalma.** 2,574 to 2,620.
Eyes imperfectly developed; stalks capable of comparatively little motion, and contracted distally to the very small eyes; pigment light brownish; papilla minute; apparently no dorsal area.

22. **Acanthephyra brevirostris.** 1,395 to 2,949.
Eyes much less highly developed than in 19, but larger than the diameter of the stalks; pigment brownish black; papilla well developed; dorsal area apparently absent.

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* Station 2550, August 9, 1885, north latitude 39° 44′ 30″, west longitude 70° 30′ 45″ 1,081 fathoms, brown mud, temperature 30°,—1 ♀ (10661).

† The peculiar, conspicuously faceted area on the dorsal side of the eye and near to the margin of the cornea proper, and often darker than it, which is conspicuous in many Alpheidæ and Palæmonidæ, is entirely absent in this species. This area, however, is also absent in *Pandalus propinquus*, although it is very conspicuous in *P. Montagui*, *leptocerus*, and *borealis*. For convenience, I refer to this area, in the following part of the list, as the "dorsal area."

‡ A single very imperfect specimen of this species, which is very distinct from any other in the collections of the Fish Commission, was taken at station 2565, August 28, 1885, north latitude 38° 19′ 20″, west longitude 69° 02′ 30″, 2,069 fathoms, gray and brown ooze, temperature 37°.

23. **Acanthephyra gracilis.** 1,632 to 2,512.
Eyes highly developed; cornea more expanded than in 19; pigment black and abundant; *two* well-developed papillæ on each stalk; dorsal area conspicuous, elongated, in contact with the cornea proper.

24. *Notostomus robustus.* 1,309 to 1,555.
Eyes rather small, but larger than the diameter of the stalks, which are somewhat expanded distally; pigment black; papilla well developed; dorsal area absent or perhaps represented by a conspicuous narrow process from the margin of the cornea.

25. **Notostomus vescus.** 2,949.
Eyes larger than the diameter of the stalks; pigment black; papilla well developed.

26. *Meningodora mollis.* 1,106 to 1,632.
Eyes imperfectly developed, smaller than the diameter of the stalks, which are somewhat tapered distally; pigment black; papilla conspicuous; dorsal area absent.

27. **Hymenodora glacialis.** 2,369 to 2,949.
Eyes similar to those of 26, except that the pigment is brownish white.

28. **Hymenodora gracilis.** 826 to 2,949.
Eyes as in the last species, but the pigment apparently a little darker in color.

PASIPHAIDÆ.

29. *Pasiphaë princeps.* 444 to 1,342.
Eyes highly developed, black; no distinct papilla nor dorsal area.

30. **Parapasiphaë sulcatifrons.** 516 to 2,949.
Eyes somewhat similar to those of 27 and 28; cornea hemispherical, not larger than the non-expanded stalks; pigment brown; papilla very conspicuous, projecting by the margin of the cornea; dorsal area absent.

31. *Parapasiphaë cristata.* 826 to 1,628.
Eyes similar to those of the last species, but the cornea a little smaller and the papilla very much larger, broad at base and tapered to an obtuse tip, which reaches considerably beyond the whole cornea.

32. **Parapasiphaë compta.** 1,537 to 2,369.
Eyes similar to those of 30, but somewhat smaller, and the pigment black.

PENÆIDÆ.

33. **Hymenopenæus microps.** 906 to 2,620.
Eyes very much smaller than in any of the closely allied species, yet slightly larger than the diameter of the stalks, and hemispherical; pigment black; papilla well developed and situated near the middle of the stalk.

34. **Aristeus ? tridens.** 843 to 2,620.
Eyes rather small but well developed, larger than the diameter of the stalks and hemispherical; pigment black or brownish black; papilla well developed, broad and low, and on the middle of the stalk.

35. **Hepomadus tener.** 1,209 to 2,949.
Eyes as in the last species, except that the papilla is more prominent.

36. **Amalopenæus elegans.** 445 to 2,369.
Eye-stalks not expanded distally, with a spot of black pigment on the outer side a little way from the cornea, which is hemispherical and little larger than the diameter of the stalks; pigment brown; papilla very prominent, conical, directed upward and inward from the middle of the stalk.

37. *Benthœcetes Bartletti.* 578 to 1,081.
Eyes about as large and of the same color as in the last species; papilla very conspicuous, but low and obtuse; a mass of black pigment near the middle of the stalk, more distinctly visible from the ventral than from the dorsal side.

38. *Benthonectes filipes.* 693 to 1,043.
Eyes very large, swollen, reniform, extending far along the mesial side of the stalk; pigment dark brown, abundant; papilla prominent.

39. *Benthesicymus? carinatus.* 1,020.
Eyes apparently very nearly as in 37, but imperfect in the single known specimen.

40. *Benthesicymus? moratus.* 1,537 to 1,710.
Eyes nearly as in 38, except that the pigment is apparently white or very light in color.

SERGESTIDÆ.

41. **Sergestes arcticus.** 221 to 2,516.
Eyes highly developed, large; pigment black; apparently neither papilla nor dorsal area.

42. **Sergestes robustus.** 372 to 2,574.
Eyes similar to those of the last species, but even larger, the cornea being nearly hemispherical.

43. **Sergestes mollis.** 373 to 2,949.
Eyes small, little larger than the diameter of the stalks; pigment black, abundant.

The following species, though not yet recorded from below 1,000 fathoms, might properly enough be added to this list, as they undoubtedly all extend below the 1,000-fathom line:

44. *Sclerocrangon Agassizii.* 390 to 959.
Eyes small, no larger than the stalks, which are very little dilated distally; pigment black or nearly so.

45. *Sabinea princeps.* 353 to 888.
Eyes highly developed, large; pigment black.

46. *Nematocarcinus cursor.* 384 to 838.
Similar to 18, but somewhat larger, and with the papilla very distinct, though small.

47. *Acanthephyra eximea.* 938.
Eyes very nearly as in 19.

48. *Ephyrina Benedicti.* 959.
Eyes rather small, apparently not capable of great mobility, very little larger than the diameter of the stalks; pigment black; papilla distinct; dorsal area absent.

The first question which arises in discussing the bathymetrical habitats of the species in this list is, Which of them actually inhabited the bottom, or the region near the bottom, at the depths from which they are recorded, and what depths do the remaining species inhabit? That none of them are truly pelagic surface species may, I think, be taken for granted, for, with the single exception of *Acanthephyra Agassizii*, none of the free-swimming species have been taken anywhere near the surface. Species well known to be inhabitants of the surface are sometimes found in the trawl (and of course excluded from the list of species dredged), but are rarely so taken.

The first fifteen species in the list, and 44 and 45 as well, are unquestionably inhabitants of the bottom, and never swim any great distance from it. Nos. 16, 17, 18, and 46, though species which may swim freely for considerable distances from the bottom, undoubtedly rest upon it a part of the time, the structure of the peræopods being fitted, apparently, to do this.

The species of *Acanthephyra*, *Ephyrina*, *Notostomus*, *Meningodora*, and *Hymenodora*, which are very much alike in the structure of the articular appendages and branchiæ and are here grouped together as Miersiidæ, are among the most common and characteristic forms taken in trawling at great depths, but it is perhaps doubtful whether any of them are, strictly speaking, inhabitants of the bottom. The occurrence at the surface of a living and active specimen of *Acanthephyra Agassizii*, shows that this species at least is capable of living at the surface in water of a temperature of more than 30 degrees higher than that of the abyssal depths. Such facts make it very difficult to draw any conclusions from the mere finding of specimens of any free-swimming species in the trawl coming from particular depths, and we are compelled to resort to the structure of the animal itself for evidence as to the depth of its habitat. The highly developed black eyes, the comparatively small eggs, and the firm integument of *A. Agassizii* and *A. eximea* are some evidence, though perhaps inconclusive, that these species do not normally inhabit the greatest depths from which the former species has been recorded; and neither the length nor the structure of the peræopods shows special adaptation for resting on soft oozy bottoms. We are therefore led to conclude that these two species normally inhabit the upper part of the vast space between the surface and the bottom regions. The similarity in the structure of the peræopods in all the species of the genus except *A. gracilis*, apparently indicates similarity in habits, but the imperfectly developed eyes and soft integument of *A. microphthalma* and *brevirostris* are evidence that these species inhabit greater depths than *A. Agassizii* and *eximea*, and that they are truly abyssal if not bottom-inhabiting species, and their absence from the trawl when coming from moderate depths, as shown in the records of their capture, helps to confirm this. The small number and great size of the eggs of *A. gracilis* would seem to indicate an abyssal habitat for that species also, but the large black eyes are probable evidence that it does not descend to the extreme depths inhabited by *A. microphthalma*.

Their similarity of structure makes it probable that the species of *Ephyrina*, *Notostomus*, *Meningodora*, and *Hymenodora* are similar in habits to the species of *Acanthephyra*, and the structure of their eyes and integument and the small number and great size of the eggs, in the species in which they are known, as well as the records of their capture, indicate that they are all abyssal, or at least deep-water species.

The form of the body and the structure of the peræopods of *Pasiphaë princeps* indicate that, like the other species of the genus, it is a free-swimming species, probably never resting on the bottom. It is probably neither a truly abyssal, nor, judging from the size of the eggs as well as the record of its capture, a surface species. The structure of the eyes, the very small number and great size of the eggs, and the soft integument of the species of *Parapasiphaë* render it probable that they are really abyssal species, though probably not confined to the immediate region of the bottom.

The eight species of Penæidæ in the list are undoubtedly all free-swimming forms not confined to the immediate region of the bottom, but, judging from the relatively small size of the eyes and the presence of well-developed ocular papillæ, they are all deep-water if not abyssal species.

The records of the occurrence of the three species of *Sergestes* show that they are not confined to abyssal depths. The relatively small eyes and exceedingly soft integument of *S. mollis* would seem to indicate that it inhabited much greater depths than the other species, but the records of its capture afford no additional evidence of this.

We may then divide these species provisionally into the four following classes:

I.—*Species inhabiting the bottom or its immediate neighborhood.*

Geryon quinquedens.
Ethusina abyssicola.
Lithodes Agassizii.
Parapagurus pilosimanus.
Munidopsis curvirostra.
Munidopsis crassa.
Munidopsis similis.
Munidopsis Bairdii.
Munidopsis rostrata.
Pentacheles sculptus.
Pentacheles nanus.
Pentacheles debilis.
Sclerocrangon Agassizii.
Pontophilus abyssi.
Sabinea princeps.
Glyphocrangon sculptus.
Glyphocrangon longirostris.
Bythocaris gracilis.
Heterocarpus oryx.
Nematocarcinus ensiferus.
Nematocarcinus cursor.

II.—*Species probably not confined to the immediate neighborhood of the bottom, but showing structural evidences of inhabiting abyssal depths.*

Acanthephyra microphthalma.
Acanthephyra brevirostris.
Notostomus robustus.
Notostomus vescus.
Meningodora mollis.
Hymenodora glacialis.
Hymenodora gracilis.
Parapasiphaë sulcatifrons.
Parapasiphaë cristata.
Parapasiphaë compta.

III.—*Doubtful, but probably inhabiting abyssal depths.*

Acanthephyra gracilis.
Ephyrina Benedicti.
Hymenopenæus microps.
Aristeus? tridens.
Hepomadus tener.
Amalopenæus elegans.
Benthœcetes Bartletti.
Benthonectes filipes.
Benthesicymus? carinatus.
Benthesicymus? moratus.
Sergestes mollis.

IV.—*Species probably not inhabiting abyssal depths.*

Acanthephyra Agassizii.
Acanthephyra eximea.
Acanthephyra, sp.
Pasiphaë princeps.
Sergestes arcticus.
Sergestes robustus.

Summing up these lists according to the greatest depths from which the species are recorded we have the following:

Class.	Number of species.		
	Total.	Below 1,000 fathoms.	Below 2,000 fathoms.
I.—From the neighborhood of the bottom	21	18	5
II.—Abyssal, but not confined to the bottom	10	10	7
III.—Doubtful, but probably abyssal	11	10	6
IV.—Probably not abyssal	6	5	4
Total	48	43	22

The great differences in depth through which some of the species, unquestionably inhabiting the region of the bottom, are recorded as ranging is worthy of notice. Of the 18 inhabitants of the neighborhood of the bottom which are recorded as taken below 1,000 fathoms, 9 have a recorded range of over 800 fathoms, and one of them, *Parapagurus pilosimanus*, of nearly 2,000 fathoms. The case of the *Parapagurus* is very remarkable. It was taken at fifteen stations and in 250 to 640 fathoms by the Fish Hawk and Blake in 1880–'81–'82, and in great abundance at one station in 319 fathoms, where nearly four hundred large specimens were taken at once. All these earlier specimens were inhabiting carcinœcia of *Epizoanthus paguriphilus.* In the Albatross dredgings of 1883–'84–'85, it was taken at twenty-one stations, ranging in depth from 353 to 2,221 fathoms; but at fourteen of these stations, all of which were below 1,500 fathoms, none of the specimens were associated with the same species of *Epizoanthus*, some of them being in *Epizoanthus abyssorum*, others in naked gastropod shells, and still others in an actinian polyp, apparently the *Urticina consors* Verrill, which often serves for the carcinœcium of *Sympagurus pictus*, from 164 to 264 fathoms.

The color of the abyssal crustacea is very characteristic. A few species are apparently nearly colorless, but the great majority are some shade of red or orange, and I have seen no evidence of any other bright color. A few species from between 100 and 300 fathoms are conspicuously marked with scarlet or vermilion, but such bright markings were not noticed in any species from below 1,000 fathoms. Below this depth, orange red of varying intensity is apparently the most common color, although in several species, very notably in *Notostomus robustus*, the color is an exceedingly intense dark crimson.

The structure of the eyes of the abyssal Decapoda is of the highest interest, and worthy of the most minute and careful investigation and comparison with the corresponding structures of the shallow-water and surface forms. Such an investigation I have not been able thus far to make, but the importance of the subject induces me to record the results of a superficial examination of the external characters of the eyes of most of the abyssal species from the Albatross collections. These imperfect observations have been briefly given under each species in the list of species taken below 1,000 fathoms.

If we exclude from this list all the species whose bathymetrical habitats are in any degree doubtful, and examine the 21 species given as inhabiting the immediate neighborhood of the bottom, we find that *Geryon quinquedens*, *Lithodes Agassizii*, and *Sabinea princeps* have normal, well-developed large black eyes apparently entirely similar to those of allied shallow-water species. *Sclerocrangon Agassizii*, *Bythocaris gracilis*, *Heterocarpus oryx*, *Nematocarcinus ensiferus*, and *N. cursor* have normal black eyes apparently a little smaller than those of the allied shallow-water species. *Ethusina abyssicola* and *Parapagurus pilosimanus* have distinctly faceted black eyes, which, though very much smaller than in most shallow-water species, are still fully as large and apparently quite as perfect as in those of some shallow-water species in which they are evidently sensitive to ordinary changes of light. The eyes of the species of *Glyphocrangon* are very large, with the faceted surface much larger than the allied shallow-water species, but they are borne on very short stalks with comparatively little mobility, and have dark purple instead of black pigment. The eyes of *Pontophilus abyssi* are lighter in color than those of the species of *Glyphocrangon*, but are faceted and apparently have some of the normal visual elements. All the species of *Munidopsis* and of *Pentacheles* have peculiarly modified eyes from which the normal visual elements are apparently wanting. Of these 21 abyssal species, 7 are thus seen to have normal black eyes, 2 have abnormally small eyes, and 3 have large eyes with purplish or very light colored pigment, while 8 have eyes of perhaps doubtful function. If we confine this examination to the 5 species taken below 2,000 fathoms, we have 1 species with well-developed black eyes, 2 with abnormally small black eyes, 1 with light colored eyes, and 1 with eyes of doubtful function.

These facts and the comparison of the eyes and the color of the abyssal species with the blind and colorless cave-dwelling crustaceans certainly indicates some difference in the conditions as to light in caverns and in the abysses of the ocean, and make it appear probable, in spite of the objections of the physicists, that some kinds of luminous vibrations do penetrate to depths exceeding even 2,000 fathoms. The fact that, excluding shallow-water species, there is no very definite relation between the amount of the modification of the eyes and the depth which the species inhabit, many of the species with the most highly modified eyes being inhabitants of much less than 1,000 fathoms, might at first be thought antagonistic to this view. But when we consider how vastly greater the purity of the water must be in the deep ocean, far from land, than in the comparatively shallow waters near the borders of the continents, and how much more transparent the waters of the ocean abysses than the surface waters above, we can readily understand that there may usually be as much light at 2,000 fathoms in mid ocean as at 500 or even at 200, near a continental border. These considerations also explain how the eyes of specimens of species like *Parapagurus pilosimanus*, coming from 2,220 fathoms, are not perceptibly different from the eyes of specimens from 250 fathoms.

Although some abyssal species do have well-developed black eyes, there can be no question that there is a tendency toward very radical modification or obliteration of the normal visual organs in species inhabiting deep water. The simplest and most direct form of this tendency is shown in the gradual reduction in the number of the visual elements, resulting in the obsolescence and, in some cases, in final obliteration of the eye. The stages of such a process are well represented, even among the adults of living species. The abyssal species with black eyes, referred to in a previous paragraph, contains the first part of such a series, beginning with species like *Geryon quinquedens* and *Lithodes Agassizii* and ending with *Ethusina abyssicola*, in which there are only a very few visual elements at the tips of the immobile eye-stalks. A still later stage is represented by A. M.-Edwards's genus *Cymonomus*, in which the eye-stalks are immobile, spiny rods, tapering to obtuse points, without visual elements, or even (according to the description) a cornea. *Cymonomus* is not known to be an abyssal genus, neither of the species having been recorded from much below 700 fathoms, and is a good example of the fact already mentioned, that many of the species with the most highly modified eyes are inhabitants of comparatively shallow water. There are, however, several cases of very closely allied species inhabiting different depths, where the eyes of the deeper-water species are much the smaller, for example: *Sympagurus pictus*, 164 to 264, and *Parapagurus pilosimanus*, 250 to 2,221 fathoms; *Pontophilus gracilis*, 225 to 458, and *P. abyssi*, 1,917 to 2,221 fathoms; and *Nematocarcinus cursor*, 384 to 838, and *N. ensiferus*, 588 to 2,033 fathoms.

In a large number of deep-water and abyssal species the ocular pigment is deep purplish, brownish, reddish, light purplish, light reddish, or even nearly colorless, while the number of visual elements may be either very much less or very much greater than usual. The eyes of the species of *Glyphocrangon* and of *Benthonectes* are good examples of well-developed eyes of this class. In many cases the presence of light-colored pigment is accompanied with reduction in the number of visual elements precisely as in black eyes, *Parapasiphaë sulcatifrons*, *P. cristata*, *Acanthephyra microphthalma*, and the species of *Hymenodora* being good examples.

In other cases there are apparently radical modifications in the structural elements of the eye without manifest obsolescence. The large and highly developed but very short-stalked eyes of the species of *Glyphocrangon*, apparently specialized for use in deep water, probably represent one of the earlier stages of a transformation which results finally in the obliteration of the visual elements of the normal eye and the substitution of an essentially different sensory structure. In *Pontophilus abyssi* the transformation has gone further; the eyes, though fully as large as in the allied shallow-water species, are nearly colorless, not very distinctly faceted, and have probably begun to lose the normal visual elements over a portion of the surface. In the eyes of several of the species of *Munidopsis* the normal visual elements have entirely disappeared and there is an expanded transparent cornea backed by whitish pigment and some kind of nervous elements. I am very well aware that there is as yet no conclusive evidence that these colorless eyes in the species of *Munidopsis* are anything more than the functionless remnants of embryonic or inherited organs, but the fact that in some species they are as large as the normal eyes of allied shallow-water species is certainly a strong argument against this view.

In the species of *Pentacheles* there is better evidence that the eyes are not functionless, for, although they have retreated beneath the front of the carapax, they are still exposed above by the formation of a deep sinus in the margin, and the ocular lobe itself has thrown off a process which is exposed in a special sinus in the ventral margin. It is very easy to conceive how the eyes of *Pentacheles*, probably as highly modified as those of any deep-water species, may have been derived from eyes like those of the species of *Glyphocrangon* and *Pontophilus abyssi* through a stage like the eyes of *Calocaris*, which are practically sessile, have lost all the normal visual elements, and have only colorless pigment, but still present large flattened transparent non-faceted corneas at the anterior margin of the carapax. It is interesting to note that the highly modified eyes of *Pentacheles* are found in a well-defined group confined to deep water and of which all the species have probably been inhabitants of deep water for considerable geological periods, while the equally deep-water species with less modified or obsolescent eyes are much more closely allied to shallow-water species, from whose ancestors they may have been derived in comparatively recent times.

Many of the deep-water Caridea have a peculiar papilla-like process on the mesial or mesio-dorsal side of the eye-stalk, somewhere between the middle of the stalk and the cornea. This organ is very highly developed in many of the Miersiidæ and deep-water Penæidæ, appears to receive a branch of the optic nerve, is apparently sensory in its function, and has sometimes been referred to as a phosphorescent organ. A somewhat similar, though very small, papilla is present in some shallow-water Caridea and Schizopoda, but, having no knowledge whatever of its function, I have simply described it, in the list of abyssal species already given, as the "papilla."

The large size and small number of the eggs is a very marked characteristic of many deep-water Decapoda. The eggs are extraordinarily large in several species of *Munidopsis*, *Glyphocrangon*, and *Bythocaris*, and in *Elasmonotus inermis*, *Sabinea princeps*, *Acanthephyra gracilis*, and *Pasiphaë princeps*. But the largest crustacean egg which I have seen is that of the little shrimp *Parapasiphaë sulcatifrons*, which carries only fifteen to twenty eggs, each of which is more than 4 millimeters in diameter, and approximately equal to a hundredth of the bulk of the animal producing it—a case in which the egg is relatively nearly as large as in many birds! My suggestion (Amer. Jour. Sci., II, xxviii, p. 56, 1884) that the great size of the eggs in the deep-water Decapoda was probably accompanied by an abbreviated metamorphosis within the egg, thus producing young of large size and in an advanced stage of development, specially fitting them to live under conditions similar to those environing the adults, has already been proved true by Prof. G. O. Sars, in the case of *Bythocaris leucopis*, in which the young are in a stage essentially like the adult before leaving the egg.

Although the great size of the eggs is highly characteristic of many deep-water species, it is by no means characteristic of all, and, as the following table of measurements shows, the size of the eggs has no definite relation to the bathymetrical habitat, and is often very different in closely allied species, even where both are inhabitants of deep water. For example, the eggs of *Acanthephyra gracilis* are very large, while those of *A. brevirostris* and *Agassizii* are normally small, and those of *Pontophilus abyssi* are fully as small as in the comparatively shallow-water species of the genus, and much smaller than those of many shallow-water Crangonidæ.

For the purpose of comparing the size of the eggs of the deep-water and shallow-water species, I have measured a considerable number of Decapod eggs, and in several cases have estimated approximately the number of eggs carried by an individual. The results are given in the following table, in which the bathymetrical habitat is given approximately in even hundreds of fathoms, habitats of less than 100 fathoms being indicated by —100; the diameter is the approximate average of the longer and shorter diameters, usually of several eggs from two or three individuals; and the number of eggs is the estimate for a single individual of medium or large size, or the extremes of variation in two or more individuals. The measurements given have all been made from alcoholic specimens, and in some cases, where the eggs were not very well preserved, may not agree perfectly with measurements of fresh eggs, though all the measurements are probably within the range of variation for the species. Measurements of fresh eggs of *Homarus Americanus* and *Palæmonetes vulgaris*, and of the same eggs after preservation in alcohol, show no marked shrinkage in the diameter of the chorion, and this probably holds good for other Decapod eggs when well preserved. In many cases the form of the egg, and possibly the size also, changes slightly during the development of the embryo, there being a tendency for the egg to elongate as development proceeds. For this reason, as well as for greater ease of comparison, the average of the longer and shorter diameters is given.

Diameter and number of Decapod eggs.

Species and bathymetrical habitat.	Fathoms.	Diameter.	Number.
BRACHYURA.			
MAIOIDEA.			
		Millim.	
Hyas araneus	—100	0.67	
Hyas coarctatus	—100 to 200	0.60	
Lispognathus Thomsoni	200 to 300	0.7	
Collodes depressus	—100	0.48	
Collodes robustus	—100 to 400	0.80	
Euprognatha rastellifera	—100 to 200	0.65	
Metoporhapis calcaratus	—100	0.57	
Leptopodia sagittaria	—100	0.50	
Podochela Riisei	—100	0.57	
CANCROIDEA.			
Callinectes hastatus	—100	0.28	4,500,000
Neptunus Sayi	—100	0.33	
Achelous anceps	—100	0.26	
Geryon quinquedens	—100 to 1,100	0.74	47,000
OCYPODOIDEA.			
Nautilograpsus minutus	—100	0.35	
Pinnixa chætopterana	—100	0.26	
ANOMURA.			
LATREILLIOIDEA.			
Latreillia elegans	—100 to 200	0.45	1,660
HOMOLOIDEA.			
Homola barbata	—100 to 400	0.36	
LITHODOIDEA.			
Lithodes Agassizii	400 to 1,300	2.6	
PAGUROIDEA.			
Eupagurus bernhardus	—100	0.57	
Eupagurus politus	—100 to 600	1.12	2,000
Eupagurus pubescens	—100 to 600	0.70	
Eupagurus Kröyeri	—100	0.90	
Catapagurus Sharreri	—100 to 300	0.65	
Catapagurus gracilis	—100 to 200	0.52	
Parapagurus pilosimanus	300 to 2,200	1.2	

Diameter and number of Decapod eggs—Continued.

Species and bathymetrical habitat.	Fathoms.	Diameter.	Number.
ANOMURA—Continued.			
GALATHEOIDEA.			
		Millim.	
Munida Caribæa? Smith	—100 to 300	0.47	
Munidopsis curvirostra	—100 to 1,300	1.6	14 to 52
Munidopsis Bairdii	1,500 to 1,800	3.1	
Munidopsis crassa	1,700 to 2,600	3.5	
Munidopsis similis	1,060	2.8	22
Munidopsis rostrata	1,100 to 1,400	3.7	304
Anoplonotus politus	—100 to 200	1.1	25
MACRURA.			
ERYONTIDÆ.			
Pentacheles sculptus	300 to 1,100	0.75	
Pentacheles nanus	700 to 1,900	0.77	1,250 to 1,500
HOMARIDÆ.			
Homarus Americanus	—100	1.9	12,000 to 20,000
CRANGONIDÆ.			
Crangon vulgaris	—100	0.47	
Sclerocrangon Agassizii	400 to 1,000	2.5	
Sclerocrangon boreas	—100	2.1	
Pontophilus brevirostris	—100 to 200	0.70	
Pontophilus Norvegicus	—100 to 600	1.1	
Pontophilus abyssi	1,900 to 2,200	0.7	
Nectocrangon lar	—100	1.6	
Sabinea septemcarinata	—100	1.4	
Sabinea Sarsii	—100 to 200	1.3	
Sabinea princeps	300 to 900	2.8	353
GLYPHOCRANGONIDÆ.			
Glyphocrangon sculptus	1,000 to 1,400	3.0	97
Glyphocrangon longirostris	800 to 1,100	3.0	86
ALPHEIDÆ.			
Hippolyte spinus	—100	0.90	....
Hippolyte Gaimardii	—100	0.95	....
Hippolyte polaris	—100 to 300	1.6	....
Bythocaris gracilis	900 to 1,100	1.6	....
Bythocaris nana	—100 to 200	0.9	....
Latreutes ensiferus	—100	0.42	....
Virbius zostericola	—100	0.40	....
Pandalus propinquus	200 to 600	1.0	....
Pandalus borealis	—100 to 200	1.2	....
Pandalus leptocerus	—100 to 300	0.7	....
PALÆMONIDÆ.			
Palæmon forceps	—100	0.60	7,000
Leander tenuicornis	—100	0.60	....
Palæmonetes vulgaris	—100	0.70	360
NEMATOCARCINIDÆ.			
Nematocarcinus ensiferus	600 to 2,000	0.68	16,000 to 21,000
Nematocarcinus cursor	400 to 800	0.64	20,000
MIERSIIDÆ.			
Acanthephyra Agassizii	—100 to 3,000	0.85	5,000
Acanthephyra brevirostris	1,400 to 3,000	0.70	....
Acanthephyra gracilis	1,600 to 2,500	2.5	21
Hymenodora gracilis	800 to 3,000	2.6	....
PASIPHAIDÆ.			
Pasiphaë tarda	—100 to 200	2.0	94
Pasiphaë princeps	400 to 1,400	3.5	....
Parapasiphaë sulcatifrons	500 to 3,000	4.2	15 to 19

BRACHYURA.

MAIOIDEA.

LEPTOPODIA SAGITTARIA Leach.

Station 2280, October 19, off Cape Hatteras, north lat. 35° 21′, west long. 75° 21′ 30″, 16 fathoms, gray sand; 2 ♂, 1 ♀ (8841).

METOPORHAPIS CALCARATUS Stimpson.

Leptopodia calcarata Say, Jour. Acad. Nat. Sci. Phila., i, p. 455, 1818.

Metoporhapis calcarata Stimpson, Ann. Lyceum Nat. Hist. New York, vii, p. 198 (70), 1860.

Metoporhapis forficulatus A. M.-Edwards, Crust. Région Mexicaine, p. 174, pl. 31, figs. 3-3*e*, 1878.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth and nature of bottom.		Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″			1884.	♂	♀	
7269	2285	35 21 25	75 24 25	13	crs. gy. S.	Oct. 19	1	1	1
8845	2286	35 21 30	75 25 00	11	crs. gy. S.	Oct. 19	..	1	1
7270	2296	35 35 20	74 58 45	27	crs. gy. S.	Oct. 20	3	3	3

PODOCHELA RIISEI Stimpson.

Podochela Riisei Stimpson, Ann. Lyceum Nat. Hist. New York, vii, p. 196 (68), pl. 2, fig. 6, 1860. A. M.-Edwards, Crust. Région Mexicaine, p. 193, pl. 34, figs. 1–1*a*, 1879.

Podonema Riisei Stimpson, Bull. Mus. Com. Zool., ii, p. 126, 1870.

Coryrhynchus Riisei Kingsley, Proc. Acad. Nat. Sci. Phila., 1879, p. 384, 1880.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth and nature of bottom.		Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″			1884.	♂	♀	
8777	2275	35 20 40	75 18 40	16	gy. S.	Oct. 19	..	1y	......
8773	2277	35 20 50	75 19 50	16	gy. S.	Oct. 19	..	1y	0
8792	2285	35 21 25	75 24 25	13	crs. gy. S.	Oct. 19	1	1	1
7268	2285	35 21 25	75 24 25	13	crs. gy. S.	Oct. 19	1	..	
8814	2296	35 35 20	74 58 45	27	crs. gy. S.	Oct. 20	1	1	1
8799	2297	35 38 00	74 53 00	49	bk. M. brk. Sh.	Oct. 20	1	..	
7253	2297	35 38 00	74 53 00	49	bk. M. brk. Sh.	Oct. 20	1	..	

Collodes depressus A. M.-Edwards.

Crust. Région Mexicaine, p. 176, pl. 32, figs 4-4 *e*, 1878. Smith, Proc. National Mus., vi, pp. 5, 8, 1883.

Station 2296, off Cape Hatteras, October 20, north lat. 35° 35′ 20″, west long. 74° 58′ 45″, 27 fathoms, coarse gray sand; three females, two of which were carrying eggs (7248).

Collodes robustus Smith.

Specimens examined.

[Locality: Off Chesapeake Bay.]

Catalogue number.	Station number.	Locality. N. lat.	Locality. W. long.	Depth, temperature, and nature of bottom. Fathoms.	°	Materials.	Date.	Specimens. Number. ♂	♀	With eggs.
		° ′ ″	° ′ ″				1884.			
7211	2265	37 07 40	74 35 40	70	63	gn. M. G.	Oct. 18	6	1	0

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	N. lat.	W. long.	Fathoms.	°	Materials.	Date.	Number. ♂	♀	With eggs.
8901	2297	35 38 00	74 53 00	49	....	bk.M.brk.Sh.	Oct. 20	1		......
7261	2297	35 38 00	74 53 00	49	....	bk.M.brk.Sh.	Oct. 20		1	0

Euprognatha rastellifera Stimpson.

Specimens examined.

[Locality: Off Chesapeake Bay.]

Catalogue number.	Station number.	Locality. N. lat.	Locality. W. long.	Depth, temperature, and nature of bottom. Fathoms.	°	Materials.	Date.	Specimens. Number. ♂	♀	With eggs.
		° ′ ″	° ′ ″				1884.			
8741	2264	37 07 50	74 34 20	167	58	gy. S	Oct. 18	4	2	+
8906	2265	37 07 40	74 35 40	70	63	gn. M. G.	Oct. 18	42	61	+
8775	2265	37 07 40	74 35 40	70	63	gn. M. G.	Oct. 18	23	31	+

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	N. lat.	W. long.	Fathoms.	°	Materials.	Date.	Number. ♂	♀	With eggs.
8748	2269	35 12 30	75 05 00	48	76	gy. M.	Oct. 19	3		......
8864	2308	35 43 00	74 53 30	45	....	gy. S.	Oct. 21		1	......

LISPOGNATHUS THOMSONI A. M.-Edwards.

Dorynchus Thomsoni Norman, in Thomson, Depths of the Sea, p. 174 (cut), 1873.

Lispognathus Thomsoni A. M.-Edwards, Rapport sur la Faune sous-marine dans les grandes profondeurs de la Méditerranée et de l'Océan Atlantique (Arch. Missions Sci. et Littéraires, ix), pp. 16, 39, 1882; Recueil de figures de Crustacés nouveaux ou peu connus, pl. [3], 1883.

Lispognathus furcatus Smith, Proc. National Mus., vi, p. 12, 1883.

(Plate I, Figs. 1, 1*a*.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1881.	♂ ♀	
......	951	39 57 00	70 31 30	225	....	M.	Aug. 23	1	
......	1096	39 53 00	69 47 00	317	....	sft. gn. M.	1882. Aug. 11	1	1
7190	2262	39 54 45	69 29 45	250	42	M. S.	1883. Sept. 28	1	1

The specimens taken in 1881 and 1882 were referred very doubtfully to A. M.-Edwards's *L. furcillatus** before I had seen the figure in his great work on the crustacea of the Mexican region. A comparison with Milne-Edwards's figure (which is that of a female, and not of a male as stated in the explanation of the plate) appears to indicate that our specimens are specifically distinct, but a comparison of them with four females of *L. Thomsoni*, from the Bay of Biscay, received from the Rev. Dr. Norman, shows that they are very closely allied to that species, and probably only a robust variety of it. Our specimens are all considerably larger than any of those from the Bay of Biscay, and have the carapax broader and its spines larger and stouter. These differences are so slight, however, that I think a large series of specimens from the two sides of the Atlantic would show all intermediate forms. On account of the differences exhibited, I give the following full description of the three specimens enumerated above:

The carapax, excluding the rostral and lateral spines, is about four-fifths as broad as long in the male, and slightly broader and much thicker and more swollen in the female. The rostral horns are acicular, very slightly divergent, and slightly ascending, and in the male nearly three-

*In Bull. Mus. Comp. Zool., vii, p. 9, 1880, the species is described as new under the name *furcatus*, but in the Crust. Région Mexicaine, p, 349, pl. 31 *A*, fig. 4, 1880, the same specimen, apparently, is described under the name *furcillatus*, which is also used in the Rapport sur la Faune sous-marine dans les grandes profondeurs de la Méditerranée et de l'Océan Atlantique, pp. 16, 39, 1882. The first two of these works bear the same date, and, although the Cambridge Bulletin probably appeared first, it seems best to use the name *furcillatus*, apparently adopted by Milne-Edwards himself, and the one used in connection with the first-published figure.

tenths as long as the rest of the carapax. The three erect gastric and the postorbital spines are subequal and very slender and acute, and the postorbital spine each side is situated slightly in front of a line from the middle to the lateral gastric in the females, but slightly in front of it in the male. The cardiac spine is considerably stouter and a little higher than the gastric spines, and either side of it on the dorsal part of the branchial region there is a much smaller erect spine, and on a line between this and the lateral gastric there is a similar spine in the females, but only a minute spine or tubercle in the male. There are two or three minute spines or tubercles on the protuberant superior lobe of the hepatic region, and about as many more back of these on the side of the branchial region, while on the inferior hepatic lobe, opposite the middle of the buccal area, there is a much larger spine directed downward, and back of this a smaller one, near the base of the cheliped. The supraorbital spine is slender and about as long as the gastric spines, and in the male the interantennular is fully as long, stouter, and directed downward and curved slightly forward. The basal segment of the antenna is irregularly armed beneath with small spines or teeth, and in the male with a slender spine at the distal end. The eye-stalk is armed with a minute spine or tubercle in front, and above with a small tubercle at the emargination of the cornea. The exposed surface of the ischium and merus of the external maxillipeds is armed conspicuously with marginal and submarginal spines, of which one on the inner edge of the merus is very long.

The chelipeds in the male are stout and nearly twice as long as the carapax, including the rostral horns; the merus is a little shorter than the chela and triquetral, with all three of the angles thickly armed with very long and slender spines; the carpus is rounded externally, but armed like the merus; the chela is longer than the carapax, excluding the rostral horns, and naked and unarmed except by a few spines along the proximal part of the dorsal edge; the body is stout and swollen, and the digits slightly shorter than the body, nearly straight vertically but strongly curved laterally, very much compressed, grooved longitudinally on the sides and on the rather broad dorsal edge of the dactylus, and the prehensile edges crenately serrate and in contact throughout when closed. In the female the chelipeds are only about once and a half as long as the carapax, including the rostral spines, much more slender than in the male, and armed with proportionally longer spines; the chela is much shorter than the carapax, excluding the rostral horns; the body is scarcely at all swollen, and is armed with slender spines along both edges and with minute spines or tubercles on the sides, and the digits are proportionally longer and narrower than in the male.

The ambulatory legs are very long and slender, clothed to the tips of the dactyli with numerous curved setiform hairs which persistently retain mud and other foreign substances, and each is armed with a slender spine on the upper side of the distal end of the merus.

In the male the abdomen is much broader relatively to the sternum than in *Euprognatha rastellifera*, and has a low tuberculiform elevation on each somite. The first and second somites are narrow, the third broadest of all, the fourth and fifth successively a very little narrower, the fifth fully twice as broad as long, and the sixth and seventh consolidated as in *Euprognatha* and *Collodes*, together much broader than long and very broad and obtuse at the tip. The appendages of the first somite reach nearly to the tip of the abdomen, and their tips are stout and curved outward very strongly.

The eggs are numerous, nearly spherical, and approximately 0.7^{mm} in diameter in alcoholic specimens.

These specimens and three others from the Bay of Biscay give the following:

Measurements in millimeters and hundredths of length of carapax.

Station.	951.	1,096.	2,262.	Bay of Biscay.		
Sex	♂	♀	♀	♀	♀	♀
Length of carapax, including rostral spines	12.0	12+	......	8.2	7.2	7.1
Length of carapax, excluding rostral spines	9.3	10.8	10.5	7.0	6.2	6.3
Breadth of carapax, including spines	7.6	9.6	9.4	5.8	5.2	5.2
Breadth of carapax, excluding spines	7.6	9.3	9.3	5.7	5.1	5.1
Same in hundredths of the length, excluding rostral spines	82	86	98	81	82	81
Breadth of front between orbits	2.0	2.1	2.0	1.6	1.4	1.4
Length of cheliped	23.0	19.0	20.0	13.0		
Length of chela	10.0	8.0	8.5	5.4		
Breadth of chela, excluding spines	3.1	2.1	2.0	1.3		
Length of dactylus	4.6	4.0	4.5	2.6		
Length of first ambulatory peræopod	41.0	38.0	......	27.0		
Length of propodus	13.5	12.0	......	9.0		
Length of dactylus	8.6	8.0	......	6.0		
Length of second ambulatory peræopod	37.0	34.0	36.0	24.0		
Length of propodus	10.8	9.9	10.7	7.1		
Length of dactylus	7.0	6.8	7.3	5.3		
Length of fourth ambulatory peræopod	31.0	30.0	31.0	20.0		
Length of propodus	9.0	8.0	8.8	6.0		
Length of dactylus	5.5	6.0	6.1	4.2		

ANAMATHIA AGASSIZII Smith.

Amathia Agassizii Smith, Bull. Mus. Comp. Zool., x, p. 1, pl. 2, figs. 2, 3, 1882; Proc. Nat. Mus., vi, p. 3, 1883; Report U. S. Fish Com., x, for 1882, p. 346, 1884.

Anamathia Agassizii Smith, Proc. National Mus., vii, p. 497, 1885.

(Plate I, Figs. 2, 3, 3*a*.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8042	2183	39 57 45	70 56 30	195	44	gn. M. S.	Aug. 2	1 ..	......
8043	2200	39 53 30	69 43 20	148	45	crs. S.	Aug. 6	1 ..	......

Measurements in millimeters.

Catalogue number	8043
Station	2200
Sex	♂
Length of carapax, including rostral and posterior spines	70
Length of carapax, excluding rostral and posterior spines	57
Length of rostral horns or spines	13
Breadth of carapax, including lateral spines	48
Breadth of carapax, excluding lateral spines	45
Length of branchial spines	4
Length of cheliped	109
Length of chela	51
Breadth of chela	6.5
Length of dactylus	18
Length of first ambulatory peræopod	180
Length of dactylus	29
Length of second ambulatory peræopod	144
Length of dactylus	27
Length of fourth ambulatory peræopod	114
Length of dactylus	24

Prof. G. O. Sars, in his great work on the Crustacea of the Norwegian North-Atlantic Expedition, states that this species is evidently congeneric with *Scyramathia Carpenteri* A. M.-Edwards, and his excellent figures and description of that species incline me not only to adopt the same view, but to include, with *A. Agassizii*, all the other American species, and, moreover, to be somewhat doubtful of the validity of the genus *Scyramathia*, notwithstanding that Professor Sars regards it as widely separated from *Anamathia*. In regard to the systematic position of *Scyramathia*, Professor Sars says: "It should certainly, from the structure of the orbita and other characters, be classed under the family Maiidæ, within the limits at present usually assigned to that family, hence comparatively remote alike from the genus *Amathia* and from the genus *Scyra*, the first of which belongs to the family Periceridæ, according to the revision of the Oxyrhyncha lately published by E. Miers. Again, among the Maiidæ it unquestionably belongs to the sub-family Maiinæ, and would seem to approximate closest to the genus *Hyastenus* White, chiefly represented in the northern part of the Pacific Ocean."

When proposing the genus *Scyramathia*, A. Milne-Edwards (Comp. rend. Acad. Sci. Paris, xci, p. 356, 1881) gives no characters whatever by which it may be distinguished from *Anamathia*, but from the fact that he places in it *Scyra umbonata* Stimpson, it is very readily inferred that he regarded the peculiar truncated tubercles with which the carapax is armed in both species as the principal generic character. That he did not base the separation on the character of the orbits is evident from the fact that he has retained in the genus *Amathia* several species (one of which is very likely specifically identical with *A. Agassizii*) in which the structure of the orbits is similar to that in *Scyramathia Carpenteri*. Unfortunately I have seen no specimens of the Mediterranean *A. Rissoana*, the type of the genus *Anamathia*, but judging by the figures given by Roux, and more particularly those in the third edition of Le Règne Animal de Cuvier, it is very closely allied to the American species referred to the genus, and the structure of the orbits appears to be not unlike that in *Scyramathia Carpenteri*, except that no supraorbital or preorbital spines or processes are shown in the figures, and their absence is confirmed by Miers's diagnosis of the genus. The preorbital spines, though prominent in *A. Agassizii*, *crassa*, *Tanneri*, and *hystrix*, are small and inconspicuous in *Scyramathia Carpenteri*, their absence would apparently change the character of the orbits very little, and, as Miers has said in another place, is "a character which by itself cannot be considered of generic importance." It is still quite possible that *A. Rissoana* is different enough to be separated from the American species, in which case they should all, apparently, be referred to *Scyramathia*, which, as Professor Sars remarks, belongs most properly to the Maiidæ. Miers, however, evidently saw the resemblance between *A. Rissoana* and the Maiidæ, for he says that the genus *Halimus*, which he places next to *Amathia*, "establishes a transition to the *Maiidæ*." Until *A. Rissoana* is carefully compared with the other species, it seems best to retain them all in the genus *Anamathia*.

Though Professor Sars is "greatly disposed to regard the two forms as identical," I think there can be very little doubt that Stimpson's *Scyra umbonata* is at least specifically distinct from *Anamathia Carpenteri*. Stimpson says of his species that "the rostrum is rather longer than the interorbital width of the carapax," while in *A. Carpenteri* the rostrum is more than twice as long as the interorbital width of the carapax. Moreover, Stimpson compares his species with *Scyra acutifrons* Dana, which has a broad lamellar rostrum, divided only at the tip, and very unlike the long and spreading rostral horns of the species of *Anamathia*, and he nowhere alludes to rostral horns, as he does under his *Amathia modesta*, or even mentions that the rostrum is divided at all. It is, perhaps, useless to speculate upon the affinities of Stimpson's species until it is rediscovered, but I am confident that it will be found to have a rostrum very different from that of *Anamathia Carpenteri*.

ANAMATHIA TANNERI Smith.

Amathia Tanneri Smith, Proc. National Mus., vi, p. 4, 1883.
Anamathia Tanneri Smith, Proc. National Mus., vii, p. 493, 1885.

(Plate I, Fig. 4.)

I have seen only the type specimens taken by the Fish Hawk in 1881. The figure is from the larger of these specimens.

HYAS COARCTATUS Leach.

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
7168	2253	40 34 30	69 50 45	32	53	gy. S.	Sept. 27	3s. 1s.	0
8733	2253	40 34 30	69 50 45	32	53	gy. S.	Sept. 27	1s. ..	......
8660	2255	40 46 30	69 50 15	18	56	gy. S.	Sept. 27	1 ..	.....
7169	2256	40 38 30	69 29 00	30	53	yl. S.	Sept. 28	2 3	1
8657	2257	40 32 30	69 29 00	33	52	yl. S.	Sept. 28	1 1	1
8860	2308	35 43 00	74 53 30	45	....	gy. S.	Oct. 21	.. 1	1

Station 2308, off Cape Hatteras, is the farthest south that this species has been observed.

LIBINIA EMARGINATA Leach.

Libinia emarginata Leach, Zoological Miscellany, ii, p. 130, pl. 108, 1815.
Libinia canaliculata Say, Jour. Acad. Nat. Sci. Phila., i, 77, pl. 4, fig. 1, 1817.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8743	2268	35 10 40	75 06 10	68	77	gy. M.	Oct. 19	.. 1*y*.	0
7238	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19	.. 1*y*.	0
8877	2286	35 21 30	75 25 00	11	....	crs. gy. S.	Oct. 19	2 ..	......
7247	2296	35 35 20	74 58 45	27	....	crs. gy. S	Oct. 20	.. 1*y*.	0
8862	2298	35 39 00	74 52 00	80	....	bk. M. brk. Sh.	Oct. 20	.. 7*y*.	0

NIBILIA ERINACEA A. M.-Edwards.

Crust. Région Mexicaine, p. 133, pl. 25, 1878.

Station 2301, October 21, off Cape Hatteras, north lat. 35° 11′ 30″, west long. 75° 05′, 59 fathoms, coarse sand, temperature 75°; two specimens (7256), which give the following:

Measurements in millimeters.

Sex	♂	♀
Length of carapax, including rostral and posterior spines	39.0	48.0
Length of carapax, excluding rostral and posterior spines	29.3	40.0
Length of rostral spines or horns	9.2	7.7
Breadth of carapax, including lateral spines	21.3	31.0
Breadth of carapax, excluding lateral spines	18.4	27.4
Length of cheliped	32.0	45.0
Length of chela	13.5	19.8
Breadth of chela	2.4	3.3
Length of dactylus	5.0	7.6
Length of first ambulatory peræopod	45.0	60.0
Length of dactylus	8.7	11.3
Length of fourth ambulatory peræopod	33.0	40.6
Length of dactylus	7.2	10.2

Both specimens are small and the female apparently immature. In the female the spines of the carapax are shorter and more obtuse than in the male, and the rostral horns shorter and less divergent.

PERICERA, species.

Station 2268, October 19, off Cape Hatteras, north lat. 35° 10′ 40″, west long. 75° 06′ 10″, 68 fathoms, temperature 77°, gray mud; a single young specimen, with the carapax, excluding the rostrum, scarcely 10^{mm} in length. It resembles the *P. spinosissima* Saussure, but the carapax is armed with fewer and smaller spines, LAMBRUS VERRILLII Smith.

Proc. National Mus., iii, p. 415, 1881; vi, p. 14, 1883.

(Plate II, Fig. 2.)

Specimens examined.

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Material.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8655	2244	40 05 15	70 23 00	67	53	gn. M. S.	Sept. 26	1 1 *y.*	......

[Locality: Off Cape Hatteras.]

7217	2268	35 10 40	75 06 10	68	77	gy. M.	Oct. 19	2 *s.* ..	......
7218	2268	35 10 40	75 06 10	68	77	gy. M.	Oct. 19	1 *s.* ..	......
7255	2301	35 10 30	75 05 00	59	73	crs. S.	Oct. 21	1 *l.* ..	......

Measurements in millimeters.

Catalogue number	8655	7217	7218	8655	7217	7255
Station	2244	2268	2268	2244	2268	2301
Sex	Young.	♂	♂	♂	♂	♂
Length of carapax	9.6	12.7	13.7	14.6	15.7	28.4
Breadth, including lateral spines	10.4	14.3	16.4	17.6	18.9	35.0
Breadth, excluding lateral spines	9.7	13.0	15.0	15.8	16.5	30.8
Length of cheliped	21.0	29.0	35.0	36.0	38.0	88.0
Length of merus	7.3	11.0	12.5	13.5	14.0	34.0
Length of propodus	10.0	13.5	16.0	16.5	17.5	41.0

Some of these specimens vary considerably from those originally described. The small male, 7218, is armed with fewer and much less conspicuous tubercles and teeth, all the spiniform elevations of the dorsal surface of the carapax being reduced to low and inconspicuous tubercles, the teeth of the anterior part of the antero-lateral margin are nearly obsolete, and the marginal teeth of the chelipeds are much shorter and some of them, especially on the outer edge of the chela, are obsolete. On the other hand, in the two small males, 7217, and the large male, 7255, the tubercles of the dorsal surface of the carapax and many of those of the chelipeds are much more prominent than in the specimens originally described, the rostrum is more abruptly constricted and the terminal portion narrower, longer, spiniform, and armed with lateral tubercles.

These variations incline me to the belief that this species is really the *L. Pourtalesii* of Stimpson and that A. Milne-Edwards's figure of that species is either incorrect or based on some other species.

LAMBRUS AGONUS Stimpson.

Bull. Mus. Comp. Zool., ii, p. 131, 1870. A. M.-Edwards, Crust. Région Mexicaine, p. 151, pl. 28, figs. 3–3*b*, 1878.

Station 2296, October 20, off Cape Hatteras, north lat. 35° 35′ 20″, west long. 74° 58′ 45″, 27 fathoms, coarse gray sand; one male (7250).

PLATYLAMBRUS SERRATUS A. M.-Edwards.

Lambrus serratus M.-Edwards, Hist. Nat. Crust., i, p. 357, 1834 (teste A. M.-Edwards).

Lambrus crenulatus Saussure, Crust. Mexique et des Antilles, p. 13, pl. 1, fig 4, 1858. Stimpson, Ann. Lyceum Nat. Hist. New York, vii, p. 201 (73), 1860; Bull. Mus. Comp. Zool., ii, p. 129, 1870 (*Platylambrus* is suggested as an appropriate name for a group, to which this species and *L. laciniatus* De Haan belong, if future studies prove it to be distinct from the triangular *Lambri*, but the new name is not adopted).

Platylambrus serratus A. M.-Edwards, Crust. Région Mexicaine, p. 156, pl. 30, 1–1*c*, 1878.

With the last species at station 2296; one male and one small female (7249).

CANCROIDEA.

CANCER BOREALIS Stimpson.

Specimens examined.

Catalogue number.	Station number.	Locality. N. lat.	Locality. W. long.	Depth, temperature, and nature of bottom. Fathoms.	°	Material.	Date.	Specimens. Number. ♂	♀	With eggs.
[Locality: Off Chesapeake Bay.]										
		° ′ ″	° ′ ″				1884.			
8938	2170	37 57 00	73 53 30	155	....	gy. S.	July 20.	8	8	0
[Locality: Off Long Island.]										
8005	2177	39 33 40	72 08 45	87	52	gn. M. S.	July 22	..	2 *s.*	0
[Locality: Off Martha's Vineyard.]										
8038	2185	40 00 45	70 54 15	129	51	gn. M. S.	Aug. 2	2 *s.*		......
8039	2197	39 56 30	69 43 20	84	52	S. brk. Sh.	Aug. 6	3 *s.*		......
8040	2199	39 57 30	69 41 10	78	....	gy. S.	Aug. 6	2 *s.*	4 *s.*	0
8662	2239	40 38 00	·70 29 45	32	....	gn. M.	Aug. 26	1 *s.*		......
8656	2240	40 27 30	70 29 00	44	....	gn. M.	Sept. 26	2 *s.*		......
8648	2240	40 27 30	70 29 00	44	....	gn. M.	Sept. 26		1	0
8645	2241	40 21 00	70 29 15	50	51	gn. M.	Sept. 26	1	2	0
8654	2241	40 21 00	70 29 15	50	51	gn. M.	Sept. 26	2 *s.*	2 *s.*	0
8658	2242	40 15 30	70 27 00	58	51	gn. M.	Sept. 26	1		......
8644	2243	40 10 15	70 26 00	63	52	gn. M.	Sept. 26	4	2 *s.*	0
8647	2244	40 05 15	70 23 00	67	53	gn. M. S.	Sept. 26	3 *s.*	3	0
8652	2245	40 01 15	70 22 00	98	51	gn. M. bk. S.	Sept. 26	1		......
8643	2247	40 03 00	69 57 00	78	52	gn. M. S.	Sept. 27		3 *l.*	0
8649	2248	40 07 00	69 57 00	67	52		Sept. 27		1 *l.*	0
8650	2249	40 11 00	69 52 00	53	51		Sept. 27	1 *l.*		......
8053	2250	40 17 15	69 51 45	47	51		Sept. 27	6 *s.*	8 *s.*	......
8659	2253	40 34 30	69 50 45	32	53	gy. S.	Sept. 27		1 *y.*	0
8063	2259	40 19 30	69 29 10	41	50	gy. S.	Sept. 28	1 *s.*		......
8651	2260	40 13 15	69 29 15	46	50	gy. S.	Sept. 28	8	3	0
8646	2261	40 04 00	69 29 30	58	54	gy. S.	Sept. 28	12 *s.*	3 *s.*	0
[Locality: Off Chesapeake Bay.]										
8757	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	13	12	0
8749	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	5	4	0
8767	2265	37 07 40	74 35 40	70	63	gn. M. G.	Oct. 18	5	9	0
[Locality: Off Cape Hatteras.]										
8897	2297	35 38 00	74 53 09	49	....	M. brk. Sh.	Oct. 20	1	[30] 3	0
8797	2297	35 38 00	74 53 00	49	....	M. brk. Sh.	Oct. 20	5 *y.*		0
8801	2298	35 39 00	74 52 00	80	....	M. brk. Sh.	Oct. 20	4	2	0
8909	2299	35 40 00	74 51 30	296	....	brk. M.	Oct. 20	4	3	0
8900	2307	35 42 00	74 54 30	43	57	gy. S.	Oct. 21	2	[63] 2	0
										0

CANCER IRRORATUS Say.

Specimens examined.

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7167	2253	40 34 30	69 50 45	32	53	gy. S.	Sept. 27	2 s. 1 y.		......
8661	2256	40 38 30	69 29 00	30	53	yl. S.	Sept. 28		5 s.	0
8664*	......	-- -- --	-- -- --	....	....	....	Sept. 23	3 f.		......
[Locality: Off Chesapeake Bay.]										
7207	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	..	1	......
[Locality: Off Cape Hatteras.]										
8857	2297	35 38 00	74 53 00	49	....	M. brk. S.	Oct. 20	1		......
8898	2297	35 38 00	74 53 00	49	....	M. brk. S.	Oct. 20	4 [275+]		......
8780	2298	35 39 00	74 52 00	80	....	M. brk. S.	Oct. 20	26	5	0
8858	2298	35 39 00	74 52 00	80	....	M. brk. S.	Oct. 20	1		......
8908	2299	35 40 00	74 51 30	296	....	bk. M.	Oct. 20	4		......
8859	2307	35 42 00	74 54 30	43	57	gy. S.	Oct. 21	1	2	......
8861	2308	35 43 00	74 53 30	45	....	gy. S.	Oct. 21	5		0
8899	2309	35 43 30	74 52 00	56	....	gy. S.	Oct. 21	5 [220]	1	0

* Stomach of dogfish.

Cancer amœnus Herbst, Krabben und Krebse, vol. iii, part 1, p. 64, pl. 49, Fig. 3, 1799, is evidently this species, and the name should be substituted for the later name given by Say.

XANTHO, sp.

Station 2280, October 19, off Cape Hatteras, north lat. 35° 21′, west long. 75° 21′ 30″, 16 fathoms, gray sand; eight specimens (8851).

PILUMNUS ACULEATUS M.-Edwards.

Cancer aculeatus Say, Jour. Acad. Nat. Sci. Phila., i, p. 420, 1818.
Pilumnus aculeatus M.-Edwards, in Guérin, Iconog. Règne Animal, Crust., pl. 3, Fig. 2; Hist. Nat. Crust., i, p. 420, 1834. A. M.-Edwards, Crust. Région Mexicaine, p. 282, pl. 50, Figs. 1–1c, 1880.

Station 2287, off Cape Hatteras, October 20, north lat. 35° 22′ 30″, west long. 75° 26″, 7 fathoms, coarse sand; one young specimen (7245).

GERYON QUINQUEDENS Smith.

Specimens examined.

Catalogue number.	Station number.	Locality. N. lat.	Locality. W. long.	Depth, temperature, and nature of bottom. Fathoms.	°	Materials.	Date.	Specimens. Number. ♂	♀	With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
[Locality: Off Chesapeake Bay.]										
8001	2171	37 59 30	73 48 40	444	39	gn. M.	July 20	1 *l.*		
8003	2172	38 01 15	73 44 00	568	39	gn. M.	July 20		1 *s.*	0
[Locality: Off Long Island.]										
8000	{2179	39 30 10	71 50 00	510	39	bk. M.	July 23}	34	22	14
	{2180	39 29 50	71 49 30	523	39	bk. M.	July 23}			
7799	2181	39 29 00	71 46 00	693	39	gn. M., fne. S.	July 23	5 *l.*	1 *l.*	0
8004	2181	39 29 00	71 46 00	693	39	gn. M., fne. S.	July 23	1 *y.*		
8002	2182	39 25 30	71 44 00	861	39	gn. M.	July 23	1		
[Locality: Off Martha's Vineyard.]										
8037	2186	39 52 15	70 55 30	353	40	gn. M., S.	Aug. 2	2 *l.*		
8035	2187	39 49 30	71 10 00	420	40	gn. M., S.	Aug. 3	1	2	0
8036	2189	39 49 30	70 26 00	600	40	gn. M., S.	Aug. 4		1	1
8188	2201	39 39 45	71 35 15	538	39	bu. M.	Aug. 19	8 *l.*	8 *l.*	2
8172	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	6 *s.*	5 *s.*	0
8175	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	1 *s.*	1 *s.*	0
8188	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	15 *l.*		
8188	2203	39 34 15	71 45 15	705	39	gn. M., S.	Aug. 19	1 *l.*		
8188	2204	39 30 30	71 44 30	728	39	bu. M.	Aug. 19	1 *l.*		
8188	2206	39 35 00	71 24 30	1043	38	gn. M.	Aug. 20	11 *l.*	9 *l.*	0
8188	2215	39 49 15	70 31 45	578	....		Aug. 22	9 *l.*	2 *l.*	1
8188	2216	39 47 00	70 30 30	963	39	gn. M.	Aug. 22	2 *l.*	4 *l.*	0
8626	2234	39 09 00	72 03 15	816	39	gn. M.	Sept. 13		3	
8627	2235	39 12 00	72 03 30	707	39	gn. M.	Sept. 13	13	8	0
8628	2236	39 11 00	72 08 30	636	39	gn. M.	Sept. 13	11		

The eggs of this species are nearly spherical and about 0.74^{mm} in diameter. A female, from station 2189, measuring 70 by 85^{mm} in length and breadth of carapax, including lateral teeth, was carrying, approximately, 47,000 eggs.

PLATYONICHUS OCELLATUS Latreille.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality. N. lat.	Locality. W. long.	Depth, temperature, and nature of bottom. Fathoms.	°	Materials.	Date.	Specimens. No. ♂	♀	With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
8751	2269	35 12 30	75 05 00	48	76	gy. M.	Oct. 19	2		
8779	2271	35 16 00	75 09 00	26	....		Oct. 19	1		
7228	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19	2	1	0
7237	2285	35 21 25	75 24 25	13	....	crs. gy. S	Oct. 19		2	0
8791	2286	35 21 30	75 25 00	11	....	crs. gy. S.	Oct. 19		3	0
7244	2289	35 22 50	75 25 00	7	....	crs. S.	Oct. 20	1 *y.*		0
8856	2291	35 25 30	75 20 30	15	...	gy. S. brk. Sh.	Oct. 20		2	0
8811	2302	35 14 00	75 03 00	49	71	S. Cr.	Oct. 21		1	0
8813	2303	35 17 00	75 01 00	41	....	fne. gy. S.	Oct. 21	2		

All the specimens from stations 2269, 2271, 2283, 2291, 2302, and 2303 differ conspicuously in color from all the specimens from stations 2285 and 2286, and from all ordinary specimens from the New England coast, and represent a well marked variety. These specimens, though recently preserved, like the others, in strong alcohol, present no trace whatever of the beautiful dark purplish red markings upon the dorsal surface of the carapax, chelipeds, and ambulatory peræopods, these parts being a uniform obscure brownish yellow, except the spine on the inner side of the carpus and a few tubercles on the chela, which are dark reddish brown in many of the specimens. The smooth areas between the teeth of the antero-lateral margin of the carapax are very much larger and more conspicuous, and the tubercles of the margin itself are larger and more regular, as are also the tubercles on the dorsal surface of the chelæ in most of the specimens. The following measurements of seven specimens of the unspotted variety, followed by similar measurements of four normal specimens from the same region, and two others from Vineyard Sound, show no noticeable differences in the proportions of the carapax or chelæ:

Measurements in millimeters.

Catalogue number	7228.	8779.	8813.	7283.	8751.	8811.	8856.
Station	2283.	2271.	2303.	2383.	2269.	2302.	2291.
Sex	♂	♂	♂	♂	♂	♀	♀
Length of carapax, including frontal spine	42.0	45.5	47.5	50.0	51.5	49.7	52.0
Breadth of carapax in front of lateral spiuo	48.0	51.0	54.0	56.5	58.5	56.6	59.0
Breadth of carapax, including lateral spine	52.0	54.5	57.3	60.0	63.0	60.0	63.0
Breadth between external angles of orbits	22.3	25.6	25.3	26.7	26.6	26.0	27.6
Length of chela	35.5	39.5	42.0	48.0	49.0	39.8	42.0
Height of chela	11.4	12.2	12.7	14.0	14.0	13.2	13.8
Length of dactylus	19.0	20.8	22.0	24.8	26.0	22.0	24.5

Catalogue number	8791.	7237.	7237.	8791.		
Station	2286.	2285.	2285.	2286.	V. S.	V. S.
Sex	♀	♀	♀	♀	♀	♂
Length of carapax, including frontal spine	37.5	45.6	49.0	50.0	56.3	69.0
Breadth of carapax in front of lateral spine	43.9	51.8	56.1	57.0	65.0	80.0
Breadth of carapax, including lateral spine	47.0	56.0	60.7	61.2	68.4	84.5
Breadth between external angles of orbits	22.3	26.1	27.7	28.0	32.0	37.2
Length of chela	31.0	37.0	40.5	42.2	45.0	71.0
Height of chela	11.1	12.7	14.0	13.5	14.3	18.5
Length of dactylus	17.8	21.8	23.7	24.0	25.0	40.0

BATHYNECTES LONGISPINA Stimpson.

Bathynectes longispina Stimpson, Bull. Mus. Comp. Zool., Cambridge, ii, p. 146, 1870 (young ♂). A. M.-Edwards, Crust. Région Mexicaine, p. 234, pl. 42, fig. 1, 1879 (young ♂). Smith, Proc. National Mus., iii, p. 418, 1881; vi, p. 17, 1883.

Bathynectes brevispina Stimp., loc. cit., p. 147, 1870 (large ♀). A. M.-Edwards, op. cit., p, 235, 1879 (=Stimpson).

Specimens examined.

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8041	2199	39 57 30	69 41 10	78	....	gy. S.	Aug. 6	.. 1	0

[Locality: Off Chesapeake Bay.]

7209	2264	37 07 59	74 34 20	167	58	gy. S.	Oct. 18	3 ..	......
7210	2265	37 07 40	74 35 40	70	63	gn. M. G.	Oct. 18	3 ..	......

Measurements in millimeters.

Catalogue number	7209	7210	8041
Station	2264	2265	2199
Sex	♂	♂	♀
Length of carapax, including frontal teeth	29.6	37.0	35.0
Length of carapax, excluding frontal teeth	28.7	35.2	34.1
Breadth of carapax in front of lateral spines	36.0	45.1	42.0
Breadth of carapax, including lateral spines	51.2	63.0	61.0
Length of lateral spine	8.5	10.2	10.3
Length of right cheliped	50.	62.	55.
Length of chela	26.5	32.0	30.0
Height of chela, excluding spines	8.7	12.0	12.0
Length of dactylus	14.0	17.0	15.5
Length of left cheliped	49.	66.	55.
Length of chela	25.7	34.8	29.0
Height of chela	10.0	13.0	11.0
Length of dactylus	13.3	17.2	15.3
Length of third ambulatory leg	69.	87.	80.
Length of fourth ambulatory leg	46.	57.	53.
Length of dactylus	14.5	17.3	16.0
Breadth of dactylus	5.6	7.3	6.8

CALLINECTES ORNATUS Ordway.

Jour. Bost. Soc. Nat. Hist., vii, p. 571 (6), 1863. Smith, Trans. Conn. Acad., ii, pp. 8, 34, 1869. Stimpson, Bull. Mus. Comp. Zool., ii, p. 148, 1870. A. M.-Edwards, Crust. Région Mexicaine, p. 225, 1879.

Station 2283, off Cape Hatteras, October 19, north lat. 35° 23′ 15″, west long. 75° 23′ 15″, 14 fathoms, gray sand; one male (8863).

Stimpson's statement, that the Brazilian species which I have referred to as the *C. ornatus* is probably not the same as that of Ordway, is an error evidently resulting from a careless reading of my account of the species, where, after referring to a male specimen agreeing perfectly with Ordway's description, I mention an indeterminable "sterile" female from the same locality as possibly belonging to *ornatus* or to *larvatus*.

ACHELOUS SPINIMANUS De Haan.

Portunus spinimanus Latreille.

Lupa spinimana Leach, in Desmarest, Considérat. Crust., p. 98, 1825.

Achelous spinimanus De Haan, Fauna Japonica, Crust., p. 8, 1833. A. M.-Edwards, Archives Mus. Hist. Nat., x, p. 341, pl. 32, fig. 1, 1861; Crust. Région Mexicaine, p. 230, pl. 39, figs. 2–2*a*, 1879.

Station 2285, October 19, off Cape Hatteras, north lat. 35° 21′ 30″, west long. 75° 24′ 25″, 13 fathoms, gray sand; 1 ♂, and 7 ♀ (8853).

ACHELOUS GIBBESII Stimpson.

Lupa Gibbesii Stimpson, Ann. Lyceum Nat. Hist. New York, vii, p. 57 (11), 1859.

Achelous Gibbesii Stimpson, loc. cit., p. 222 (94), 1860.

Neptunus Gibbesii A. M.-Edwards, Archives Mus. Hist. Nat., x, p. 326, pl. 31, fig. 1, 1861; Crust. Région Mexicaine, p. 215, 1879.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7219	2269	35 12 30	75 05 00	48	76	....	Oct. 19	..	2	0
8850	2277	35 20 50	75 19 50	16	....	gy. S.	Oct. 19	2	..	......
8776	2277	35 20 50	75 19 50	16	....	gy. S.	Oct. 19	2	1	0
7230	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19	1	..	......
7232	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19	4 4*y*.		......

ACHELOUS ANCEPS Stimpson.

Lupa anceps Saussure, Crust. Antilles et Mexique, p. 18, pl. 2, fig. 11, 1858.

Achelous anceps Stimpson, Ann. Lyc. Nat. Hist. New York, x, p. 113, 1871.

Neptunus anceps A. M.-Edwards, Archives Mus. Hist. Nat., x, 328, 1861; Crust. Région Mexicaine, 213, 1879.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
8852	2281	35 21 05	75 22 05	16	....	gy. S.	Oct. 19	1*s*.	1*s*.	0
7233	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19	..	..	......
8854	2287	35 22 30	75 26 00	7	....	crs. gy. S.	Oct. 20	..	1	1
8842	2288	35 22 40	75 25 30	7	....	crs. S.	Oct. 20	..	2	0
8855	2289	35 22 50	75 25 00	7	....	crs. S.	Oct. 20	7	8	6

ACHELOUS SPINICARPUS Stimpson.

Bull. Mus. Comp. Zool., ii, p. 148, 1870.

Neptunus spinicarpus A. M.-Edwards, Crust. Région Mexicaine, p. 221, pl. 40, figs. 1–1*b*, 1879.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7216	2268	35 10 40	75 06 10	68	77	gy. M.	Oct. 19	1	..	......
8796	2301	35 11 30	75 05 00	59	75	crs. S.	Oct. 21	1	3	0
7257	2302	35 14 00	75 03 00	49	71	S. Cr.	Oct. 21	2	2	0
7254	2307	35 42 00	74 54 30	43	57	gy. S.	Oct. 21	..	1	0

DORIPPOIDEA.

ETHUSINA ABYSSICOLA Smith.

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
8566	2226	37 00 00	71 54 00	2221	37	glb. O.	Sept. 10	2	..	......
8565	2228	37 25 00	73 06 00	1582	37	bn. M.	Sept. 11	..	1	0

LEUCOSOIDEA.

CALAPPA MARMORATA Fabricius ex Herbst.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7226	2282	35 21 10	75 22 10	14	....	bk. S.	Oct. 19	..	1	0
7227	2283	52 21 15	75 23 15	14	....	gy. S.	Oct. 19	..	1	0
7285	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19	1	..	......
8817	2296	35 21 30	75 25 00	27	....	crs. gy. S.	Oct. 20	1*y*.	..	......

HEPATUS DECORUS Gibbes ex Herbst.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
8782	2282	35 21 10	75 22 40	14	....	bk. S.	Oct. 19	1	..	......
8784	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19	3	1	1
8787	2284	35 21 20	75 23 50	13	....	crs. gy. S.	Oct. 19	1	..	......
8783	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19	3 2*y*.	3	0
7239	2286	35 21 30	75 25 00	11	....	crs. gy. S.	Oct. 19	1	1	0

Measurements in millimeters.

Catalogue number.	Sex.	Length of carapax.	Breadth of carapax, including teeth.
8783	......	13.1	17.8
8783	......	16.8	23.6
7239	♀	27.0	37.5
8783	♀	29.7	42.3
8783	♀	39.8	59.2
8783	♀	42.1	62.0
8784	♀	46.5	69.5
8784	♂	27.7	40.1
8783	♂	30.6	45.0
8784	♂	33.0	49.5
8784	♂	34.0	50.0
7239	♂	38.7	58.8
8783	♂	43.7	63.8
7239	♂	45.8	68.0
8782	♂	45.5	67.0
8782	♂	47.0	70.0

In the first of these measured specimens the color markings of the carapax are indistinct, but are apparently all narrow and transversely elongated spots, arranged in transverse bands. The second specimen has large color spots on the central portions of the carapax, nearly as in the adult, and a few indistinct markings along the edges of the carapax, but is without the smaller spots usually present on the inner portions of the branchial regions. The third specimen has the markings very nearly as in the first, but much more distinct. All the other specimens have the usual coloration of the adult.

OSACHILA TUBEROSA Stimpson.

Bull. Mus. Comp. Zool., ii, p. 154, 1870.

Station 2269, October 19, off Cape Hatteras, north lat. 35° 12′ 30″, west long. 75° 07′, 48 fathoms, temperature 76°; one female (8746).

Measurements in millimeters.

Length of carapax to middle of front	18.0
Length of carapax, including lobes of front	18.4
Breadth of carapax, including lateral teeth	20.2
Greatest breadth, excluding lateral teeth	19.8
Length of cheliped	20.0
Length of chela	10.2
Breadth of chela, including teeth	6.1
Length of dactylus	5.0
Length of first ambulatory peræopod	20.6
Length of second ambulatory peræopod	15.5

PERSEPHONE PUNCTATA Stimpson ex Browne.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		With eggs.
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		
		° ′ ″	° ′ ″				1884.	♂	♀	
8771	2277	35 20 50	75 19 50	16	....	gy. S.	Oct. 19	2	..	......
7229	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19	..	1	......
7231	2284	35 21 20	75 23 50	13	....	crs. gy. S.	Oct. 19	1	..	......
7236	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19	3	1	0
7240	2286	35 21 30	75 25 00	11	....	crs. gy. S.	Oct. 19	1	..	......

ANOMURA.

LATREILLIOIDEA.

LATREILLIA ELEGANS Roux.

Station 2199, August 6, off Martha's Vineyard, north lat. 39° 57′ 30″, west long. 69° 41′ 10″, 78 fathoms, gray sand; 1 female carrying eggs (8044). The eggs are about 0.44 by 0.46^{mm} in shorter and longer diameter, and this specimen, in which the carapax, excluding rostral spines, measures 12^{mm} in length, was carrying approximately 1650.

HOMOLOIDEA.

HOMOLA BARBATA White.

(Plate II, Fig. 1.)

Station 2197, August 6, off Martha's Vineyard, north lat. 39° 56′ 30″, west long. 69° 43′ 20″, 84 fathoms, sand and broken shells, temperature, 52°; 1 small male (8045). Station 2265, October 18, off Chesapeake Bay, north lat. 37° 7′ 40″, west long. 74° 35′ 40″, 70 fathoms, mud and gravel, temperature, 63°; 1 female (8770).

PORCELLANOIDEA.

PORCELLANA SAYANA White.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8793	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19	3s. ..	0
8878	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19	3s. ..	0
8883	2286	35 21 30	75 25 00	11	....	crs. gy. S.	Oct. 19	.. 1s.	1
7252	2296	35 35 20	74 58 45	27	....	bk. M. brk. Sh.	Oct. 20	1s. ..	0

PORCELLANA SOCIATA Say.

Station 2280, October 19, off Cape Hatteras, north lat. 35° 21′, west long. 75° 21′ 30″, 16 fathoms, gray sand; fifty or more specimens (8843).

PTEROLISTHES SEXSPINOSUS Stimpson ex Gibbes.

Station 2280, with the last species; 2 ♂ and 3 young.

HIPPOIDEA.

ALBUNEA GIBBESII Stimpson.

Ann. Lyceum Nat. Hist. New York, vii, 78 (32), pl. 1, fig. 6, 1859. Miers, Jour. Linn. Soc. London, Zool., xiv, 329, 1878.

Station 2274, October 19, off Cape Hatteras, north lat. 35° 20′ 35″, west long. 75° 18′ 5″, 16 fathoms, gray sand; one small male.

LITHODOIDEA.

LITHODES AGASSIZII Smith.

(Plate III, Figs. 1, 2.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8046..	2193	39 44 30	70 10 30	1122	38	gn. M.	Aug. 5	.. 1 *l.*	1
8047..	2196	39 35 00	69 44 00	1230	38	gn. M.	Aug. 6	.. 1 *l.*	1
8049..	2196	39 35 00	69 44 00	1230	38	gn. M.	Aug. 6	.. 1 *l.*	1
8048..	2196	39 35 00	69 44 00	1230	38	gn. M.	Aug. 6	1 *s.* ..	......
8050..	2196	39 35 00	69 44 00	1230	38	gn. M.	Aug. 6	1 *y.* .	......
8187..	2203	39 34 15	71 45 15	705	39	gn. M. S.	Aug. 19	.. 1 *l.*	1
							1883.		
5718..	2115	35 49 37	74 34 45	843	39	....	Nov. 11	1 *l.* ..	......

Measurements in millimeters.

Catalogue number	8050	8048	5718	8049	8046
Station	2196	2196	2115	2196	2193
Sex	♂	♂	♂	♀	♀
Length of carapax, including rostrum and posterior spines	41	115	176	204	210
Length of carapax, excluding rostrum and posterior spines	18.2	56	142	152	158
Breadth of carapax between tips of hepatic spines	28	71	70	97	101
Breadth of carapax between tips of branchial spines	30	77	138	147	165
Greatest breadth of carapax, excluding spines	14.5	46	141	131	143
Length of rostrum	17.5	37.3	19	44	37
Length of spines at base of rostrum	16.6	41	18	28	31
Length of anterior gastric spines	15.7	39	13	27	23
Length of anterior cardiac spines	13.0	33.5	15	20	22
Length of right cheliped	28	82	230	220	250
Length of right chela	11.4	31.5	86	81	90
Breadth of right chela	3.5	8.8	36	34	39
Length of dactylus of right chela	6.7	21	56	50	48
Length of left cheliped	29	83	230	215	246
Length of left chela	11.4	34	82	74	82
Breadth of left chela	3.0	7.0	24	25	26
Length of dactylus of left chela	7.3	24	60	45	48
Length of first ambulatory peræopod	48	158	405	355	430
Length of second ambulatory peræopod	52	172	445	395	460
Length of third ambulatory peræopod	52	175	450	390	475
Greatest expanse of ambulatory peræopods	100	375	980	850	1,000

PAGUROIDEA.

EUPAGURUS BERNHARDUS Brandt ex Linné.

Specimens examined.

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
8709	2253	40 34 30	69 50 45	32	53	gy. S.	Sept. 27	2	2	
8695	2254	40 40 30	69 50 30	25	54	gy. S.	Sept. 27	4	4	0
8694	2255	40 46 30	69 50 15	18	56		Sept. 27	9	1	0
7177	2256	40 38 30	69 29 00	30	53	yl. S.	Sept. 28	13	8	0
8696	2256	40 38 30	69 29 00	30	53	yl. S.	Sept. 28	1 s. E.		
8698	2257	40 32 30	69 29 00	33	52	yl. S.	Sept. 28	..	2	0
8710	2258	40 26 00	69 29 00	36	51	gy. S.	Sept. 28	1	..	

NOTE.—Under this and the following species of *Eupagurus* and *Catapagurus*, in the column giving the number of specimens, E. indicates that the carcinœcia were formed of *Epizoanthus Americanus*.

EUPAGURUS POLITUS Smith.

Specimens examined.

[Locality: Off Chesapeake Bay.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7939	2170	37 57 00	73 53 30	155	....	gy. S.	July 20	2	6	6

Specimens examined—Continued.

[Locality: Off Long Island.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.			
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.			With eggs.
		° ′ ″	° ′ ″				1884.	♂		♀	
7940	2176	39 32 30	72 21 30	302	41	bk. M.	July 22	--	2 *y.*	--	0
7941	2177	39 33 40	72 08 45	87	52	gn. M., S.	July 22		9		1
7942	2178	39 29 00	72 05 15	229	42	gn. M., S.	July 22		3		
[Locality: Off Martha's Vineyard.]											
8055	2183	39 57 45	70 56 30	195	44	gn. M., S.	Aug. 2		60		
8056	2184	40 00 15	70 55 30	136	49	gn. M., S.	Aug. 2		1 *l.*		
8057	2185	40 00 45	70 54 15	129	51	gn. M., S.	Aug. 2	4 *l.*		14 *l.*	10
8058	2186	39 52 15	70 55 30	353	40	gn. M., S.	Aug. 2		12		0
8228	2187	39 49 30	71 10 00	420	40	gn. M., S.	Aug. 2		6		0
8059	2198	39 56 30	69 43 20	84	52	S., brk. Sh.	Aug. 6	1 *s.*			
8060	2199	39 57 30	69 41 10	78	....	gy. S.	Aug. 6	1		2	1
8061	2200	39 53 30	69 43 20	148	45	crs. S.	Aug. 6		1		
8174	2212	39 59 30	70 30 45	428	40	gn. M.	Aug. 22		4		
8617	2232	38 37 30	73 11 00	243	43	gn. M.	Sept. 12		3 *s.*		
8699	2240	40 27 30	70 29 00	44	....	gn. M.	Sept. 26		1 *s.*		0
8700	2241	40 21 00	70 29 00	50	51	gn. M.	Sept. 26		6 *s.*		0
8701	2243	40 10 15	70 26 00	63	52	gn. M.	Sept. 26		57 *s.*		1
A. 8294	2243	40 10 15	70 26 00	63	52	gn. M.	Sept. 26		2 *s.* E.		
8702	2244	40 05 15	70 23 00	67	53	gn. M., S.	Sept. 26		15		2
7171	2245	40 01 15	72 22 00	98	51	gn. M., bk. S.	Sept. 26		13		0
8703	2246	39 56 45	70 20 30	122	48	gn. M.	Sept. 26		10 *s.*		3
8704	2247	40 03 00	69 57 00	78	52	gn. M., S.	Sept. 27		9 *s.*		0
8705	2248	40 07 00	69 57 00	67	52		Sept. 27		12 *s.*		0
8706	2249	40 11 00	69 52 00	53	51		Sept. 27		11 *s.*		0
8707	2250	40 17 15	69 51 45	47	51		Sept. 27		30		2
8691	2250	40 17 15	69 51 45	47	51		Sept. 27		15		0
8692	2251	40 22 17	69 51 30	42	51		Sept. 27	7 *l.*			......
8708	2252	40 28 00	69 51 00	38	50		Sept. 27	1 *l.*		1	0
8711	2259	39 19 30	69 29 00	41	50	gy. S.	Sept. 28	3			......
8712	2260	40 13 15	69 29 15	46	50	gy. S.	Sept. 28		13		2
8713	2261	40 04 00	69 29 30	58	54	gy. S.	Sept. 28		3		......
8714	2262	39 54 45	69 29 45	250	42	gn. M., S.	Sept. 28		10		......
[Locality: Off Chesapeake Bay.]											
8754	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18		53		20
8769	2265	37 07 40	74 35 40	70	63	gn. M. G.	Oct. 18		2		0
[Locality: Off Cape Hatteras.]											
8887	2299	35 40 00	74 51 30	296	....	bk. M.	Oct. 20	1 *l.*			......

A female from station 2185, measuring 14.5^{mm} in length of carapax, was carrying approximately 2,000 eggs, of which the average diameter was about 1.12^{mm}.

EUPAGURUS PUBESCENS Brandt ex Kröyer.

Specimens examined.

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.
		N. lat.	W. long.	Fathoms.	°	Materials.		
		° ′ ″	° ′ ″				1884.	
8054	2199	39 57 30	69 41 10	78	....	gy. S.	Aug. 6	1 *s.* E.
7179	2243	40 10 15	70 26 00	63	52	gn. M.	Sept. 26	3(1 E.)
7206	2250	40 17 15	69 51 45	47	51	gn. M., S.	Sept. 27	22 *s.*
A. 8291	2250	40 17 15	69 51 45	47	51	gn. M., S.	Sept. 27	5 *s.* E.
7173	2254	40 40 30	69 50 30	25	54	gy. S.	Sept. 27	9 *s.*
7174	2256	40 38 30	69 29 00	30	53	yl. S.	Sept. 28	50 *s.*
A. 8287	2256	40 38 30	69 29 00	30	53	yl. S.	Sept. 28	28 *s.* E.
7176	2257	40 32 30	69 29 00	33	52	yl. S.	Sept. 28	26 *s.*
A. 8289	2257	40 32 30	69 29 00	33	52	yl. S.	Sept. 28	3 *s.* E.
7175	2258	40 26 00	69 29 00	36	51	gy. S.	Sept. 28	2 *s.*
A. 8288	2258	40 26 00	69 29 00	36	51	gy. S.	Sept. 28	47 *s.* E.
7186	2259	40 19 30	69 29 10	41	50	gy. S.	Sept. 28	3 *s.*
A. 8292	2259	40 19 30	69 29 10	41	50	gy. S.	Sept. 28	6 *s.* E.
7187	2260	49 13 15	69 29 85	46	52	gy. S.	Sept. 28	3 *s.*

EUPAGURUS KRÖYERI Stimpson.

Specimens examined.

[Locality: Off Long Island.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.
		N. lat.	W. long.	Fathoms.	°	Materials.		
		° ′ ″	° ′ ″				1884.	
7943	2177	39 33 40	72 08 45	87	53	gn. M., S.	July 22	1 E.

[[Locality: Off Martha's Vineyard.]

8051	2183	39 57 45	70 56 30	195	44	gn. M., S.	Aug. 2	27 *s.* E.
8053	2197	39 56 30	69 43 20	84	52	S., brk. Sh.	Aug. 6	2 *s.* E.
8052	2199	39 57 30	69 41 10	78	....	gy. S.	Aug. 6	2 *s.* E.
7172	2243	40 10 15	70 26 00	63	52	gn. M.	Sept. 26	8 *s.* (3 E.)
A. 8294	2243	40 10 15	70 26 00	63	52	gn. M.	Sept. 26	2 *s.* E.
7179	2244	40 05 15	70 23 00	67	53	gn. M., S,	Sept. 26	4 *s.* E.
7180	2245	40 01 15	70 22 00	98	51	gn. M., bk. S.	Sept. 26	4 *s.* E.
A. 8295	2245	40 01 15	70 22 00	98	51	gn. M., bk. S.	Sept. 26	1 *s.* E.
7203	2246	39 56 45	70 20 30	122	48	gn. M.	Sept. 26	18 *s.*
A. 8290	2246	39 56 45	70 20 30	122	48	gn. M.	Sept. 26	52 *s.* E.
7205	2247	40 03 00	69 57 00	78	52	gn. M., S.	Sept. 27	2 *s.* E.
7185	2250	40 17 15	69 51 45	47	51	....	Sept. 27	7 *s.*
7188	2261	40 04 00	69 29 30	58	54	gy. S.	Sept. 28	5 *s.* E.
7189	2262	39 54 45	69 29 45	250	42	gn. M., S.	Sept. 28	3 *l.* ♂

[Locality: Off Chesapeake Bay.]

7212	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	1 *y.*

Eupagurus longicarpus Stimpson ex Say.

Station 2288, Oct. 20, 1884, off Cape Hatteras, north lat. 35° 22′ 40″, west long. 75° 25′ 30″, 7 fathoms, coarse gravel; 1 specimen (8885).

Eupagurus pollicaris Stimpson ex Say.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		♂		♀
		° ′ ″	° ′ ″				1884.			
8879	2280	35 21 00	75 21 30	16	....	gy. S.	Oct. 19	1		
8880	2282	35 21 10	75 22 40	14	....	bk. S.	Oct. 19		1y.	
8888	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19			1
8781	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19			2
8881	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19		10	
7234	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19		1	
8882	2286	35 21 30	75 25 00	11	....	crs. gy. S.	Oct. 19		2	
8884	2287	35 22 30	75 26 00	7	....	crs. gy. S.	Oct. 20		3	
8803	2290	35 23 00	75 24 30	9¾	....	S. brk. Sh.	Oct. 20	1		

Catapagurus Sharreri A. M.-Edwards.

Specimens examined.

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
8693	2245	40 01 15	70 22 00	98	51	gn. M., bk. S.	Sept. 26	104	15	11
7195	2245	40 01 15	70 22 00	98	51	gn. M., bk. S.	Sept. 26	1	1	1
7204	2247	40 03 00	69 57 00	78	52	gn. M., S.	Sept. 27		1E.	1
[Locality: Off Chesapeake Bay.]										
8889	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	24	9	7
8905	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	10	7	5

Catapagurus gracilis Smith.

Specimens examined.

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7170	2245	40 01 15	70 22 00	98	51	gn. M., bk. S.	Sept. 26	1E.	1E.	1
[Locality: Off Chesapeake Bay.]										
7213	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	2		......

PARAPAGURUS PILOSIMANUS Smith.

*Specimens examined.**

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7944	2174	38 15 00	72 03 00	1,549	....	gy. M.	July 21	2s. G.	1s. G.	1
8007	2174	38 15 00	72 03 00	1,549	....	gy. M.	July 21	1s. Ea.		......
8062	2186	39 52 15	70 55 30	353	40	gn. M., S.	Aug. 2	30 Ep.	1s. Ep.	......
8064	2187	39 49 30	71 10 00	420	40	gn. M., S.	Aug. 3	6 Ep.		......
8173	2212	39 59 30	70 30 55	428	40	gn. M.	Aug. 22	1s. Ep.	20 Ep.	......
8572	2226	37 00 00	71 54 00	2,021	37	glb. O.	Sept. 10	8 Ea.	6 Ea.	6
8697	2262	39 54 45	69 29 45	250	42	gn. M., S.	Sept. 28	2 Ep.		......

*In the column giving the number of specimens G. indicates that the carcinœcia were naked gastropod shells; Ea., that the carcinœcia were formed of *Epizoanthus abyssorum*; and Ep., that they were formed of *Epizoanthus paguriphilus*.

The figures of the branchiæ of this species and *Sympagurus pictus*, given in the Proceedings of the National Museum, vol. vi, plate 5, figures 2, 2a and 3, 3a were accidentally transposed; 2 and 2a are of this species, and 3, 3a are of *Sympagurus pictus*.

GALATHEOIDEA.

GALATHEA, species.

Station 2269, October 19, off Cape Hatteras, north lat. 35° 12′ 30″, west long. 75° 5′, 48 fathoms, temperature 76°; one small male (7271).

MUNIDA CARIBÆA? Smith.

Specimens examined.

[Locality: Off Long Island.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. lat.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7945	2177	39 33 40	72 08 45	87	52	gn. M., S.	July 22	2s.		....

[Locality: Off Martha's Vineyard.]

8065	2197	39 56 30	69 43 20	84	52	S. brk. Sh.	Aug. 6	1	2	0
8066	2199	39 57 30	69 43 10	78	....	gy. S.	Aug. 6	1		....
8720	2243	40 10 15	70 26 00	63	52	gn. M.	Sept. 26	1		....
8721	2247	40 03 00	69 57 00	78	52	gn. M., S.	Sept. 27		1	1
8722	2248	40 07 00	69 57 10	67	52	gn. M., S.	Sept. 27	1y.		....
8723	2261	40 04 00	69 29 30	58	54	gy. S.	Sept. 28	1		....

Specimens examined—Continued.

[Locality: Off Chesapeake Bay.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.		
8752	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	74	5
8753	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	206	9
8890	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	55	....
8758	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	200+	....
8759	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	200+	....
8760	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	180+	....
8761	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	250+	....
8762	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	250+	....
8763	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	100+	....
8764	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	200+	....
8765	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	250+	....
8766	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	150+	....
8902	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	300+	....
8903	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	180+	....

[Locality: Off Cape Hatteras.]

8747	2269	35 12 30	75 05 00	48	76		Oct. 19	5	0
8892	2297	35 38 00	74 53 00	49	....	bk. M.	Oct. 19	5	0
8898	2297	35 38 00	74 53 00	49	76	bk. M., G.	Oct. 19	19	0
8893	2298	35 39 00	74 52 00	80	....	bk. M., G.	Oct. 20	5	0
8795	2301	35 11 30	75 05 00	59	75	crs. S.	Oct. 21	160	13
8894	2307	35 42 00	74 54 30	43	57	gy. S.	Oct. 21	3	0
8808	2307	35 42 00	74 54 30	43	57	gy. S.	Oct. 21	1	0
8807	2309	35 43 30	74 52 00	56	...	gy. S.	Oct. 21	97	8
8895	2309	35 43 30	74 52 00	56	....	gy. S.	Oct. 21	7	0

MUNIDOPSIS Whiteaves.

Amer. Jour. Sci., III, vii, p. 212, 1874; Smith, Proc. National Museum, vii, p. 493, 1885.

As I have stated in a paper referred to above, a careful examination of the structural characters of the type species of this genus with A. Milne-Edwards's *Galacantha rostrata*, my *G. Bairdii*, and the two species here described, induces me to refer them all to a single genus. The oral appendages are almost exactly alike in all the species, except unessential differences in the armament of the second gnathopods. The number and arrangement of the branchiæ are the same in all, and like that in the typical species of *Munida*, though the number of epipods varies. In *Munidopsis curvirostra* and *Bairdii* there are only two epipods on each side, as in the typical species of *Munida*, one at the base of the maxilliped and the other at the base of the second gnathopod; in *Munidopsis crassa* and *similis* there is an additional pair at the base of the first peræopod; while in *Munidopsis rostrata* there are additional ones at the bases of each of the first three pairs of peræopods. The eyes in *Munidopsis Bairdii*, *crassa*, and *similis* are much alike and considerably different from those of the other species, but it does not seem desirable to consider such differences or those in the number of epipods as of generic value.

MUNIDOPSIS CURVIROSTRA Whiteaves.

Specimens examined

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8067	2196	39 35 00	69 44 00	1,230	38	gn. M.	Aug. 6	1 *s.*	1
8248	2205	39 35 00	71 18 45	1,073	38	gy. O.	Aug. 20	1 1	2
8249	2206	?39 35 00	?71 24 30	1,043	38	gn. M.	Aug. 20	2	2
8250	2209	39 34 45	71 21 30	1,080	39	glb. O.	Aug. 21	2	1
8251	2210	?39 37 45	?71 18 45	991	38	gy. glb. O.	Aug. 21	1 1	1
8252	2211	?39 35 00	?71 18 00	1,064	38	gn. M.	Aug. 21	1 1	
8253	2213	?39 58 30	?70 30 00	384	39	gn. M.	Aug. 22	1	0
8254	2218	39 46 22	69 29 00	948	39	gy. M.	Aug. 23	1 *s.*	
8559	2233	?38 36 30	?73 06 00	630	39	gn. M.	Sept. 12	1	2
8561	2234	39 09 00	72 03 15	816	39	gn. M.	Sept. 13	1 2 *y.* 2	1
8562	2235	39 12 00	72 03 30	707	39	gn. M.	Sept. 13	4 1 *y.* 2	1
8560	2236	39 11 00	72 08 30	636	39	gn. M.	Sept. 13	1 1	1
8567	2237	39 12 17	72 09 30	520	39	gn. M.	Sept. 13	1 2	
8609	......	....	....	....	....	....	....	1	

Measurements in millimeters.

Catalogue number	8248	8254	8248	8250
Station	2205	2218	2205	2209
Sex	♂	♀	♀	♀
Length from tip of rostrum to tip of telson	29.5	20.0	27.0	37.0
Length of carapax, including rostrum	17.1	12.3	16.0	21.0
Length of carapax, excluding rostrum	9.7	7.0	10.0	12.7
Length of rostrum	7.7	6.0	6.8	10.2
Breadth of carapax at antero-lateral angles	7.4	5.3	7.2	9.7
Greatest breadth	7.4	5.4	7.5	10.1
Diameter of eye	1.2	0.7	1.0	1.4
Length of cheliped	25.5	16.5	20.5	27.0
Length of chela	10.0	5.6	8.0	10.3
Breadth of chela	1.9	1.4	1.7	2.1
Length of dactylus	4.9	3.0	3.9	5.0
Length of first ambulatory peræopod	20.5	13.5	17.5	22.0

MUNIDOPSIS CRASSA Smith.

Proc. National Mus., viii, p. 494, 1885.

(Plate IV.)

Station 2224, September 8, north lat. 36° 16′ 30″, west long. 68° 21′, 2,574 fathoms, globigerina ooze, temperature 37°, one female (8563).

Three additional specimens of this species were taken in 1885, a male and a female (10802), at station 2566, August 29, north lat. 37° 23′, west long. 63° 8′, 2,620 fathoms, gray ooze, temperature 37°; and a single female (10803) at station 2573, north lat. 40° 34′ 18″, west long. 66° 9′, 1,742 fathoms, gray mud and sand, temperature 37°.

This species resembles *M. Bairdii* in having spine-tipped eye-stalks and the dorsum of the pleon without median teeth or spines, but is at once distinguished from it by the broad and stout non-spined rostrum, the spiny propodi of the ambulatory peræopods, and the very different armament of the carapax.

Female.—The carapax is very broad and the lateral margins nearly parallel. The front is gradually narrowed from between the bases of the peduncles of the antennæ into a very broad, stout, triangular, and nearly horizontal rostrum about half as long as the greatest breadth of the carapax, and over the bases of the ocular spines fully half as broad as long. The rostrum is flat or very slightly concave, and nearly smooth beneath, but the dorsal side has a strong median carina, and is roughened with small tubercles; the sharp lateral edges are armed with a few minute teeth. There is a prominent acutely triangular spine on the anterior margin over the base of the antenna each side, and outside of this a conical spine directed forward from the angle of the small hepatic region, which really forms the antero-lateral angle of the carapax, though the anterior lobe of the branchial region expands laterally much beyond the hepatic region, and is armed at its anterior angle with a great dentiform spine, back of which there are several smaller spines on the lateral margin of this lobe and a single small one at the anterior angle of the posterior branchial lobe. The gastric region is prominent, and armed in front with a pair of sharp conical spines, and back and outside of these with many smaller spines and tubercles, as are also the anterior branchial lobes, and the extreme anterior portions of the branchial and cardiac regions. The cervical suture and the suture between the anterior and posterior lobes of the branchial region are marked by smooth grooves, of which the gastro-cardiac portion of the cervical is the most conspicuous. The whole posterior part of the cardiac and branchial regions is armed with sharply crenulated, transverse, and broken rugæ with smooth spaces between, and a broader smooth space along the posterior margin, which is armed with a high double crest, the edges of which are sharply crenulated.

The eye-stalks are short, broad, and somewhat cuboidal in form, are capable of very little motion, bear the rather small hemispherical white eye partially embedded at the end, which projects on the dorso-mesial side in a slender spine longer than the diameter of the cornea, and are armed with a much smaller spine on the outer edge just back of the eye, and with a very small spine or tubercle similarly situated on the lower mesial angle.

The stout first segment of the peduncle of the antennula is armed distally with two long spines on the outer side, and beneath with a short, somewhat truncated and minutely dentate process. The second segment of the peduncle of the antenna is armed with a dentiform process below and a sharp tooth on the outer side; the third segment is armed with a single large distal spine on the outside; the fourth and fifth segments are only inconspicuously armed. The flagellum is slightly compressed, more than twice as long as the carapax, and sparsely clothed with slender setæ.

The infero-mesial edge of the merus of the second gnathopod is armed with three conical spines.

The chelipeds are not very much longer than the carapax, including the rostrum, and very stout; the merus is considerably shorter than the chela and armed with a few sharp spines along the dorsal edge and at the distal end, and with numerous small tubercles; the carpus is armed somewhat like the merus, but there are more and smaller spines at the distal end; the chela is about as long as the breadth of the carapax between the hepatic spines, more than a third as broad as long, considerably compressed vertically, somewhat roughened with small tubercles, especially along the inner edge, and with the stout and straight digits making more than half the whole length. The three pairs of ambulatory peræopods are very nearly alike and a little longer than the chelipeds; the meri and carpi are roughened with small tubercles, angulated, and armed with a series of spines above; the propodi are angulated, with all the angles rough and tuberculous and the dorsal spiny; the dactyli are very stout, very slightly tapered except near the curved, acute, and chitinous tip, and armed along the lower edge with a series of stout spiniform teeth which rapidly decrease in size and become obsolete proximally. The posterior peræopods are very nearly as in the allied species.

The pleon is about as broad as the carapax, only slightly narrowed posteriorly, and the dorsum is transversely rounded and devoid of longitudinal carinæ, teeth, or spines. The second and third somites each have two slightly roughened transverse ridges upon the dorsum separated by a smooth sulcus, but the dorsa of the succeeding somites are nearly smooth. The posterior margin of the sixth somite projects in a prominent median lobe, with a smaller and much less prominent lobe either side. The exposed parts of all the pleura are sparsely tuberculous and their lower edges obtuse. The second pleuron is broader than the others and its anterior edge upturned, leaving a broad depression between it and the prolongation of the transverse carina of the dorsum, which makes a median ridge.

The telson, uropods, and pleopods are very nearly as in *M. Bairdii* ane *M. rostrata.*

The eggs in the recently preserved alcoholic specimen measure 3.4 by 3.6^{mm} in less and greater diameter.

Measurements are given farther on with those of the next species.

MUNIDOPSIS SIMILIS Smith.

Proc. National Mus., vii, p. 496, 1885.

(Plate V, Figs. 1–1*e*; Plate VI, Figs. 2, 2*a*.)

Station 2192, August 5, 1884, north lat. 39° 46′ 30″, west long. 70° 14′ 45″, 1,060 fathoms, globigerina ooze, temperature, 38.6°; one female (8255).

This species, represented by a single egg-bearing female, is very closely allied to *M. crassa*, and will possibly prove to be a variety of it. The single specimen is very much smaller than those of *M. crassa*, but is evidently fully adult if not grown to the full size to which the species attains.

Female.—The form and proportions of the carapax are almost exactly as in the last species, but all the marginal spines are more slender and the only spines on the dorsal surface proper are a single pair on the anterior part of the gastric region; the rest of the anterior part of the carapax being only slightly roughened with minute transverse broken rugæ, while the posterior portions are armed very nearly as in *crassa*, though the carina of the posterior margin is proportionally wider and not distinctly double nor sharply crenulated.

The eyes, antennulæ, and antennæ are almost exactly as in the last species, and so are the oral appendages, except the merus of the second gnathopod, which is armed with a few scarcely spiniform tubercles in place of conical spines.

The right cheliped is considerably smaller than the left, and is apparently a reproduced appendage. The left is considerably more slender and much longer than in *crassa*, being fully once and two-thirds as long as the carapax, including the rostrum; the merus is armed along all the angles, except the outer or posterior, as well as at the distal end, with long spines; the carpus is armed dorsally with three spines at the distal end, and with one or two on the inner edge; the chela is much longer than the greatest breadth of the carapax, a third as broad as long, armed along the inner edge with two or three spines, and has the digits about half the whole length. The ambulatory peræopods are nearly alike and a little longer than in *crassa;* the meri and carpi are armed nearly as in that species, but the propodi each have only a single spine on the dorsal edge.

The whole dorsal surface of the pleon is nearly smooth, though there is a shallow transverse sulcus on the second and third somites. The middle of the posterior margin of the sixth somite is truncated and less prominent than the small lobe on either side.

The eggs are apparently considerably smaller than in *crassa*, measuring 2.7 by 2.9^{mm} in the recently preserved alcoholic specimen, which was carrying only 24 eggs, the bulk of which was equal to between an eighth and a ninth of the bulk of the entire animal excluding the eggs.

Measurements in millimeters.

	M. crassa.	M. similis.
Catalogue number	8563	8255
Station	2224	2192
Sex	♀	♀
Length from tip of rostrum to tip of telson	125	45
Length of carapax, including rostrum	65	24.2
Length of rostrum	19.2	7.5
Greatest breadth of carapax, including spines	39.2	13.7
Breadth of bases of antero-lateral spines	29.4	10.5
Breadth at branchial regions	38.0	13.3
Length of eye-stalk, including spine	7.5	2.3

Measurements in millimeters—Continued.

	M. crassa.	M. similis.
Length of spine	3.0	1.5
Diameter of eye	2.7	1.2
Length of right cheliped	73	37
Length of right chela	29.3	13.5
Breadth of right chela	10.9	3.2
Length of dactylus	16.8	7.1
Length of left cheliped	74.0	41
Length of left chela	29.5	15.0
Breadth of chela	11.0	5.0
Length of dactylus	16.8	7.6
Length of first ambulatory peræopod	85	40
Length of propodus	22.0	5.9
Length of dactylus	15.4	11.3
Length of posterior peræopod	48	22
Length of telson	16.0	6.0
Breadth of telson	23.5	7.4
Length of inner lamella of uropod	13.0	5.0
Breadth of inner lamella of uropod	14.5	4.0
Length of outer lamella of uropod	14.5	5.2
Breadth of outer lamella of uropod	12.7	4.0

MUNIDOPSIS ROSTRATA Smith.

Galacantha rostrata A. M.-Edwards, Bull. Mus. Comp. Zool., viii, p. 52, 1880. Smith, *ibid.*, x, p. 21, pl. 9, figs. 2–2*a*, 1882; Report U. S. Fish Com., x, for 1882, p. 355, 1884.

Munidopsis rostrata Smith, Proc. National Mus., vii, p. 493, 1885.

(Plate VI, Figs. 1, 1*a*.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8176	2208	39 33 00	71 16 15	1178	38	gn. M. S.	Aug. 21	.. 1	1
8564	2230	38 27 00	73 02 00	1168	37	gy. O.	Sept. 12	.. 1s	0

MUNIDOPSIS BAIRDII Smith.

Galacantha Bairdii Smith, Report U. S. Fish Com., x, for 1882, p. 356, 1884.
Munidopsis Bairdii Smith, Proc. National Mus., vii, p. 493, 1885.

(Plate V, Fig. 2.)

No specimens of this species were taken in 1884. Two additional specimens (10801) were, however, taken in 1885 with a specimen of *M. crassa*, at station 2,573, in 1,742 fathoms. The figure is from the type taken in 1883.

In the original description of the species, in my report on the Albatross crustacea of 1883, the transverse ridges on the dorsum of the second, third, and fourth somites of the pleon are described, by an evident mistake, as on the first, second, and third.

EUMUNIDA PICTA Smith.

Proc. National Mus., vi, p. 44, pl. 2, fig. 2, pl. 3, figs. 6–10, pl. 4, figs. 1–3a, 1883.

Station 2264, October 18, off Chesapeake Bay, north lat. 37° 07′ 50″, west long. 74° 34′ 20″; 167 fathoms, gray sand, temperature, 58°; one male and one small female (8891). The male, which is larger than any previously seen, gives the following:

Measurements in millimeters.

Length from tip of rostrum to tip of telson	50
Length of carapax, including rostrum	26.2
Length of rostrum	8.2
Breadth of front	6.9
Breadth at basis of antennal spines	12.4
Greatest breadth, including spines	18.7
Length of eye-stalk and eye	3.9
Greatest diameter of eye	3.1
Length of cheliped	70
Length of merus	29
Length of carpus	5.5
Length of chela	30
Breadth of chela	3.4
Length of dactylus	15
Length of first ambulatory peræopod	42
Length of propodus	13.3
Length of dactylus	6.3
Length of telson	4.4
Breadth of telson	9.5
Length of inner lamella of uropod	4.5
Breadth of inner lamella of uropod	3.1
Length of outer lamella of uropod	5.5
Breadth of outer lamella of uropod	3.2

MACRURA.

ERYONTIDÆ.

PENTACHELES SCULPTUS Smith.

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
8242	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	..	1	......
8243	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	1 *y.*	1 *y.*	......
8244	2213	39 58 30	70 30 00	384	39	gn. M.	Aug. 22	1 *y.*	..	......
8568	2233	38 36 30	73 06 00	630	39	gn. M.	Sept. 12	1 *s.*	..	......
7164	2235	39 12 00	72 03 30	707	39	gn. M.	Sept. 13	1 *s.*	..	......

PENTACHELES NANUS Smith.

(Plate VII, Figs. 1, 1*a*.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
7946	2182	39 25 30	71 44 00	861	39	gn. M.	July 23	1 ..	......
8068	2192	39 46 30	70 14 45	1,060	39	gy. O.	Aug. 5	.. 1	1
8235	2203	39 34 15	71 45 15	705	39	gn. M., S.	Aug. 19	.. 1	0
8236	2204	39 30 30	71 44 30	728	39	bn. M.	Aug. 19	.. 1 y. ..	0
8237	2205	39 35 00	71 18 45	1,073	38	gy. O.	Aug. 20	1 4	2
8238	2206	39 35 00	71 24 30	1,043	38	gn. M.	Aug. 20	.. 1 y. 1	1
8239	2209	39 34 45	71 21 30	1,080	39	glb. O.	Aug. 21	.. 2	0
8240	2210	39 37 45	71 18 45	991	38	gy. glb. O.	Aug. 21	.. 1 y.	0
8241	2217	39 47 20	69 39 15	924	38	gy. M.	Aug. 23	.. 1	0
8571	2230	38 27 00	73 02 00	1,168	37	gy. O.	Sept. 12	.. 2	0
8570	2231	38 29 00	73 09 00	965	39	gy. O.	Sept. 12	1 ..	......
8545	2234	39 09 00	72 03 15	816	39	gn. M.	Sept. 13	1 s. ..	......
8569	2235	39 12 00	72 03 30	707	39	gn. M.	Sept. 13	1 s. ..	......

PENTACHELES DEBILIS Smith.

(Plate VII, Fig. 2.)

No specimens have been taken since 1883.

CRANGONIDÆ.

CRANGON VULGARIS Fabricius.

Specimens examined.

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8684	2253	40 34 30	69 50 45	32	53	gy. S.	Sept. 27	.. 1	0
8685	2256	40 38 30	69 29 00	30	53	yl. S.	Sept. 28	.. 1	1

[Locality: Off Cape Hatteras.]

7259	2307	35 42 00	74 54 30	43	57	gy. S.	Oct. 21	1 y.	......

Sclerocrangon Agassizii.

Ceraphilus Agassizii Smith, Bull. Mus. Comp. Zool., x, p. 32, pl. 7, figs. 4–5*a*, 1882; Rep. U. S. Fish Com., x, for 1882, p. 362, 1884.

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7949	2171	37 59 30	73 48 40	444	39	gn. M.	July 20	..	1	1
7950	2172	38 01 15	73 44 00	568	39	gn. M.	July 20	..	1	1
8178	2201	39 39 45	71 35 15	538	39	bu. M.	Aug. 19	..	5 *s.*	0
......	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	..	1	0
8603	2237	39 12 17	72 09 30	520	39	gn. M.	Sept. 13	..	3	2

This species should evidently be referred to G. O. Sars's genus *Sclerocrangon*, which includes *Ceraphilus boreas* and *C. ferox*. The genus is distinguished from the typical species of *Ceraphilus* by the inner lamellæ of the pleopods being very much smaller than the outer and without the stylet on the mesial edge. The thick, rough integument and the very slender second peræopods with minute chelæ are, perhaps, also characteristic.

Pontophilus Norvegicus Sars.

(Plate XI, Figs. 6, 6*a*, 7.)

Specimens examined.

[Locality: Off Long Island.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7947	2178	39 29 00	72 05 15	229	42	gn. M., S.	July 22	..	1	0

[Locality: Off Martha's Vineyard.]

8069	2183	39 57 45	70 56 30	195	44	gn. M., S.	Aug. 2		1	......
8070	2186	39 52 15	70 55 30	353	40	gn. M., S.	Aug. 2		2	0
8071	2187	39 49 30	71 10 00	420	40	gn. M., S.	Aug. 3	1	3	......
8171	2212	?39 59 30	?70 30 45	428	40	gn. M.	Aug. 22		8	0
8618	2232	?38 37 30	?73 11 00	243	43	gn. M.	Sept. 12	1	2	......
7197	2246	39 56 45	70 20 30	122	48	gn. M.	Sept. 26		1*y*	0
8674	2262	39 54 45	69 29 45	250	42	gn. M., S.	Sept. 28		8	2
8689	2262	39 54 45	69 29 45	250	42	gn. M., S.	Sept. 28		1	0
7192	(?)	....	....	....	....	....	....	1	..	

PONTOPHILUS BREVIROSTRIS Smith.

Specimens examined.

Catalogue number.	Station number.	Locality. N. lat.	Locality. W. Long.	Depth, temperature, and nature of bottom. Fathoms.	°	Materials.	Date.	Specimens. Number. ♂	Specimens. Number. ♀	Specimens. With eggs.
[Locality: Off Long Island.]										
		° ′ ″	° ′ ″							
7948	2177	39 33 40	72 08 45	87	52	gn. M., S.	1884. July 22	..	1	1
[Locality: Off Martha's Vineyard.]										
......	2183	39 57 45	70 56 30	195	44	gn. M., S.	Aug. 2	..	1	0
7193	2243	40 10 15	70 26 00	63	52	gn. M.	Sept. 26	1	2	1
7194	2244	40 05 15	70 23 00	67	53	gn. M., S.	Sept. 26	..	2	1
7196	2247	40 03 00	69 57 00	78	52	gn. M., S.	Sept. 27	..	6	3
7198	2248	40 07 00	69 57 00	67	52	gn. M., S.	Sept. 27	1 5*y*.	2	1
[Locality: Off Chesapeake Bay.]										
8904	2265	37 07 40	74 35 40	70	63	gn. M., G.	Oct. 18	..	15	4
[Locality: Off Cape Hatteras.]										
7243	2287	35 22 30	75 26 00	7	....	crs. gy. S.	Oct. 20	2	..	......

PONTOPHILUS ABYSSI Smith.

(Plate XI, Figs. 3, 3*a*, 4, 5.)

Station 2226, September 10, north lat. 37°, west long. 71° 54′, 2,021 fathoms, globigerina ooze, temperature 37°; 3 ♂ and 2 ♀ carrying eggs (8600). The station of another female (8525) is unfortunately not given.

These specimens are in much better condition than those originally described, and show that the species is perfectly distinct from *P. gracilis*. A large female gives the following:

Measurements in millimeters.

Length from tip of rostrum to tip of telson	62.0
Length of carapax, including rostrum	17.0
Length of rostrum	2.8
Breadth of carapax at antennal spines	8.0
Greatest breadth of carapax	8.5
Greatest diameter of eye	1.8
Length of antennal scale	9.1
Breadth of antennal scale	2.7
Length of first peræopod	21.0
Length of chela	7.5
Length of dactylus	3.1

Length of second peræopod	9.5
Length of third peræopod	25.0
Length of merus	6.0
Length of carpus	7.3
Length of propodus	3.7
Length of dactylus	1.9
Length of fourth peræopod	23.0
Length of merus	5.4
Length of carpus	3.3
Length of propodus	4.5
Length of dactylus	2.8
Length of sixth somite of pleon	11.0
Height of sixth somite of pleon	3.5
Length of telson	11.5
Length of inner lamella of uropod	9.0
Breadth of inner lamella of uropod	1.7
Length of outer lamella of uropod	8.4
Breadth of outer lamella of uropod	2.5

PONTOPHILUS GRACILIS Smith.

Bull. Mus. Comp. Zool., x, p. 36, pl. 7, figs. 2, *2a*, *2b*, *2c*, 3, *3a*, 1882.

(Plate XI, Figs. 1, *1a*, 2.)

This species, first described from a single specimen in the Blake collection of 1880, has not yet been found in the Albatross collections, although two specimens were taken by the Fish Hawk in 1881 off Martha's Vineyard: Station 994, September 8, north lat. 39° 40′, west long. 71° 30′, 368 fathoms, mud, temperature 40°—one female; and station 1029, September 14, north lat. 39° 57′ 6″, west long. 69° 16′, 458 fathoms, mud and sand, temperature 40°—one male.

SABINEA PRINCEPS Smith.

(Plate X, Figs. 1, *1a*, *1b*, 2.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
7951	2171	37 59 30	73 48 40	444	39	gn. M.	July 20	2 *l.*	1
7952	2172	38 01 15	73 44 00	568	39	gn. M.	July 20	1 *y.*	0
7953	2179	39 30 10	71 50 00	510	39	bk. M.	July 22	4 3	1
7954	2180	39 29 50	71 49 30	523	39	bk. M.	July 23	1 4	1
8072	2186	39 52 15	70 55 30	353	40	gn. M., S.	Aug. 2	1 *y.* 2	0
8074	2187	39 49 30	71 10 00	420	40	gn. M., S.	Aug. 3	1	0
8170	2201	39 39 45	71 35 15	538	39	bu. M.	Aug. 19	1 *y.*	0
8168	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	4 10	6
8165	2213	?39 58 30	?70 30 00	384	39	gn. M.	Aug. 22	7 15	8
8163	2214	39 57 00	70 32 00	475	39	gn M.	Aug. 22	1 2	2
8593	2233	?38 36 30	?73 06 00	630	39	gn. M.	Sept. 12	1 3	0
8580	2237	39 12 17	72 09 30	520	39	gn. M.	Sept. 13	5	0

A female 130mm in length, taken in 1885 at station 2546, was carrying 353 eggs, about 2.6 by 3.0mm in shorter and longer diameter. Although so few in number the eggs were equal to a fifth of the bulk the entire animal exclusive of the eggs.

SABINEA SARSII Smith.

(Plate X, Figs. 3, 3*a*, 4.)

This northern species was not taken in 1884 and is figured from specimens taken the year previous.

GLYPHOCRANGONIDÆ.

GLYPHOCRANGON SCULPTUS Smith.

(Plate VIII, Fig. 3; Plate IX, Figs. 1, 2.)

Station 2196, August 6, north lat. 39° 35′, west long. 69° 44′, 1,230 fathoms, green mud, temperature 38°; one female carrying 97 eggs (8073). The eggs measured 2.6 by 3.4mm in shorter and longer diameter, and the entire number were equal to rather more than a tenth of the bulk of the entire animal exclusive of the eggs.

GLYPHOCRANGON LONGIROSTRIS Smith.

Rhachocaris longirostris Smith, Bull. Mus. Comp. Zool., x, p. 51, pl. 5, fig. 1, pl. 6, fig. 1, 1882.

Glyphocrangon longirostris Smith, Report U. S. Fish Com., x, for 1882, p. 365, 1884.

(Plate VIII, Figs. 1, 2; Plate IX, Figs. 3, 4, 5.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
8256	2205	39 35 00	71 18 45	1,073	38	gy. O.	Aug. 20	.. 1	1
8257	2206	39 35 00	71 24 30	1,043	38	gn. M.	Aug. 20	2 ..	......

These specimens obtained by the Albatross are all adult, and differ considerably from the young female originally described. The adult specimens have dark-colored eyes as in the other species, and in several particulars are more like *G. sculptus* than the young specimen was, although the two species are specifically very distinct, as the accompanying figures and the following description of the adults will show.

The rostrum is relatively shorter than in the young specimen but still rather longer than in *G. sculptus;* the basal two-thirds is horizontal, but the tip strongly upturned, regularly tapered, and acute; there is a slight median carina nearly or quite the whole length; there are lateral spines and the corresponding pair of spines at the base of the rostrum as in *G. sculptus;* and between the lateral spines and the curved tip the surface is irregularly corrugated. The inferior edge of the rostrum is grooved, the groove being broadest at the beginning of the curved portion, and toward the tip there is in addition a slight median carina. The carinæ of the carapax have nearly the same arrangement as in *G. sculptus.* The tubercles of the slightly prominent dorsal carinæ are all very low, obtuse, and punctate, and the space between the carinæ unarmed or armed only by a few small tubercles in front. On the lateral lobes of the gastric region the tubercles are all low and more or less obtuse, except the anterior, which is acute and much more prominent than the others. The antennal and antero-lateral spines are nearly as in *G. sculptus.* The lateral carina of the antennal region is continuous and terminates anteriorly in a sharp tooth, back of which the edge is obtuse and punctate. Back of the cervical suture the upper lateral carina is prominent; the tubercles with which it is surmounted are all obtuse and punctate. The middle lateral carina is continuous, broad, and punctate, and the lower carina is very low, but well marked by being punctate. The inferior margin of the carapax is carinated, as in the other species.

The eye-stalks are very short, and the eyes themselves relatively about as broad as in the other species, and in the alcoholic specimen are dark purplish brown.

The peduncles of the antennulæ reach to the tips of the antennal scales in the female and a little beyond in the male, and are less hairy than in *G. sculptus.* The inner flagellum is very slender, regularly tapered, slightly longer than the outer, about as long as the carapax excluding the rostrum, in the male, and considerably shorter in the female, but in other respects not different in the two sexes. The proximal half of the outer flagellum is very broad and strongly compressed vertically in the male, and tapers suddenly to the very slender terminal portion, while in the female the proximal half, though compressed and expanded, is only about half as broad as in the male. The antennal scales are smaller than in *G. sculptus*, being only about three-sevenths as long as the carapax, excluding the rostrum, ovate, about three-fifths as broad as long, and have a very indistinct tooth about the middle of the outer margin, which is only obscurely ciliated back of the tooth.

The second gnathopods and first peræopods are almost exactly as in *G. sculptus.* The second peræopods are alike in the two sexes and very nearly like those of *G. sculptus*, but a little longer, reaching slightly by the tips of the antennal scales, and the right carpus has about twenty-five segments, two or three more than the left, which is very slightly shorter than the right. The third peræopods are nearly as in the other species, reach a little beyond the tips of the antennal scales, and their dactyli are a little more than a third as long as the propodi and very slender. The fourth and fifth pairs of peræopods are but very little if at all stouter than the third; the fascicles of setæ at the tips of the propodi are about half as long as the propodi themselves, and the propodi are about as long as in the third pair, strongly compressed as in *G. Agassizii*, but slender and not expanded at all in the middle.

The sculpturing of the abdomen resembles that of *G. sculptus*, but the dorsal carina is less prominent and more obtuse, and the tubercles are fewer in number, obtuse, and punctate. The marginal spines of the pleura of the second to the fifth somite are all short, and there is usually no posterior spine on the fifth. The lateral spines of the sixth somite are about as prominent and fully as stout as in *G. sculptus*.

The telson is shorter than in the young specimen originally described, being considerably shorter than the carapax exclusive of the rostrum, and has nearly the same form and sculpturing as in *G. sculptus*, though the tip is slightly more upturned and the carinæ smoother toward the base. The outer lamella of the uropod is only about three-fourths as long as the telson, rather more than a third as broad as long, with the lateral spine farther from the tip than in the other species. The inner lamella is narrow and usually longer than the outer. The uropodal lamellæ are, however, occasionally subject to considerable variation, as shown in the first column of the accompanying table of measurements. There is no appearance of injury or redevelopment in the uropods of the specimen from which these measurements were taken, although the abnormal variation is very likely due to some such cause.

A female 104^mm^ long, taken, 1885, at station 2550, was carrying 86 eggs, 2.8 by 3.1^mm^ in shorter and longer diameter, and the entire number were equal to a little more than a tenth of the bulk of the entire animal, exclusive of the eggs.

Measurements in millimeters.

Catalogue number	8257		8257		8256	
Station	2206		2206		2205	
Sex	♂		♂		♀	
Length from tip of rostrum to tip of telson	99		101		107	
Length of carapax, including rostrum	41.2		...		43.4	
Length of rostrum	19.0		...		18.0	
Breadth of carapax in front, including spines	20.3		...		20.0	
Breadth of carapax at cervical suture	13.5		...		15.0	
Breadth of carapax back of cervical suture	16.0		...		18.6	
Length of eye-stalk and eye	5.6		5.8		5.5	
Greatest diameter of eye	5.5		5.7		5.8	
Length of antennal scale	8.7		...		11.0	
Breadth of antennal scale	5.7		...		6.5	
Length of second gnathopod	22		...		23	
Length of first peræopod	21		...		22	
Length of merus	8.2		...		8.8	
Length of carpus	2.2		...		2.1	
Length of propodus	4.1		...		4.6	
Length of dactylus	2.5		...		2.8	
	right.	left.			right.	left.
Length of second peræopod	29	28	...		33	32
Length of merus	5.3	5.4	...		5.5	5.5
Length of carpus	13.5	12.0	...		15.0	14.5
Length of chela	1.2	1.5	...		1.3	1.6
Length of third peræopod	35		...		35	
Length of propodus	8.5		...		8.2	
Length of dactylus	2.5		...		2.6	
Length of fifth peræopod	34		...		36	
Length of propodus	8.0		...		8.4	
Length of dactylus	2.3		...		2.9	
Length of sixth somite of pleon	8.0		...		9.0	
Length of telson	17.5		18.3		20.0	
	right.	left.	right.	left.	right.	left.
Length of inner lamella of uropod	13.3	11.3	13.6	13.6	14.5	14.6
Breadth of inner lamella of uropod	2.9	2.8	3.0	3.0	3.5	3.5
Length of outer lamella of uropod	12.6	13.6	13.0	13.0	14.0	14.0
Breadth of outer lamella of uropod	4.8	4.7	4.7	4.7	5.8	5.7

ALPHEIDÆ.

ALPHEUS MINUS Say.

Station 2280, October 19, off Cape Hatteras, north lat. 35° 21′, west, long. 75° 21′ 30″, 16 fathoms, gray sand; 15 specimens (8846).

HIPPOLYTE LILJEBORGII Danielssen.

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
[Locality: Off Long Island.]									
		° ′ ″	° ′ ″		°		1884.	♂ ♀	
7956	2175	39 33 00	72 18 30	452	40	gn. M.	July 22	.. 1	0
7957	2178	39 29 00	72 05 15	229	42	gn. M. S.	July 22	.. 2	0
[Locality: Off Delaware Bay.]									
8606	2232	38 37 30	73 11 00	243	43	gn. M.	Sept. 12	3 ..	0
[Locality: Off Martha's Vineyard.]									
7200	2262	39 54 45	69 29 45	250	42	gn. M. S.	Sept. 28	5 ..	0
[Locality: Off Chesapeake Bay.]									
7208	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	2 ..	0
7214	2265	37 07 40	74 35 40	70	63	gn. M. G.	Oct. 18	1 ..	0

BYTHOCARIS GRACILIS Smith.

Proc. National Mus., vii, p. 497, 1885.

Specimens examined.

(Plate XII, Figs. 3, 4.)

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
[Locality: Off Cape Hatteras.]									
		° ′ ″	° ′ ″				1883.	♂ ♀	
7132	2116	35 45 23	74 31 25	888	39	bu. M. fne S.	Nov. 11.	 1	1
[Locality: Off Martha's Vineyard.]									
							1884.		
8258	2206	39 35 00	71 24 30	1043	38	gn. M.	Aug. 20	 1	1

This species is closely allied to *B. Payeri* G. O. Sars, but the specimens differ conspicuously from specimens of *B. Payeri* from the Faröe Channel, received from the Rev. Dr. Norman, in the size of the eyes and the form of the antennal scales.

Female.—The carapax is about two-thirds as broad as its length along the dorsum, and the front about a sixth as broad as the length and very nearly as in *B. Payeri*, but the lateral teeth are a little more prominent than in that species. The short median carina on the gastric region terminates abruptly in a small tooth anteriorly, not present in any of the specimens of *B. Payeri.* The eye-stalk and eye are about a fourth as long as the dorsum of the carapax, and the diameter of the black eye about three-fifths of the length of the stalk and eye. In the specimens of *B. Payeri* the eyes are considerably smaller, about a fifth as long as the carapax, and the diameter about half the length of the eye and stalk. The first segment of the peduncle of the antennula is armed with a very slender and acute lateral spine, which reaches nearly as far forward as the segment itself. The antennal scale is fully as long as the dorsum of the carapax and less than a third as broad as long, while in *B. Payeri* it is rather shorter and considerably broader. The peræopods and pleon are very nearly as in *B. Payeri.*

The eggs in the alcoholic specimens are about 1.8 by 1.4^{mm} in longer and shorter diameter.

In the following table similar measurements of this species and a specimen of *B. Payeri* are given for comparison.

Measurements in millimeters and hundredths of length of carapax.

	B. gracilis.		B. Payeri.	
Station	2116		.	
Sex	♀		♀	
	Mm.	*Per cent.*	*Mm.*	*Per cent.*
Length from front to tip of telson	39.0=	464	50.0=	476
Length of carapax	8.4	100	10.5	100
Breadth of carapax	5.5	65	6.7	64
Breadth of front	1.4	17	1.6	15
Length of eye-stalk and eye	2.0	24	2.0	19
Greatest diameter of eye	1.3	15	1.0	10
Length of antennal scale	8.5	101	9.6	92
Breadth of antennal scale	2.8	35	4.3	41
Length of sixth somite of pleon	6.1	73	8.0	76
Height of sixth somite of pleon	2.3	27	3.6	34
Length of telson	7 5	89	9.0	86
Length of inner lamella of uropod	5.6	67	7.3	70
Breadth of inner lamella of uropod	1.8	21	2.4	23
Length of outer lamella of uropod	7.0	83	8.8	84
Breadth of outer lamella of uropod	2.4	29	3.5	33

Bythocaris Payeri and the following species, *B. nana*, differ remarkably from *Hippolyte* and the allied genera in the reduced number of the branchiæ and epipods. There are no epipods proper at the bases of any of the gnathopods or peræopods, and no podobranchiæ nor arthrobranchiæ on any of the somites, as the following branchial formula shows:

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	0	0	0	0	0	0	0	(1)
Podobranchiæ	0	0	0	0	0	0	0	0	0
Arthrobranchiæ	0	0	0	0	0	0	0	0	0
Pleurobranchiæ	0	0	0	1	1	1	1	1	5
									5+(1)

BYTHOCARIS NANA Smith.

Proc. National Mus., vii, p. 499, 1885.

(Plate XII, Fig. 2.)

Specimens examined.

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1880.	♂	♀	
......	865	40 05 00	70 23 00	65	68	fne. S. M.	Sept. 4	3	5	5
......	872	40 05 39	70 23 52	86	50	S. G. Sh. Spg.	Sept. 4	......	2	1
......	874	40 00 00	70 57 00	85	51	sft. M.	Sept. 14	1	......	......
......	878	39 55 00	70 54 15	142	52	M.	Sept. 24	2	6	6

[Locality: Off Chesapeake Bay.]

7215	2265	37 07 40	74 35 40	70	63	gn. M. G.	1884. Oct. 18	2	......	......

This is a small species, at once distinguished from *B. Payeri* and *B. gracilis* by the very much broader and differently shaped front, and the much longer eye-stalks.

The carapax is about three-fourths as broad as its length along the dorsum, and the breadth of the front fully a third of the length. The supraorbital teeth are very large, and project as far forward as the very small rostral tooth. The median carina of the gastric region is low and inconspicuous.

The eyes are well developed, placed obliquely upon the stalks, and black. The length of the eye and stalk is about equal to the breadth of the front, and the diameter of the eye considerably greater than that of the stalk, equaling about a fifth the length of the carapax. The first segment of the peduncle of the antennula reaches a little beyond the eye, and its lateral spine is slender and falls considerably short of the distal end of the segment itself. The outer flagellum is very stout in both sexes, and tapers rapidly to a very slender tip, reaching to, or a little beyond, the tip of the antennal scale. The inner flagellum is very slender, and slightly longer than the outer. The antennal scale is shorter than the dorsum of the carapax, a little more than a third as broad as long, and has the tip more elongated than in the last species. The flagellum of the antenna is very slender, subcylindrical, and much longer than the body of the animal.

The endopod of the second gnathopod reaches nearly to the tip of the antennal scale; the distal and proximal of the three segments of which it is composed are approximately equal in length; the middle segment is about two-fifths as long as the proximal, and the exopod scarcely reaches to the middle of the proximal segment of the endopod and is very slender. The first peræopods reach to near the tips of the peduncles of the antennæ; the carpus and chela are together as long as the rest of the endopod; the chela is about once and two-thirds as long as the carpus, slightly stouter, about a fourth as broad as long, and the digits slender and a little less than half as long as the whole length of the chela. The second peræopods are very slender and reach considerably beyond the antennal scales; the ischium and merus are subequal in length; the carpus is a little less than twice as long as the merus, and composed of eight segments; the chela is nearly cylindrical and about once and two-thirds as long as the distal segment of the carpus, and no stouter. The third, fourth, and fifth peræopods are nearly alike, and about as long as the second; the meri and propodi are subequal in length, and the meri are armed with three to seven spines along the distal part of the lower edge; the lower edges of the propodi are clothed with a few plumose hairs, and armed with several very slender spines; the dactyli are approximately a fourth as long as the propodi, slightly curved, regularly tapered to an acute tip, and armed along the lower edge with a regular series of spinules.

The pleon is somewhat geniculated and slightly compressed dorsally at the third somite, but none of the somites are carinated. The telson is a little shorter than the sixth somite, evenly rounded above, and regularly tapered to a narrow truncated tip armed with six slender spines, of which the sublateral pair are much larger than the lateral and median.

The eggs, in the alcoholic specimens, are approximately 1.0 by 0.8^{mm} in longer and shorter diameter.

Many of the specimens, after long preservation in alcohol, show dark bands of pigment spots across the antennal scales, uropodal lamellæ, and somites of the pleon.

This is the species to which I have referred as *Bythocaris*, sp. indet., in Proc. National Mus., iii, p. 437, 1881, and Bull. Mus. Comp. Zool., x, p. 55, 1882.

Measurements in millimeters and hundredths of length of carapax.

Station	878.		878.	
Sex	♂		♀	
	Mm.	*Per cent.*	*Mm.*	*Per cent.*
Length from front to tip of telson	25.5=	455	25.0=	455
Length of carapax	5.6	100	5.5	100
Breadth of carapax	4.3	77	4.2	76
Breadth of front	2.0	36	1.9	35
Length of eye-stalk and eye	2.0	36	1.9	35
Greatest diameter of eye	1.1	20	1.1	20
Length of antennal scale	5.0	89	4.6	84
Breadth of antennal scale	1.8	32	1.7	31
Length of sixth somite of pleon	4.1	73	4.0	73
Height of sixth somite of pleon	1.7	30	1.8	33
Length of telson	4.9	87	5.0	91
Length of inner lamella of uropod	3.8	68	3.8	69
Breadth of inner lamella of uropod	1.1	20	1.1	20
Length of outer lamella of uropod	4.2	75	4.3	78
Breadth of outer lamella of uropod	1.3	23	1.4	26

PANDALUS MONTAGUI Leach.

(Plate XIII, Fig. 2.)

Not taken in 1884.

PANDALUS PROPINQUUS G. O. Sars.

(Plate XIII, Fig. 1.)

Specimens examined.

[Locality: Off Long Island.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7958	2175	39 33 00	72 18 30	452	40	gn. M.	July 22	2	1*l.*	0
7959	2178	39 29 00	72 05 15	229	42	gn. M., S.	July 22	..	2*l.*	0
7960	2179	39 30 10	71 50 00	510	39	bk. M.	July 23	2	..	......
7961	2180	39 29 50	71 49 30	523	39	bk. M., S.	July 23	1	1	0

[Locality: Off Martha's Vineyard.]

Catalogue number.	Station number.	N. lat.	W. long.	Fathoms.	°	Materials.	Date.	♂	♀	With eggs.
8076	2186	39 52 15	78 55 30	353	40	gn. M., S.	Aug. 2	3	1	0
8075	2187	39 49 30	71 10 00	420	40	gn. M., S.	Aug. 3	3	2	0
8162	2201	39 39 45	71 35 15	538	39	bu. M.	Aug. 19	2	..	......
8161	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	..	2	......
8160	2212	?39 59 30	?70 30 45	428	40	gn. M.	Aug. 22	..	1	0
8586	2237	39 12 17	72 09 30	520	39	gn. M.	Sept. 13	..	2	2
8673	2262	39 54 45	69 29 45	250	42	gn. M., S.	Sept. 28	45		0

PANDALUS LEPTOCERUS Smith.

Specimens examined.

[Locality: Off Chesapeake Bay.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
7962	2170	37 57 00	73 53 30	155	....	gy. S.	July 20	2 *l.* 14 *l.*	0
7963	2176	39 32 30	72 21 30	302	41	bk. M.	July 22	.. 2	0
7964	2177	49 33 40	72 08 45	87	52	gn. M. S.	July 22	3	0

[Locality: Off Martha's Vineyard.]

8077	2184	40 00 15	70 55 30	136	49	g. M., S.	Aug. 2	1 2	0
8078	2185	40 00 45	70 54 15	129	51	g. M., S.	Aug. 2	2 1	0
8079	2197	39 56 30	69 43 20	84	52	S., brk. Sh.	Aug. 6	12 29	0
8080	2198	39 56 30	69 43 20	84	52	S., brk. Sh.	Aug. 6	.. 2	0
8081	2199	39 57 30	69 41 10	78	....	gy. S.	Aug. 6	10 9	0
8082	2200	39 53 30	69 43 20	148	45	crs. S.	Aug. 6	60	0
8690	(?)	....	....	....	....	....	....	14	8
8676	2239	40 38 00	70 29 45	32	....	gn. M.	Sept. 26	8	1
8677	2240	40 27 30	70 29 00	44	....	gn. M.	Sept. 26	36	3
8678	2241	40 21 00	70 29 15	50	51	gn. M.	Sept. 26	26	2
8679	2242	40 15 30	70 27 00	58	51	gn. M.	Sept. 26	20	3
8680	2243	40 10 15	70 26 00	63	52	gn. M.	Sept. 26	5	2
8667	2244	40 05 15	70 23 00	67	53	gn. M., S.	Sept. 26	75	27
8668	2244	40 05 15	70 23 00	67	53	gn. M., S.	Sept. 26	45	......
8669	2244	40 05 15	70 23 00	67	53	gn. M., S.	Sept. 26	130	......
8670	2245	40 01 15	70 22 00	98	51	gn. M., bk. S.	Sept. 26	95	19
8671	2245	40 02 15	70 22 00	98	51	gn. M., bk. S.	Sept. 26	105	
8681	2246	39 56 45	70 20 30	122	48	gn. M.	Sept. 26	15	12
8672	2247	40 03 00	69 57 00	78	52	gn. M., S.	Sept. 27	74	4
8682	2248	40 07 00	69 57 00	67	52	gn. M., S.	Sept. 27	8	0
8683	2249	40 11 00	69 52 00	53	51	gn. M., S.	Sept. 27	30	1
8666	2250	40 17 15	69 51 45	47	51	gn. M., S.	Sept. 27	190	11
8686	2257	40 32 30	69 29 00	33	52	yl. S.	Sept. 28	1	0
8687	2259	40 19 34	69 29 10	41	50	gy. S.	Sept. 28	5	0
8675	2260	40 13 15	69 29 15	46	50	gy. S.	Sept. 28	50	5
8688	2261	40 04 00	69 29 30	58	54	gy. S.	Sept. 28	18	1

[Locality: Off Chesapeake Bay.]

8755	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	126	12
8756	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	130	13
8865	2264	37 07 50	74 34 20	167	58	gy. S.	Oct. 18	50	3
8768	2265	37 07 40	74 35 40	70	63	gn. M., S.	Oct. 18	68	14

[Locality: Off Cape Hatteras.]

8810	2307	35 42 00	74 54 30	43	57	gy. S.	Oct. 21	1 *y.*	0

NEMATOCARCINIDÆ.

NEMATOCARCINUS ENSIFERUS Smith.

(Plate XVII, Fig. 2.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.			
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.			With eggs.
		° ′ ″	° ′ ″				1884.	♂		♀	
7965	2173	37 57 00	72 34 00	1,600	37	glb. O.	July 21	....		2 *l.*	1
7966	2174	38 15 00	72 03 00	1,594	....	gy. M.	July 21	2 *l.*		9 *l.*	6
7967	2182	39 25 30	71 44 00	861	39	gn. M.	July 23	1 *s.*		1 *s.*	0
8084	2193	39 44 30	70 10 30	1,122	38	gn. M.	Aug. 5	....		2 *s.*	0
8083	2196	39 35 00	69 44 00	1,230	38	gn. M.	Aug. 6	2 *s.*		....	......
8158	2205	39 35 00	71 18 45	1,073	38	gy. O.	Aug. 20	7 *s.*		3 *s.*	0
8157	2206	?39 35 00	?71 24 30	1,043	38	gn. M.	Aug. 20	2 *s.*		2 *s.*	0
8156	2208	39 33 00	71 16 15	1,178	38	gn. M., S.	Aug. 21	1		1	0
8154	2209	39 34 45	71 21 30	1,080	39	glb. O.	Aug. 21	5 *s.*		6 *s.*	0
8153	2210	?39 37 45	?71 18 45	991	38	gy. glb. O.	Aug. 21	8 *s.*		14 *s.*	0
8152	2211	?39 35 00	?71 18 00	1,064	38	gn. M.	Aug. 21	2		2	0
8159	2216	39 47 00	70 30 30	963	39	gn. M.	Aug. 22		5 *y.*		0
8619	2221	39 05 30	70 44 33	1,525	37	gy. O.	Sept. 6	4		5	2
8620	2222	39 03 15	70 50 45	1,537	37	gy. O.	Sept. 6	....		2 *l.*	1
8621	2226	37 00 00	71 54 00	2,021	37	glb. O.	Sept. 10	1	1 *y.*	2	0
8622	2229	?37 38 40	73 16 30	1,423	38	glb. O.	Sept. 11	5 *l.*		....	......
8623	2230	38 27 00	73 02 00	1,168	37	gy. O.	Sept. 12	1		1	......
8596	2231	38 29 00	73 09 00	965	39	gy. O.	Sept. 12	....		1	0
8624	2234	39 09 00	72 03 15	816	39	gn. M.	Sept. 13		2 *s.*		0
8625	2235	39 12 00	72 03 30	707	39	gn. M.	Sept. 13		3 *s.*		0
7165	?	....	....	....	....	....	....		1 *y.*		0
8582	?	....	....	....	....	....	....	1 *l.*		....	......

The anterior margin of the carapax below the orbit and the base of the antenna were not accurately represented in the figure of this species given in my last report, and a corrected figure is therefore given with the illustrations accompanying this report.

The eggs are comparatively small and considerably elongated, being about 0.55mm in shorter and 0.75 to 0.80mm in longer diameter in recently preserved alcoholic specimens. A large female from station 2173 was carrying approximately 16,000 eggs, which were equal to about one-sixth of the bulk of the entire animal, exclusive of the eggs. A specimen 143mm in length, taken in 1885, station 2564, was carrying over 20,000 eggs, which were equal to approximately a fourth the bulk of the animal, exclusive of the eggs.

NEMATOCARCINUS CURSOR A. M.-Edwards.

Ann. Sci. Nat., Zool., VI, ix, No. 4, p. 14, 1881; Recueil de figures de Crustacés nouveaux ou peu connus, pl. [37], 1883.

(Plate XVII, Figs. 1, 1*a*.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
7968	2171	37 59 30	73 48 40	444	39	gn. M.	July 20	..	1 *l.*	1
7969	2179	39 30 10	71 50 00	510	39	bk. M.	July 23	2	2 *l.*	1
7970	2180	39 29 50	71 49 30	523	39	bk. M.	July 23	..	1 *l.*	1
7971	2180	39 29 50	71 49 30	523	39	bk. M.	July 23	2	....	......
7972	2180	39 29 30	71 49 30	523	39	bk. M.	July 23	4	1	......
7973	2181	39 29 00	71 46 00	693	39	gy. M., fne. S.	July 23	..	1 *l.*	1
8150	2201	39 39 45	71 35 15	538	39	bu. M.	Aug. 19	..	2	1
8151	2201	39 39 45	71 35 15	538	39	bu. M.	Aug. 19	1	2	0
8146	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	2	9	3
8147	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	..	1	1
8148	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	..	1	0
8149	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	..	1	0
8144	2212	?39 59 30	?70 30 45	428	40	gn. M.	Aug. 22	..	1	1
8145	2213	?39 58 30	?70 30 00	384	39	gn. M.	Aug. 22	..	1 *l.*	1
8602	2233	?38 36 30	?73 06 00	630	39	gn. M.	Sept. 12	..	1	0
8592	2237	39 12 17	72 09 30	520	39	gn. M.	Sept. 13	3	....	......

A single female was taken by the Fish Hawk in 1880, station 892, October 2, north lat. 39° 46′, west long. 71° 5′, 487 fathoms, soft brown mud and small stones, but no other specimens were found until 1884. During the winter cruise of the Albatross in 1884, a considerable number of specimens (6,810) were taken in the Eastern Caribbean, station 2117, January 27, north lat. 15° 24′ 40″, west long. 63° 31′ 30″, 683 fathoms, yellow mud and fine sand, temperature 40°.

This species is closely allied to *N. ensiferus*, but is readily distinguished by the very much shorter rostrum and larger eyes.

Aside from the rostrum the carapax is nearly as in *N. ensiferus*, but the rostral carina is not quite so high in front, and the rostrum itself is short—less than a third as long as the rest of the carapax—scarcely reaches the distal segment of the peduncle of the antennula, is horizontal, obtusely pointed, the dorsal edge armed with a series of small spines as in *N. ensiferus*, and usually with a minute tooth beneath the tip. The eyes are similar to those of *N. ensiferus*, but much larger, the length of the eye and stalk fully equaling or exceeding the breadth of the antennal scale, and the diameter of the eye equaling about three-fourths of the same amount. The antennulæ, antennæ, and oral appendages differ very little from those of *N. ensiferus*.

The peræopods are similar to those of *N. ensiferus*, but are apparently even longer than in that species. The first pair reach by the tips of the antennal scales by the length of the chelæ or a little more, are naked except at the tips of the digits and unarmed except by single spines at the distal ends of the ischia. The second pair are nearly as long as the length from tip of rostrum to tip of telson, unarmed except by a very few spines on the ischia and meri, and nearly naked except at the tips of the digits. The merus is slightly longer than the carapax, excluding the rostrum, and reaches by the tips of the antennal scales, often by half its length. The carpus is much longer than the merus, and the chela is scarcely more than a tenth as long as the carpus. The third, fourth, and fifth peræopods are approximately equal in length and nearly as long as the length from tip of rostrum to tip of telson, or even considerably longer; the ischia and meri are armed nearly as in the second pair, and the propodi and dactyli have the same structure and nearly the same relative proportions as in *N. ensiferus*.

The pleon is, in general, as in *N. ensiferus;* the dorsum of the third somite, however, is slightly prolonged over the fourth, but not in a prominent tooth, and the pleuron of the fifth somite, though slightly produced posteriorly, is obtusely angular and not prolonged in an acute tooth.

The eggs are apparently very slightly smaller than in *N. ensiferus*, measuring about 0.52^{mm} in shorter and 0.75^{mm} in longer diameter. A specimen 101^{mm} in length from station 2180, was carrying approximately 20,000 eggs, which were equal to nearly one-fourth the bulk of the animal, exclusive of the eggs.

Measurements in millimeters.

Catalogue number	8147	7971	7970	8147
Station	2202	2180	2180	2202
Sex	♀	♂	♀	♀
Length from tip of rostrum to tip of telson	77	90	101	102
Length of carapax, including rostrum	24.2	28.2	30.5	31.0
Length of rostrum	5.4	6.5	7.2	8.3
Height of carapax	10.1	11.1	12.7	12.5
Breadth of carapax	9.4	11.0	13.0	12.7
Length of eye-stalk and eye	3.6	4.4	4.6	4.6
Greatest diameter of eye	2.7	3.1	3.3	3.4
Length of antennal scale	13.2	16.3	17.6	17.7
Breadth of antennal scale	3.2	3.9	4.4	4.5
Length of first peræopod	31	40	....	40
Length of merus	8.5	10.0	....	10.5
Length of carpus	12.5	16.0	....	16.0
Length of chela	3.6	4.0	....	4.4
Breadth of chela	0.7	0.7	....	0.75
Length of dactylus	1.5	1.6	....	1.7
Length of second peræopod	72	88	....	90
Length of merus	22	26	....	27
Length of carpus	30	36	....	38
Length of chela	3.5	3.8	....	4.1
Breadth of chela	0.55	0.60	....	0.65
Length of dactylus	1.2	1.4	....	1.7
Length of third peræopod	80	110	100	104
Length of merus	28	36	32	33
Length of carpus	32	44	38	40
Length of propodus	2.5	2.4	2.5	2.6
Length of dactylus	3.0	4.0	4.3	4.5
Length of fourth peræopod	79	108	99	104
Length of merus	28	36	33	34
Length of carpus	31	45	39	40
Length of propodus	2.5	2.6	3.0	2.6
Length of dactylus	3.0	3.3	3.6	3.6
Length of fifth peræopod	80	110	101	105
Length of merus	29	35	33.5	36
Length of carpus	32	46	41	42
Length of propodus	2.4	2.5	3.0	2.8
Length of dactylus	0.5	0.6	0.5	0.6
Length of sixth somite of pleon	12.2	13.8	14.5	15.5
Height of sixth somite of pleon	6.0	6.7	7.3	7.5
Length of telson	12.6	14.8	15.6	16.0
Length of inner lamella of uropod	9.9	11.3	13.0	12.9
Breadth of inner lamella of uropod	....	2.4	2.7	2.9
Length of outer lamella of uropod	11.2	13.2	14.7	14.3
Breadth of outer lamella of uropod	....	3.0	3.4	3.5

MIERSIIDÆ.

ACANTHEPHYRA EXIMEA Smith.

(Plate XIV, Fig. 1.)

This species is still represented only by the single specimen taken in 1883.

ACANTHEPHYRA AGASSIZII Smith.

(Plate XV, Figs. 1, 6, 6*a*, 7; Plate XVI, Fig. 2.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.			
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.			With eggs.
		° ′ ″	° ′ ″				1884.	♂		♀	
7977	2174	38 15 00	72 03 00	1,594	....	gy. M.	July 21	2 *l.*			......
7978	2182	39 25 30	71 44 00	861	39	gn. M.	July 23			1 *s.*	0
8086	2190	39 40 00	70 20 15	1,800	....	glb. O.	Aug. 4	1			......
8085	2192	39 46 30	70 14 45	1,060	39	gy. O.	Aug. 5	2			......
8087	2195	39 44 00	70 03 00	1,058	38	gn. M.	Aug. 5			1	1
8143	2206	39 35 00	71 24 30	1,043	38	gn. M.	Aug. 20	1 *l.*			......
8142	2208	39 33 00	71 16 15	1,178	38	gn. M., S.	Aug. 21	1			......
8155	2209	39 34 45	71 21 30	1,080	39	glb. O.	Aug. 21	1			......
8141	2210	39 37 45	71 18 45	991	38	gy. glb. O.	Aug. 21	1			......
8138	2211	?39 37 00	?71 18 00	Surface!	74		Aug. 21			1	0
8139	2211	39 37 00	71 18 00	1,064	38	gn. M.	Aug. 21	1			......
8134	2215	39 49 15	70 31 45	578	....		Aug. 22		1 *y.*		......
8140	2220	39 43 30	69 23 00	1,054	38	gy. M.	Aug. 23	3			......
8610	2223	37 48 30	69 43 30	2,516	37	glb. O.	Sept. 7	1			......
8591	2224	36 16 30	68 21 00	2,574	37	glb. O.	Sept. 8			2 *s.*	1
8611	2231	38 29 00	73 09 00	965	39	gy. O.	Sept. 12	1 *l.*			......
8612	2234	39 09 00	72 03 15	816	39	gn. M.	Sept. 13	1			......
8613	2235	39 12 00	72 03 30	707	39	gn. M.	Sept. 13		2 *y.*		......
8614	2236	39 11 00	72 08 30	636	39	gn. M.	Sept. 13	2 *s.*			......

No. 8,138, a small specimen 76^{mm} in length, and apparently an immature female, is of special interest. It was taken by Mr. Willard Nye, jr., at 10.45 p. m., *at the surface*, in a dip-net, and was kept alive for half an hour, and then put in alcohol while still alive. Messrs. Nye and Benedict both noticed the close resemblance to the *Acanthephyra* with which they were familiar from deep water, and made a special note of the facts in regard to the occurrence of this specimen. The specimen could not have been brought to the surface by the trawl, as no haul had been made for some time previously. In the Albatross dredgings in 1883 and 1884, this species is recorded as having been taken at forty-five different stations ranging in depth from 105 to 2,949 fathoms, and nearly all of the specimens have been in far better condition than most of those of the supposed deep-water species. These facts lead me to suppose that this species is not a habitual inhabitant of the bottom at great depths, but more probably a truly free-swimming inhabitant of some part of the vast region intermediate between the surface and the bottom, such a one as might occasionally stray to the surface or to considerable depths. There is nothing in the structure of this species or of *A. eximea* to render this supposition improbable; in the two next following species, however, the structure of the eyes makes it extremely improbable that they ever approach the surface.

ACANTHEPHYRA MICROPHTHALMA Smith.

Proc. National Mus., vii, p. 502, 1885.

(Plate XIII, Fig. 3.)

Station 2224, September 8, north lat. 36° 16′ 30″, west long. 68° 21′, 2,574 fathoms, globigerina ooze, temperature 37°; two males and two females (8584).

Also taken in 1885, station 2566, August 29, north lat. 37° 23′, west long. 63° 8′, 2,620 fathoms, gray ooze, temperature 37°; one male and two females (10831).

This species differs remarkably in general appearance from those previously described, but agrees with them in all important generic characters. The rudimentary character of the eyes would seem to indicate that this, at least, is a true deep-water species.

The carapax is scarcely as broad in front as at the middle of the branchial region, and is neither compressed nor carinated dorsally, but broadly rounded, except at the high and laterally compressed base of the very slender rostrum, which is strongly upturned, wholly unarmed above except by three very obscure teeth above the orbit, and armed beneath with a series of about seven small and nearly equidistant teeth on the distal two-thirds of the length, but not quite reaching the very slender and acute tip. The orbital sinus is much smaller than in *A. Agassizii*, the lobe beneath is much broader and somewhat truncated, and the antennal and branchiostegal spines are less prominent.

The eye-stalks are much shorter than in *A. Agassizii*, strongly tapered from near the base to the minute brownish eyes, which are placed obliquely upon the outer side of the tip of the stalk.

The proximal segment of the peduncle of the antennula is less deeply excavated for the reception of the eye than in *A. Agassizii*, and the expanded proximal portion of the outer flagellum is a little narrower, but otherwise the antennula is as in that species.

The antennal scale is about two-thirds as long as the carapax excluding the rostrum, near the base about a fourth as broad as long, and narrowed to a truncated tip about a third as broad as the base. The spine upon the second segment of the peduncle below the articulation of the scale is much shorter than in *A. Agassizii*.

The oral appendages differ only slightly from those of *A. Agassizii*. The mandibles are thicker and heavier, the opposing edges of the ventral processes a little narrower, and their teeth fewer in number, thick and obtuse, and the terminal segment of the palpus is a little narrower. The mandibles are in fact more like those of *A. eximea*. The fold on the ventral side near the tip of the endopod of the first maxilla is armed, in place of the two to four short spines in *A. Agassizii*, with a series of ten to twelve setæ, of which the proximal are stout, and somewhat spiniform, but the distal very slender. The two lobes of the distal segment of the protognath and the endognath of the second maxilla are slightly more slender than in *A. Agassizii*. The anterior lobe of the scaphognath is much longer and narrower, contracted near the middle and slightly expanded at the obtuse and somewhat truncated tip, while the posterior lobe is slightly broader. The endopods and exopods of the maxillipeds are much longer and more slender than in *A. Agassizii*, but these appendages do not differ in other respects. The propodus and dactylus of the first gnathopod are a little more narrowed distally, and the line of articulation between them slightly less oblique than in *A. Agassizii*. The second gnathopods differ scarcely at all.

The peræopods are similar to those of *A. Agassizii*, but are a little more slender, somewhat less hairy, and the proportions of the segments slightly different; the carpus in the second pair is nearly as long as the merus and much longer than the chela, which is considerably shorter and much more slender than in the first; and the carpi in the third, fourth, and fifth pairs are relatively shorter than in *A. Agassizii*.

The first and second somites of the pleon are rounded above, but the third and fourth are very strongly compressed dorsally and project in a very high and sharp crest, highest at the articulation between the two somites and on the third produced into a very long, slender, compressed, and spiniform tooth which is arched over nearly or quite the whole length of the fourth somite, which is itself without any carinal tooth. The fifth and sixth somites are sharply carinated dorsally, but the carina does not project in a tooth or spine on either. The pleura are of about the same form as in *A. Agassizii*, but are somewhat less deep.

The telson is very long and slender, only very obscurely sulcated above, armed with seven or eight pairs of small dorsal aculei, and tipped with three to five slender spines between a pair of much larger lateral ones.

The uropods and pleopods are nearly as in *A. Agassizii*, but the ovate inner lamelliform ramus of the first pleopod of the male is a little narrower and the marginal stylet reaches slightly beyond the tip of the lamella itself.

Measurements in millimeters.

Sex	♂	♀
Length from tip of rostrum to tip of telson	98	100.0
Length of carapax, including rostrum	40	41.0
Length of rostrum	22.5	22.0
Length of carapax, excluding rostrum	22.0	22.8
Height of carapax	13.5	13.5
Breadth of carapax at branchiostegal spines	9.0	8.7
Greatest breadth of carapax	9.8	9.9
Length of eye-stalk and eye	2.7	2.8
Greatest diameter of eye	0.8	0.8
Length of antennal scale	14.5	15.0
Breadth of antennal scale	3.6	3.7
Length of second gnathopod	22.0	......
Length of first peræopod	18.0	......
Length of chela	3.6	......
Breadth of chela	0.9	......
Length of dactylus	1.2	......
Length of second peræopod	21.0	......
Length of chela	3.4	......
Breadth of chela	0.7	......
Length of dactylus	1.1	......
Length of third peræopod	25.0	......
Length of propodus	6.4	......
Length of dactylus	1.7	......
Length of fourth peræopod	24.0	......
Length of propodus	6.1	......
Length of dactylus	1.6	......
Length of fifth peræopod	22.0	......
Length of propodus	7.5	......
Length of dactylus	0.3	......
Height of third somite of pleon	16.0	17.0
Length of its dorsal spine	9.5	10.0
Length of sixth somite of pleon	10.5	10.8
Height of sixth somite of pleon	6.0	5.9
Length of telson	17.0	17.0
Length of inner lamella of uropod	12.1	12.5
Breadth of inner lamella of uropod	2.7	......
Length of outer lamella of uropod	13.4	14.0
Breadth of outer lamella of uropod	3.3	......

ACANTHEPHYRA BREVIROSTRIS Smith.

Proc. National Mus., vii, p. 504, 1885.

(Plate XIV, Fig. 2; Plate XV, Figs. 2, 8; Plate XVI, Figs. 1, 6.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1883.	♂	♀	
5448	2099	37 12 20	69 39 00	2949	....	glb. O.	Oct. 2	..	2	1
5449	2101	39 22 00	68 34 30	1686	37	glb. O.	Oct. 3	1	..	......
7019	2101	39 22 00	68 34 30	1686	37	glb. O.	Oct. 3	1	..	......
5673	2105	37 50 00	73 03 50	1395	41	glb. O.	Nov. 6	1	..	......
							1885.			
10832	2566	37 23 00	63 08 00	2620	37	gy. O.	Aug. 29	1l	..	......

This species was not taken in 1884, but, as indicated above, a large male, nearly 80^{mm} in length, was taken in 1885.

It is at once distinguished from the others of the genus by the very short rostrum (which, though considerably longer, strikingly recalls that of *Hymenodora glacialis*), and the very large, laterally compressed, and carinate tooth of the third somite of the pleon. All the specimens are in bad condition, very largely due, apparently, to the soft and membranaceous character of the integument, which resembles that of *Meningodora mollis* and several other deep-water species.

The carapax proper is higher and more compressed at the base of the rostrum than in *A. Agassizii* and the branchiostegal spines are less prominent. The rostrum is approximately a fourth as long as the rest of the carapax, very high at base as in *A. eximea*, acutely triangular in a side view, terminates in a slender and slightly upturned tip, and is unarmed below but armed above, at base and back upon the carina of the carapax, with a series of five or six very small and obscure teeth.

The eye-stalks are a little shorter than in *A. Agassizii* and the eyes a little smaller, but broader than the stalks, somewhat compressed vertically, face obliquely inward and forward, and are black or brownish black. The peduncle of the antenna and its scale are nearly like those of *A. microphthalma.*

The oral appendages are very nearly as in *A. Agassizii.* The opposing edges of the ventral processes of the mandibles are a little narrower, almost exactly alike on the two sides, armed with about seven teeth each, and without the small anterior teeth seen in *A. Agassizii.* The first maxillæ show no differences. The divisions of the distal segment of the protognath of the second maxilla are very slightly broader than in *A. Agassizii*, the endognath and the anterior lobe of the scaphognath are both considerably longer and the posterior lobe of the scaphognath slightly narrower. The exopod of the maxilliped does not reach beyond the endoped and the tip is broader and more truncated than in *A. Agassizii.* The gnathopods do not differ essentially from those of *A. Agassizii.*

The peræopods are very similar to those of *A. Agassizii*, but are all considerably longer and more slender; the first reach to the middle of the antennal scale, the fourth to considerably by its tip, and the fifth to about the same point as the first.

The pleon is smaller relatively to the cephalo-peræon than in *A. Agassizii* and the third somite very differently armed. The first and second somites are rounded above, but the third is strongly compressed dorsally into a very high and sharp carina which projects in a great laterally compressed tooth high at base, tapered to an acute point and overhanging the fourth somite and part of the fifth. The fourth, fifth, and sixth somites are compressed and armed with a sharp carina which projects posteriorly in a conspicuous tooth on the fourth, and in a similar but much smaller tooth on the fifth and sixth. The pleura are similar to those of *A. Agassizii*, but relatively less deep, the second is considerably broader, and the third, fourth, and fifth more produced and more evenly rounded posteriorly.

The telson is very long and slender, only very obscurely sulcated above, armed with approximately five pairs of minute dorsal aculei and tipped with three slender spines between a pair of much larger lateral ones with a small subterminal spine near the base of each.

The uropods and pleopods are nearly as in *A. Agassizii.*

Measurements in millimeters.

Station	2105	2099
Sex	♂	♀
Length from tip of rostrum to tip of telson	65	77
Length of carapax, including rostrum	23.0	26.0
Length of rostrum	5.1	6.9
Height of carapax	10.6	11.7
Length of eye-stalk and eye	2.8	3.1
Greatest diameter of eye	1.5	1.8
Length of antennal scale	10.7	12.1
Breadth of antennal scale	3.1	3.5
Length of second gnathopod	....	21.0
Length of first peræopod	17.5	19.0
Length of chela	3.9	4.4
Breadth of chela	0.8	0.9
Length of dactylus	1.2	1.3
Length of second peræopod	20	22
Length of chela	4.2	4.9
Breadth of chela	0.5	0.6
Length of dactylus	1.2	1.4
Length of third peræopod	....	27.0
Length of propodus	....	8
Length of dactylus	....	1.9
Length of fourth peræopod	26	....
Length of propodus	7.1	....
Length of dactylus	2.1	....
Length of fifth peræopod	21	25
Length of propodus	7.6	8.7
Length of dactylus	0.5	0.6
Height of third somite of pleon	11.0	12.0
Length of its dorsal spine	8.4	9.0
Length of sixth somite of pleon	8.2	9.3
Height of sixth somite of pleon	4.6	5.2
Length of telson	14.0	15.3
Length of inner lamella of uropod	9.7	......
Breadth of inner lamella of uropod	2.1	2.5
Length of outer lamella of uropod	10.6	11.0
Breadth of outer lamella of uropod	2.8	3.1

ACANTHEPHYRA GRACILIS.

Miersia gracilis Smith, Bull. Mus. Comp. Zool., x, p. 70, pl. 11, figs. 4–4*d*, pl. 12, fig. 10, 1882.

Acanthephyra debilis, var. *Europæa* A. M.-Edwards, Recueil Figs. Crust., pl. [33], fig. 2, 1883.

Station 2225, September 9, north lat. 36° 5′ 30″, west long. 69° 51′ 45″, 2,512 fathoms, yellow ooze, temperature 37°; 1 ♀ carrying eggs (8597).

Although there has been no opportunity of directly comparing this specimen with the young male originally described from the Blake collection of 1880, I have very little doubt that the two specimens are specifically identical. In the present specimen the middle dorsal teeth of the fourth and fifth somites of the pleon are a little smaller than in the young male, and the dorsal part of the margin either side is dentate, as shown in Milne-Edwards's figure above referred to, while in the young male this dentation was either absent or overlooked, as might readily have happened in the case of so small an individual. In all other respects this specimen agrees perfectly with my figures and description of the original specimen.

The epipod of the fourth peræopod is much further developed than in any other of the species which I have seen,* but it is still apparently of little or no functional importance, as it consists only of a simple elongated horizontal lamella, corresponding to the horizontal basal portion of the epipods in front of it.

The eggs are very few and very large, being approximately 4 by 3^{mm} in longer and shorter diameter.

Measurements in millimeters.

Length from tip of rostrum to tip of telson	80+
Length of carapax, excluding rostrum	15.3
Length of rostrum	20+
Height of carapax	9.5
Breadth of carapax	7.5
Length of eye-stalk and eye	3.2
Greatest diameter of eye	2.5
Length of antennal scale	11.4
Breadth of antennal scale	2.5
Length of first peræopod	14.0
Length of chela	4.2
Breadth of chela	0.8
Length of dactylus	1.8
Length of second peræopod	15.0
Length of chela	4.5
Breadth of chela	0.6
Length of dactylus	1.9
Length of third peræopod	23.0
Length of propodus	5.4
Length of dactylus	4.4
Length of fourth peræopod	22.0
Length of propodus	5.0
Length of dactylus	4.2
Length of fifth peræopod	16.0
Length of propodus	4.0
Length of dactylus	1.1
Length of sixth somite of pleon	11.0
Height of sixth somite of pleon	4.3
Length of telson	12.7
Length of inner lamella of uropod	10.1
Breadth of inner lamella of uropod	1.7
Length of outer lamella of uropod	11.0
Breadth of outer lamella of uropod	1.9

EPHYRINA Smith.

Proc. National Mus., vii, p. 506, 1885.

This genus, which is based on a single specimen, wanting the greater part of the second, third, and fourth peræopods, is readily distinguished from *Acanthephyra* by the ischial and meral segments of the fifth peræopods, which are compressed, very broad, and form broad lamellar oper-

*In all the other species here recorded there is an obscure rudiment of this epipod, a minute appressed lamelliform lobe, not longer than broad, which is not indicated in the branchio-epipodal formulæ I have given for them.

cula along the sides of the carapax. The single species is further distinguished by the unarmed rostrum, the non-carinated pleon, and the broad anterior division of the distal segment of the protognath of the second maxilla. In all other characters it agrees essentially with the species of *Acanthephyra.*

EPHYRINA BENEDICTI Smith.

Proc. National Mus., vii, p. 506, 1885.

(Plate XIV, Fig. 3, Plate XVI, Fig. 4.)

Station 2083, September 5, 1883, north lat. 40° 26′ 40″, west long. 67° 5′ 15″, 959 fathoms, gray mud, temperature 40°; one female (7156).

In general the form of the carapax proper is very similar to that of *Acanthephyra Agassizii*, but the antennal and branchiostegal spines are less prominent. An obtuse dorsal carina extends forward from near the posterior margin and gradually rises in front into a very high and sharp carina at the base of the laterally compressed lamellar rostrum, which is short, not reaching beyond the peduncle of the antennula, acutely triangular in a side view, considerably upturned, and wholly unarmed.

As in *Acanthephyra Agassizii*, the eye-stalks are short and terminated by small hemispherical black eyes, which face slightly inward when the stalks are directed forward.

The antennulæ, too, are very nearly as in *Acanthephyra Agassizii*, except that the proximal portion of the outer flagellum is much less expanded, though very much stouter than the inner. The antennal scales are imperfect at the tips, but are less rapidly narrowed distally, and are apparently more nearly as in *Acanthephyra microphthalma.*

The mandibles are essentially as in *Acanthephyra Agassizii*, but are very nearly alike on the two sides, the posterior part of the mesial edge of the ventral process in each being armed with six or seven acutely triangular teeth, in front of which the margin is sharp and chitenous, but not serrated, though there is a small tooth at the anterior end of this unserrated edge in the right mandible and a sharp angle at the same point in the left. The first maxillæ are very like those of *Acanthephyra Agassizii.* The anterior division of the distal segment of the protognath of the second maxilla is much expanded at the mesial edge, where it projects farther forward and is more than twice as broad as the posterior division; the endognath is more slender; the anterior lobe of the scaphognath is a little narrower and more evenly rounded at the end. The maxillipeds do not differ from those of *A. Agassizii*, except that the antero-mesial angle of the exopod is a little more obtusely rounded; nor do the first gnathopods, except the distal part of the endopod, which is more nearly as in *Acanthephyra gracilis*, the dactylus being longer than broad and terminally attached to the propodus by a slightly oblique articulation. The second gnathopods are imperfect at the tips, but are evidently very nearly as in *A. Agassizii*, and apparently reach to about the tips of the antennal scales.

The first peræopods are about as long as the carapax including the rostrum, and are clothed with numerous hairs; the ischium and merus make about half the length of the endopod, and are strongly compressed and broad, the merus being considerably more than a third as broad as long; the carpus is about three-fifths as long and half as broad as the merus; the chela is somewhat stouter than the carpus, not far from twice as long, and tapered distally to the bases of the digits, which are about a third of the whole length, very slender and strongly curved at the tips. The fifth peræopods are about a fourth longer than the first and are clothed with very few hairs; the ischium and merus make fully half the entire length; both are broad and strongly compressed, and the latter is fully a third as broad as long, with the dorsal margin nearly straight and the ventral strongly curved upward to the articulation with the carpus, which is very slender and scarcely longer than the breadth of the merus; the propodus is about twice as long as the carpus and no stouter; the dactylus, exclusive of the terminal spines and setæ, is stout and about twice as long as the distal diameter of the propodus.

There is no carina on any somite of the pleon, but the dorsum of the third somite projects back in a small, vertically compressed spine over the fourth somite, in the dorsum of which there is an obscure, and possibly accidental, sulcus. The pleura are similar in outline to those of *Acanthephyra Agassizii*, but the second is relatively a little broader, the third and fourth more evenly rounded posteriorly, and the fifth a little more obtuse at the posterior angle. The sixth somite is about two-thirds as long as the carapax, excluding the rostrum, and less than half as high as long.

The telson is very much longer than the sixth somite, tapers into a very long and narrow tip, and is armed along the distal two-thirds of either edge with numerous (twenty to twenty-five) small aculei. The inner lamellæ of the uropods are about as long as the sixth somite of the pleon, lanceolate in outline, and less than a sixth as broad as long. The outer lamellæ reach to near the tip of the telson, are about six times as long as broad, and evenly rounded at the tips.

Measurements in millimeters.

Length from tip of rostrum to tip of telson	56.0
Length of carapax, including rostrum	17.0
Length of rostrum	4.8
Height of carapax	8.3
Breadth of carapax	6.2
Length of eye-stalk and eye	2.8
Greatest diameter of eye	1.7
Length of peræopod	16.0
Length of merus	4.6

Breadth of merus	1.7
Length of carpus	2.9
Length of chela	5.0
Breadth of chela	0.8
Length of dactylus	1.8
Length of fifth peræopod	20.5
Length of merus	7.5
Breadth of merus	2.7
Length of carpus	2.9
Length of propodus	5.8
Length of dactylus	0.8
Length of sixth somite of pleon	8.8
Heighth of sixth somite of pleon	4.1
Length of telson	11.0
Length of inner lamella of uropod	8.6
Breadth of inner lamella of uropod	1.3
Length of outer lamella of uropod	9.8
Breadth of outer lamella of uropod	1.6

NOTOSTOMUS ROBUSTUS Smith.

(Plate XII, Fig. 5.)

Station 2228, September 11, north lat. 37° 25′, west long. 73° 6′, 1,582 fathoms, brown mud, temperature 37°; one young specimen, in bad condition (8543).

In this specimen the rostrum is much longer than in the adults originally described, being only a little less than half as long as the rest of the carapax, and has the terminal fourth of its length slender and unarmed. The eyes are proportionally larger than in the adults, as usual in the young. In other respects the specimen agrees essentially with the adults referred to.

Measurements in millimeters.

Length from tip of rostrum to tip of telson	53
Length of carapax, including rostrum	23
Length of rostrum	7.2
Length of eye-stalk and eye	3.2
Greatest diameter of eye	2.1
Length of antennal scale	8.3
Breadth of antennal scale	2.5
Length of sixth somite of pleon	5.1
Height of sixth somite of pleon	3.5
Length of telson	10.0

NOTOSTOMUS VESCUS, sp. nov.

This species, although represented only by a single imperfect male specimen, is so different from the other species of the genus that I venture to describe it. It has no dorsal tooth on the third somite of the pleon, the carapax is apparently not at all gibbous, and the dorsum is nearly straight. It is probably a very much smaller species than the *robustus*, *gibbosus*, or *elegans*, and is perhaps more nearly allied to *N.*

corallinus A. M.-Edwards (Recueil de figures de Crustacés nouveaux ou peu connus, pl. [32], 1883) than any other known species, although the areolation of the carapax and the form and dentation of the rostrum are very different.

The rostrum is a little more than a third as long as the rest of the carapax, strongly compressed laterally, vertically rather broad at base, but regularly tapered to an acute tip; the lower edge is armed with two slender teeth about a third of the way from the tip to the base, and the dorsal edge is nearly straight, approximately horizontal, and unarmed at the tip, but with four teeth above and in front of the orbit and six others in the same series back of them on the dorsal crest of the carapax proper, which is a sharp but not very high carina extending nearly to the posterior margin and entirely smooth and unarmed back of the teeth above mentioned, which do not extend more than a fourth of the way from the orbit to the posterior margin. The anterior margin is very nearly as in *N. robustus*. The upper lateral carina is conspicuous, approximately straight, nearly parallel with the dorsum, and extends very nearly to the posterior margin. The lower lateral carina is conspicuous anteriorly, but is not distinct back of the short vertical hepatic carina.

The eyes and eye-stalks are very nearly as in *N. robustus;* the eyes are slightly swollen, more than half as wide as the antennal scale, and black. The antennal scales are imperfect at the tips, but are apparently very nearly as in *N. robustus*.

The dorsum of the third and succeeding somites of the pleon are distinctly carinated, and the carina projects in a very small tooth on the fourth and fifth somites, but there is no evidence whatever of any dorsal tooth or projection on the third. The sixth somite of the pleon is more than half as long as the carapax, exclusive of the rostrum, and less than half as high as long. The telson is a little longer than the sixth somite, strongly sulcated dorsally the whole length, and armed at the tip with five spines, of which the outer are much the longer. The inner lamella of the uropod reaches to the tip of the telson, is lanceolate in outline, and between four and five times as long as broad. The outer lamella is considerably longer than the inner, nearly a fourth as broad as long, and broadly rounded at the tip.

Measurements in millimeters.

Length from tip of rostrum to tip of telson	45.0
Length of carapax, including rostrum	17.5
Length of rostrum	4.6
Length of eye-stalk and eye	2.3
Greatest diameter of eye	1.1
Breadth of antennal scale	2.0
Length of sixth somite of pleon	7.3
Height of sixth somite of pleon	3.1
Length of telson	8.3

Length of inner lamella of uropod	6.9
Breadth of inner lamella of uropod	1.5
Length of outer lamella of uropod	8.0
Breadth of outer lamella of uropod	1.9

Station 2099, October 2, 1883, north lat. 37° 12′ 20″, west long. 69° 39′, 2,949 fathoms, globigerina ooze; one male (5434).

HYMENODORA GLACIALIS G. O. Sars.

Pasiphaë glacialis Buchholz, Zweite deutsche Nordpolfahrt, ii, p. 279, pl. 1, fig. 2, 1874.

Hymenodora glacialis G. O. Sars, Archiv Mathem. Naturvid., Kristiania, ii, p. 341, 1877; Norwegian North-Atlantic Expedition, Crust., i, pp. 37, 275, pl. 4, 1885. Norman, Proc. Royal Soc. Edinburgh, 1881–'82, 684, 1882. Smith, Proc. National Mus., vii, p. 501, 1885.

(Plate XV, Figs. 3, 10; Plate XVI, Fig. 5.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth and nature of bottom.		Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	Materials.		♂ ♀	With eggs.
		° ′ ″	° ′ ″			1883.		
7159	2039	38 19 26	68 20 20	2,369	glb. O.	July 28	1*f.* 1*f.*	0
5456	2099	37 12 20	69 36 00	2,949	glb. O.	Oct. 2	2*f.* 1*f.*	0

In a paper in the Proceedings of the National Museum, above referred to, I have given a considerable list of fragmentary and imperfect specimens as belonging to this species, of which I had authentically labeled specimens from the Faröe Channel, received from the Rev. A. M. Norman; but a more critical examination of all the specimens from the Albatross collections shows that a considerable number of them are specifically distinct. An approximately perfect female, from station 2099, of which the oral appendages, branchiæ, &c., were carefully examined for comparison with the Faröe Channel specimens when writing the previous notice, and several fragmentary specimens from the same station and from station 2039, are apparently specifically identical with the arctic specimens in every particular; but all the other specimens, which I had taken for young individuals of the same species, while differing only slightly in external characters, have distinct podobranchiæ at the bases of the first gnathopods, though in some of the smaller specimens these branchiæ are very small or even rudimentary. These specimens are described further on as a new species, *H. gracilis.*

The arctic specimens and those taken by the Albatross enable me to compare the genus with the closely allied forms, and particularly with my genus *Meningodora.*

The eye-stalks and eyes are very similar to those of *Meningodora mollis*, but the eyes are apparently a little smaller and are reddish, instead of black, in recently preserved alcoholic specimens.

The mandibles are similar to those of *Meningodora mollis*, but still more like those of *Acanthephyra Agassizii*, the mesial edges being armed very nearly as in that species. The distal segment of the protognath of the first maxilla is very much broader than in *Meningodora mollis* or any of the species of *Acanthephyra* which I have examined, the mesial edge being fully as long as that of the proximal segment, which, however, is considerably narrower mesially than in *Meningodora mollis;* the endognath is like that of the *Meningodora*. The two divisions of the distal segment of the protognath of the second maxilla are nearly equal and much broader and shorter than in *Meningodora mollis*, and do not project mesially beyond the proximal segment, as they do in the species of *Acanthephyra*, *Meningodora*, *Notostomus*, and *Ephyrina;* otherwise the second maxillæ do not differ from those of *Meningodora*. The maxillipeds differ essentially from those in the allied genera in having the endopod composed of two segments only, a very short proximal segment and a long unsegmented distal one.

The first gnathopods bear no podobranchiæ in the typical species, though there are small or rudimentary podobranchiæ in *H. gracilis*, and the distal part of the endognath differs from that of *Meningodora mollis* in having the dactylus nearly as long as broad and attached to the propodus by a much less oblique articulation. The number and arrangement of the branchiæ and epipods on the succeeding somites are the same as in the allied forms, so that there are in all, on each side, six epipods, six arthrobranchiæ, and five pleurobranchiæ. The second gnathopods and first and second peræopods do not differ essentially from those of *Meninogodora mollis*, although the second peræopods are less slender and more like the first than in that species, and both pairs are somewhat more hairy. There is a peculiar excavation on the inner dorsal surface of the carpus in the first pair, as in the allied genera and as shown conspicuously in the species of *Notostomus*. This excavation is longitudinal, deepest at the distal end, and the mesial margin hairy or setose, while the opposite margin rises suddenly into a tubercular or spiniform protuberance just over the articulation with the chela. The third and fourth peræopods are more like those of *Acanthephyra Agassizii* than those of *Meningodora mollis*, being armed with small spines and setæ, and the propodi and dactyli neither grooved conspicuously nor carinated. The fifth peræopods are shorter and stouter than in *Meningodora* and very distinctly subchelate, the stout and conspicuous, though short, dactylus closing against a digital process of the propodus fully half its own length.

The dorsum of the pleon is neither carinated nor toothed. The pleura of the second somite are not as figured by Buchholz, but overlap those of the first and third as in the allied genera, and the pleura of the third, fourth, and fifth semites are evenly and similarly rounded posteriorly.

In G. O. Sars's elaborate and very fully illustrated work on the crustacea of the Norwegian North-Atlantic expedition, which I had not seen when the above was written, the telson of *H. glacialis* is described and figured as armed at the tip with seven slender spines, a pair of long lateral separated by five much smaller ones; while in the female from station 2039, the only one of the Albatross specimens in which the telson is perfect, there are only six spines, there being no odd median one, and the same is true of the two specimens from the Faröe Channel.

Partial measurements of two specimens of *H. glacialis* are given under the next species.

HYMENODORA GRACILIS, sp. nov.

(Plate XII, Fig. 6.)

This species is apparently somewhat smaller than *H. glacialis*, and is distinguished by its more slender form and longer and more slender rostrum, which is prolonged in a slender, unarmed tip, reaching as far forward as the tips of the eyes. The antennal scale is apparently considerably narrower. In the only specimen in which the tip of the telson is perfect, the male from station 2036, it is armed with only four spines, there being only two between the long lateral spines. The most remarkable difference, however, is in the first gnathopods, which, as already remarked, bear distinct podobranchiæ. In the larger specimens these branchiæ are conspicuous and composed of several lamellæ each, being nearly as large in proportion to the size of the animal as in *Meningodora mollis;* but in some of the smaller specimens they are represented by only one or two small lamellæ attached near the base of the epipod, and are very easily overlooked. There are well-developed podobranchiæ at the bases of the first gnathopods in all the species of the allied genera known to me, *Acanthephyra*, *Ephyrina*, *Notostomus*, and *Meningodora*, and I had regarded their absence as one of the best generic characters of *Hymenodora*, but their occurrence and variability in a species so very closely allied to the typical species of the genus shows that they are not always of generic importance. The two species of *Hymenodora* still differ, however, from the species of the allied genera above-named in the form of the protognath of the second maxilla and in the number of segments in the endopod of the maxilliped, characters which, for the present at least, may be regarded as of generic value.

Measurements in millimeters.

	H. glacialis.		*H. gracilis.*	
Catalogue number	....	5456	7974	7158
Station	Faröe.	2099	2182	2036
Sex	♂	♀	♂	♂
Length, from tip of rostrum to tip of telson	70	54+	55	43
Length of carapax, including rostrum	23.0	19.0	18.0	13.0
Length of rostrum	3.0	2.5	3.0	2.3
Height of carapax	....	10.0	8.4	6.8
Breadth of carapax	....	....	7.3	5.5
Length of eye-stalk and eye	3.0	2.3	2.5	2.0
Greatest diameter of eye	1.0	0.8	0.8	0.6
Length of antennal scale	9.0	....	6+	5.7
Breadth of antennal scale	3.1	2.4	2.0	1.5
Length of first peræopod	18.0	....	11.5	10.0
Length of chela	4.8	....	3.1	2.5
Breadth of chela	0.9	....	0.7	0.5
Length of dactylus	1.8	....	1.1	1.0
Length of second peræopod	18.0	....	11.5	10.0
Length of chela	4.9	....	3.2	2.5
Breadth of chela	0.7	....	0.5	0.4
Length of dactylus	2.0	....	1.2	0.9
Length of third peræopod	....	....	....	14.0
Length of propodus	....	....	....	3.5
Length of dactylus	....	....	....	1.3
Length of fourth peræopod	....	....	21.0	16.0
Length of propodus	....	....	6.3	4.3
Length of dactylus	....	....	2.6	1.9
Length of fifth peræopod	....	....	16.0	13.0
Length of propodus	....	....	4.6	3.6
Length of dactylus	....	....	0.8	0.6
Length of sixth somite of pleon	8.3	7.5	7.5	6.5
Height of sixth somite of pleon	4.0	3.5	3.3	2.8
Length of telson	14.5	8+	10.5	7.8
Length of inner lamella of uropod	10.1	....	....	5.8
Breadth of inner lamella of uropod	2.0	....	....	1.1
Length of outer lamella of uropod	11.5	....	....	6.5
Breadth of outer lamella of uropod	2.7	....	....	1.3

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1883.	♂ ♀	
7158	2036	38 52 40	69 24 40	1735	38	glb. O.	July 18	1	
7160	2083	40 26 40	67 05 15	959	40	gy. M.	Sept. 5	1 1*y*.	
7161	2083	40 26 40	67 05 15	959	40	gy. M.	Sept. 5	2*y*.	
7017	2095	39 29 00	70 58 40	1342	....	glb. O.	Sept. 30	1 2	1
7162	2099	37 12 20	69 36 00	2949	....	glb. O.	Oct. 2	1*f*. 1	
7018	2100	39 22 00	68 34 30	1628	37	glb. O.	Oct. 3	1 2*f*.	
5467	2101	39 18 30	68 24 00	1686	37	glb. O.	Oct. 3	3*y*.	
7151	2116	35 45 23	74 31 25	888	39	bn. M., fne. S.	Nov. 11	1	
							1884.		
7974	2182	39 25 30	71 44 00	861	39	gn. M.	July 23	1	
8337	2193	39 44 30	70 10 30	1122	38	gn. M.	Aug. 5.	1*s*.	

PASIPHAIDÆ.

PASIPHAË PRINCEPS Smith.

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.	With eggs.
		° ′ ″	° ′ ″				1884.	♂ ♀	
7975	2171	37 59 30	73 48 40	444	39	gn. M.	July 20	1	0
7976	2181	39 29 00	71 46 00	693	39	gy. M., fne. S.	July 23	1s.	......
8137	2201	39 39 45	71 35 15	538	39	bn. M.	Aug. 19	1	......
7166	2237	39 12 17	72 09 30	520	39	gn. M.	Sept. 13	1y.	......

These specimens are very much smaller than the single one originally described and differ from it slightly in the form of the rostrum, which in the later specimens is only very slightly or not at all upturned at the tip, which is very short and dentiform even in the smallest specimen, and very different from the spiniform and strongly upturned rostrum of *P. tarda*.

Measurements in millimeters.

Catalogue number	7976	7975	8137
Station	2181	2171	2201
Sex	♀?	♀	♂
Length from tip of rostrum to tip of telson	77	144	115
Length of carapax, including rostrum	24.1	49.0	38.0
Length of rostrum	1.5	3.1	3.0
Height of carapax	11.7	24.5	17.9
Breadth of carapax	7.0	15.0	11.5
Length of eye-stalk and eye	3.7	5.3	4.8
Greatest diameter of eye	2.1	3.3	3.0
Length of antennal scale	10.1	22.0	17.1
Breadth of antennal scale	3.0	6.0	5.1
Length of second gnathopod	....	41	35
Length of first peræopod	33.	63	50
Length of chela	12.0	23.0	17.5
Breadth of chela	1.8	3.5	2.7
Length of dactylus	5.3	10.2	8.0
Length of second peræopod	40	74	59
Length of chela	15.2	29	22.3
Breadth of chela	1.7	3.4	2.8
Length of dactylus	8.0	14.3	11.9
Length of third peræopod	23+	47	35+
Length of merus	12.2	26.0	19.2
Length of carpus	0.7	1.3	1.1
Length of propodus	4.4	8.1	6+
Length of dactylus	....	0.7	....
Length of fourth peræopod	12.8	26	20.0
Length of propodus	2.5	5.5	4.1
Length of dactylus	0.6	1.7	1.2
Length of fifth peræopod	21	43	34
Length of propodus	5.7	12.3	9.7
Length of dactylus	1.8	3.5	3.0
Height of second somite of pleon	12.8	27.0	20.0
Length of sixth somite of pleon	11.5	18.3	15.3
Heigth of sixth somite of pleon	8.0	12.8	10.2
Length of telson	11.0	19.0	15.6
Length of inner lamella of uropod	9.7	18.0	14.0
Breadth of inner lamella of uropod	....	5.0	4.2
Length of outer lamella of uropod	12.8	24.0	19.6
Breadth of outer lamella of uropod	....	6.5	5.3

In the largest specimen (7975) the superior flagellum of the antennula is 88^{mm} long; the inferior 52^{mm}; and the flagellum of the antenna 240^{mm}.

PARAPASIPHAË SULCATIFRONS Smith.

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.		Number.		With eggs.
		° ′ ″	° ′ ″				1884.	♂	♀	
8261	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19	1 y.		......
8259	2211	39 35 00	71 18 00	1064	38	gn. M.	Aug. 21		1	1
8260	2219	39 46 22	69 29 00	948	39	gy. M.	Aug. 23		1	0
8594	2223	37 48 30	69 43 30	(*)	....	....	Sept. 7		1	......
8533	2223	37 48 30	69 43 30	2516	37	glb. O.	Sept. 7	1 y.		......
8601	2231	38 29 00	73 09 00	965	39	gy. O.	Sept. 12	1		......
8598	2235	39 12 00	72 03 30	707	39	gn. M.	Sept. 13	1		......

* The bottle containing the specimen from this station had in it a printed label for "surface" specimens, which was undoubtedly put there by mistake.

PARAPASIPHAË COMPTA Smith.

Station 2222, September 6, north lat. 39° 03′ 15″, west long. 70° 50′ 45″, 1,537 fathoms, gray ooze, temperature 37°; one male in rather bad condition (8589).

Measurements in millimeters.

Sex	♂
Length of carapax, including rostrum	50
Length of rostrum	4.2
Length of eye-stalk and eye	6.4
Length of antennal scale	18.6
Breadth of antennal scale	5.0
Length of second gnathopod	45
Length of first peræopod	67
Length of chela	26
Breadth of chela	4.3
Length of dactylus	12.6
Length of second peræopod	74
Length of chela	30.2
Breadth of chela	4.0
Length of dactylus	16.0
Length of third peræopod	56
Length of merus	28.5
Length of carpus	1.3
Length of propodus	15+
Length of fourth peræopod	23
Length of propodus	4.1
Length of dactylus	2.1
Length of fifth peræopod	36
Length of propodus	10.5
Length of dactylus	3.0
Length of sixth somite of pleon	13
Length of telson	23.5
Length of inner lamella of uropod	19.0
Breadth of inner lamella of uropod	5.0
Length of outer lamella of uropod	21.5
Breadth of outer lamella of uropod	6.0

PENÆIDÆ.

SICYONIA BREVIROSTRIS Stimpson.

Sicyonia cristata Saussure, Crust. Antilles et Mexique, p. 55, pl. 3, fig. 25, 1858 (not of De Haan).

Sicyonia brevirostris Stimpson, Ann. Lyceum Nat. Hist. New York, x, p. 132, 1871.

Station 2296, October 20, off Cape Hatteras, north lat. 35° 38′ 20″, west long. 74° 58′ 45″, 27 fathoms, coarse gravel and sand; eight males and four females (8815).

?SICYONIA DORSALIS Kingsley.

Proc. Acad. Nat. Sci. Philadelphia, 1878, p. 97 (9), 1878.

Off Cape Hatteras: Station 2279, October 19, north lat. 35° 20′ 55″, west long. 75° 20′ 55″, 16 fathoms, gray sand, one young specimen (8866); and station 2280, October 19, north lat. 35° 21′, west long. 75° 21′ 30″, 16 fathoms, gray sand, two small specimens (7223).

The specimens agree well with Kingsley's short description, except that the third and fourth somites of the pleon have no spines at the postero-inferior angles.

PENÆUS BRASILIENSIS Latreille.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.			
		° ′ ″	° ′ ″				1884.	♂	♀
7224	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19	1s.	
8788	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19	3s.	3s.
7242	2286	35 21 30	75 25 00	11	....	crs. gy. S.	Oct. 19		1l.

The genus *Penæus*, as usually understood, includes species which differ remarkably in the structure of the oral appendages, the number and arrangement of the branchiæ, and in the presence of exopods and epipods at the bases of the gnathopods and peræopods, but I have recently restricted it to species like *P. carimonte*, *canaliculatus*, *Brasiliensis*, *semisulcatus*, *setiferus*, and *stylirostris*, in which the antennular flagella are very short; the distal segment of the mandibular palpus is much larger than the proximal, very broad, and not prolonged into a narrow tip; the endognath of the first maxilla is greatly elongated and segmented; the endopod of the maxilliped is slender and composed of four segments, and the exopod is lamellar and unsegmented; both pairs of gnathopods have well-developed epipods and large exopods; all the peræopods have small exopods, but only the first, second, and third are furnished with epipods; there is a well-developed pleurobranchia on the fourteenth somite. The number and arrangement of the branchiæ and epipods are the same for all these species, and as indicated in the following formula:

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	1	1	1	1	1	0	0	(6)
Podobranchiæ	0	1	0	0	0	0	0	0	1
Arthrobranchiæ	r.	2	2	2	2	2	1	0	11+r.
Pleurobranchiæ	0	0	1	1	1	1	1	1	6
									18+r.+(6)

PARAPENÆUS Smith.

The species referred to this genus are at once distinguished from the species of *Penæus* proper in having the endognath of the first maxilla short and unsegmented, the second gnathopod without an epipod, and the fourteenth somite (posterior somite of the peræon) wholly without branchiæ. The species examined further agree in having none of the sulci of the carapax conspicuous except the cervical, and in having the antennular flagella shorter than the carapax. In *Parapenæus longirostris*, *politus*, and *megalops*, the mandibular palpi are as in the typical species of *Penæus*, there are no exopods at the bases of any of the peræopods, and the branchio-epipodal formula is as follows:

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	1	0	1	1	1	0	0	(5)
Podobranchiæ	0	1	0	0	0	0	0	0	1
Arthrobranchiæ	r.	2	2	2	2	2	1	0	11+r.
Pleurobranchiæ	0	0	1	1	1	1	1	0	5
									17+r.+(5)

While in *Parapenæus constrictus* and some other species the distal segment of the mandibular palpus is slightly elongated and narrowed distally, there are very small narrow lamellar exopods at the bases of all the peræopods, there is no pleurobranchia on the thirteenth somite, and the branchio-epipodal formula is as follows:

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	1	0	1	1	1	0	0	(5)
Podobranchiæ	0	1	0	0	0	0	0	0	1
Arthrobranchiæ	0	2	2	2	2	2	1	0	11
Pleurobranchiæ	0	0	1	1	1	1	0	0	4
									16+(5)

These characters are, however, combined to a certain extent in two other species which I have examined: A Japanese species, which closely resembles the *constrictus* in general appearance, but has no exopods at the bases of the posterior peræopods and has the epipods and branchiæ as in *P. longirostris;* and *P. Goodei*, which, though resembling the *constrictus* in external characters, has the mandibular palpi, epipods, and branchiæ as in *P. longirostris*, and long and slender exopods at the bases of all the peræopods.

PARAPENÆUS CONSTRICTUS Smith.

Penæus constrictus Stimpson, Ann. Lyc. Nat. Hist. New York, x, p. 135, 1871.
Parapenæus constrictus Smith, Proc. National Mus., viii, p. 174, 1885.

Specimens examined.

[Locality: Off Cape Hatteras.]

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. lat.	Fathoms.	°	Materials.				
		° ′ ″	° ′ ″				1884.	♂		♀
8867	2280	35 21 00	75 21 30	16	....	gy. S.	Oct. 19	1		2
8868	2281	35 21 05	75 22 05	16	....	gy. S.	Oct. 19		5*y*.	
8869	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19		5*y*.	
8790	2283	35 21 15	75 23 15	14	....	gy. S.	Oct. 19			2
8870	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19		175	
7241	2285	35 21 25	75 24 25	13	....	crs. gy. S.	Oct. 19		25	
8871	2286	35 21 30	75 25 00	11	....	crs. gy. S.	Oct. 20		1	
8840	2286	35 21 30	75 25 00	11	....	crs. gy. S.	Oct. 20	1		3
8844	2288	35 22 40	75 25 30	7	....	crs. S.	Oct. 20			1
8872	2289	35 22 50	75 25 00	7	....	crs. S.	....	1		
8804	2290	35 23 00	75 24 30	10	....	S. brk. S.	Oct. 20			1
8873	2291	35 25 30	75 20 30	15	....	gy. S. brk. S.	Oct. 20		2*y*.	
7246	2296	35 35 20	74 58 45	27	....	crs. gy. S.	Oct. 20	1		2

All these specimens agree well with Stimpson's description except that the carina of the carapax is scarcely grooved longitudinally, though distinctly flattened, at the cervical suture. The dorsal crest of the rostrum proper is armed with seven to nine equidistant teeth, and back of these, on the carina of the gastric region, there is a small tooth, described by Stimpson as the gastric tooth, and not referred to in connection with the rostral teeth, which explains the apparent discrepancy pointed out by Miers (Proc. Zool. Soc. London, 1878, p. 304) between Stimpson's description and the specimen in the British Museum. The surface of the posterior part of the branchial regions of the carapax and of the whole of the pleon, except a very narrow and inconspicuous line of pubescence either side of the dorsal carina of the fifth and sixth somites, is entirely naked and glabrous. The dorsal carina of the fourth and fifth somites of the pleon is divided by a narrow incision. The telson is shorter than the sixth somite and rather suddenly tapered to a short acuminate tip armed either side with a short and very small spine.

HYMENOPENÆUS Smith.

Two new species recently described (Proc. National Mus., viii, pp. 180, 183, 1885) confirm the distinctness of this genus and enable me to state its characteristics and its relations to the allied genera. Both flagella of the antennulæ are slender and at least as long as the carapax, excluding the rostrum; the proximal segment of the mandibular palpus is larger and much broader than the distal, which is long and narrow; the endognath of the first maxilla is short and unsegmented; the second gnathopod and the first, second, third, and fourth peræopods have well-developed epipods; and there is, either side, a pleurobranchia on the fourteenth somite and two arthrobranchiæ on the thirteenth.

The branchio-epipodal formula is as follows:

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.	
Epipods	1	1	1	1	1	1	1	0		(7)
Podobranchiæ	0	1	0	0	0	0	0	0	1	
Arthrobranchiæ	0	2	2	2	2	2	2	0	12	
Pleurobranchiæ	0	0	1	1	1	1	1	1	6	
									19+	(7)

The genus thus differs from both *Penæus* and *Parapenæus* in the elongated antennular flagella, the form of the mandibular palpus, and in the presence of two arthobranchiæ and an epipod on either side of the thirteenth somite; it agrees with *Penæus* and differs from *Parapenæus* in having an epipod at the base of the second gnathopod; and it agrees with *Parapenæus* and differs from *Penæus* in having the endognath of the first maxilla short and unsegmented.

The species examined further agree in having antennal, hepatic, and branchiostegal spines, a fourth spine back of the orbit, and small epipods at the bases of all the peræopods.

HYMENOPENÆUS DEBILIS Smith.

Bull. Mus. Comp. Zool., x, p. 91, pl. 15, figs. 6–11, pl. 16, figs. 1–3, 1882.

(Plate XVI, Fig. 7.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.			
		° ′ ″	° ′ ″				1884.	♂	♀
8336	2187	39 49 30	71 10 00	420	40	gn. M. S.	Aug. 3	1	
8268	2201	39 39 45	71 35 15	538	39	bu. M.	Aug. 19	1	
8542	2233	38 36 30	73 06 00	630	39	gn. M.	Sept. 12	*f.*	

All these specimens are small and in bad condition, but are apparently specifically identical with those originally described from the Blake collection. The appendages of the second pleopods in the small male from station 2187 are very different from those of *H. microps* or *robustus*, and, though they are very likely not fully developed, are probably sufficiently advanced to show essentially the adult form, and are very characteristic. These appendages are each long and very narrow, about three times as long as broad. There is a small and narrow lobe on the anterior side near the base of the lamella; the outer edge is slightly thickened, and terminates in a short rounded lobe a little way from the tip, which is about half as wide as the proximal part of the lamella and deeply bilobed, and near the middle of the mesial edge there is a slight emargination, probably marking the distal end of that part of the edge which articulates with the lamella of the opposite side.

This specimen, from station 2187, gives the following:

Measurements in millimeters.

Length from tip of rostrum to tip of telson	33+
Length of carapax, including rostrum	12.5
Length of rostrum	4.0
Length of eye-stalk and eye	2.5
Greatest diameter of eye	2.1
Length of antennal scale	5.6
Breadth of antennal scale	1.6
Length of flagellum of antenna	100+

HYMENOPENÆUS MICROPS Smith.

(Plate XVI, Fig. 8.)

Station 2224, September 8, north lat. 36° 16′ 30″, west long. 68° 21′, 2,574 fathoms, globigerina ooze, temperature 37°; 1 ♂, 1 ♀ (8604), both in bad condition and imperfect.

A single fragmentary female (7155), in addition to the two specimens already recorded from the collection of 1883, was taken at station 2042, July 30, north lat. 39° 30′, west long. 68° 26′ 45″, 1,555 fathoms, globigerina ooze, temperature 38°.

In the male, from station 2224, the carapax, including the rostrum, is 20mm long, and the appendages of the first pleopods are fully developed. Each of these appendages is a large squarish lamellar plate, considerably narrowed distally, attached by a very short and narrow peduncle, and with the outer and distal margins slightly thickened, the latter irregularly lobed, and the median portion longitudinally plicated. There is a narrow, obtusely-tipped lobe on the mesial side of the peduncle, and close to it, on the base of the pleopod itself, a similar but more triangular lobe. The outer margin terminates at the distal end in a broad rounded lobe, on the mesial side of which there is a very much smaller rounded lobe, then a deep sinus, and then a broader bidentate lobe at the mesial side of the distal margin. The mesial edge is nearly straight, except a slight emargination near the middle, separating the proximal articular from the distal unarmed portion.

ARISTEUS ? TRIDENS Smith.

(Plate XIX, Figs. 2, 2*a*.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.			
		° ′ ″	° ′ ″				1884.	♂	♀
7979	2174	38 15 00	72 03 00	1, 594	....	gy. M.	July 21		2
......	2221	39 15 30	70 44 23	1, 525	37	gy. O.	Sept. 6		1
8615	2222	39 03 15	70 50 45	1, 537	37	gy. O.	Sept. 6		1
8581	2224	36 16 30	68 21 00	2, 574	37	glb. O.	Sept. 8		1
8584	2224	36 16 30	68 21 00	2, 574	37	glb. O.	Sept. 8	1*y*.	
8583	2226	37 00 00	71 54 00	2, 021	37	glb. O.	Sept. 10		1
8616	2226	37 00 00	71 54 00	2, 021	37	glb. O.	Sept. 10	1	1

In the original description of this species the minute terminal segment of the endopod of the maxilliped (Plate XIX, Fig. 2*a*) was overlooked.

HEPOMADUS TENER Smith.

Report U. S. Fish Com., part x, for 1882, p. 409, pl. 9, figs. 7, 8, 1884.

(Plate XIX, Figs. 3, 3*a*.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.			
		° ′ ″	° ′ ″				1883.	♂	♀
5464	2099	37 12 20	69 30 00	2, 949	....	glb. O.	Oct. 2	1	
5635	2102	38 44 00	72 38 00	1, 209	39	glb. O.	Nov. 5	1	
							1884.		
8585	2226	37 00 00	71 54 00	2, 021	37	glb. O.	Sept. 10		1

The specimen originally described (5464) was in rather bad condition, and its integument apparently much thinner and softer than in the larger and much more perfectly preserved specimens subsequently obtained. In these later specimens the integument is very much like that of *Aristeus ? tridens*, which the species resembles closely in general appearance.

In the recently preserved alcoholic specimens, the small rounded tubercle on the inner side of the eye-stalk is semi-translucent, cornea-like, slightly pigmented at the base, receives a branch of the optic nerve, and has the appearance of a secondary simple eye.

The peduncles of the antennulæ reach nearly to or a little by the tips of the antennal scales; the body of the proximal segment is about half the entire length, and the spiniform lateral process reaches to about the extremity of the segment itself, which, however, is armed with a slender spine just outside the base of the second segment; the second segment is about twice as long as the distal. The flagella are almost exactly as in *Aristeus ? tridens.* The antennal scale is about three-fourths as long as the carapax excluding the rostrum, half as broad or a little less than half as broad as long, and in form and texture like that of *Aristeus ? tridens.*

The sixth somite of the pleon is about half as high as long. The telson is nearly or quite as long as the sixth somite, regularly tapered, slightly flattened above, armed with small dorso-marginal aculei, and terminates in an acuminate tip armed with slender setæ.

A female taken in 1885, station 2563, north lat. 39° 18′ 30″, west long. 71° 23′ 30″, 1,422 fathoms, is much larger than any of the specimens previously taken, being over 200mm in length. In this specimen the rostrum is longer than the carapax proper, the antennal scales are half as broad as long, and the telson is as long as the sixth somite of the pleon.

Measurements in millimeters.

Catalogue number	5635	8585
Station	2102	2226
Sex	♂	♀
Length from tip of rostrum to tip of telson	94	125
Length of carapax, including rostrum	37.7	49.0
Length of rostrum	17.3	20.5
Height of carapax	11.6	16.0
Breadth of carapax	10.0	14.2
Length of eye-stalk and eye	5.5	7.5
Greatest diameter of eye	2.2	2.8
Length of antennal scale	15.0	21.0
Breadth of antennal scale	7.0	9.3
Length of second gnathopod	26	39
Length of first peræopod	25	39
Length of chela	7.5	11.5
Breadth of chela	1.15	1.8
Length of dactylus	5.0	7.5
Length of second peræopod	29	45
Length of chela	7.8	12.3
Breadth of chela	1.2	1.9
Length of dactylus	5.1	8.1
Length of third peræopod	33	50
Length of chela	8.2	13.3
Breadth of chela	1.25	2 0
Length of dactylus	5.2	8.3
Length of fourth peræopod	40	58
Length of propodus	6.2	9.0
Length of dactylus	5.5	7.5
Length of fifth peræopod	42	61
Length of propodus	6.6	9.5
Length of dactylus	4.5+	6+
Length of sixth somite of pleon	13.8	18.5
Height of sixth somite of pleon	6.9	8.6
Length of telson	12.0	16.7
Length of inner lamella of uropod	12.3	17.2
Breadth of inner lamella of uropod	3.2	4.3
Length of outer lamella of uropod	15.3	21.5
Breadth of outer lamella of uropod	4.1	5 4

AMALOPENÆUS ELEGANS Smith.

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.			
		° ′ ″	° ′ ″				1884.	♂	♀
8229	2190*	39 40 00	70 20 15	1,180	....	glb. O.	Aug. 4		1
8230	2193	39 44 30	70 10 30	1,122	38	gn. M.	Aug. 5	1	
8267	2201	39 39 45	71 35 15	538	39	bu. M.	Aug. 19		1
8526	2235	39 12 00	72 00 30	707	39	gn. M.	Sept. 13	1	
8537	2236	39 11 00	72 08 30	636	39	gn. M.	Sept. 13		2

* Trawl reported as "not on bottom."

BENTHŒCETES BARTLETTI Smith.

Benthesicymus? Bartletti Smith, Bull. Mus. Comp. Zool., x, p. 82, pl. 14, figs. 1–7, 1882.

Benthœcetes Bartletti Smith, Report U. S. Fish Com., x, for 1882, p. 391, pl. 10, fig. 8, 1884; Proc. National Mus., vii, p. 508, 1885.

(Plate XVIII, Figs. 2, 2*a*, 2*b*.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.			
		° ′ ″	° ′ ″				1884.	♂	♀
8019	2181	39 29 00	71 46 00	693	39	gy. M., fne, S.	July 23	1	
8262	2203	39 45 15	71 45 15	705	39	gn. M. S.	Aug. 19		1
8263	2215	39 49 15	70 31 45	578	....		Aug. 22		1
8264	2216	39 47 00	70 30 30	963	39	gn. M.	Aug. 22	2*y*.	
8588	2234	39 09 00	72 03 15	816	39	gn. M.	Sept. 13	1	
8587	2235	39 12 00	72 03 30	707	39	gn. M.	Sept. 13	1	1

Some of these specimens show that the dactyli of the fourth and fifth peræopods are, as I had supposed, normally very slender, but not multiarticulate nor very long in either sex, and that the flagella of the antennula are very long, apparently much longer than the body.

BENTHONECTES Smith.

This genus is closely allied to *Benthœcetes* and is specially charaterized by the multiarticulate flagelliform dactyli of the fourth and fifth peræopods. It is further distinguished from allied genera by the acute ventral process of the crowns of the mandibles and the narrow mandibular palpi; and probably, also, by the presence of a hepatic spine upon the carapax, the large reniform eyes, the equal lobes of the protognath of the second maxillæ, the absence or obsolescence of the third segment of the endopod of the maxilliped, the narrow merus of the first gnathopod, and the styliform dactylus of the second gnathopod. Like that of *Benthœcetes*, the relation to Bate's imperfectly described *Benthesicymus* is largely problematical, but Bate's genus is described as having the eyes "not large," the eye-stalks flattened and furnished with a conspicuous tubercle, and the flagella of the antennula "not longer than the carapax" (although under the second species these flagella are said to be "half as long as the animal"), characters which I should not expect to find in species congeneric with the one here described.

BENTHONECTES FILIPES Smith.

Proc. National Mus., vii, p. 509, 1885.

(Plate XVIII, Figs. 1, 1*a*; Plate XIX, Figs. 1, 1*a*, 1*b*.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.			
		° ′ ″	° ′ ″				1884.	♂	♀
8020	2181	39 29 00	71 46 00	693	39	gy. M. fne. S.	July 23	1*s*.	
8265	2206	39 35 00	71 24 30	1,043	38	gn. M.	Aug. 20		1
8266	2210	39 37 45	71 18 45	991	38	gy. glb. O.	Aug. 21	1*s*.	
7163	2235	39 12 00	72 03 30	707	39	gn. M.	Sept. 13	1	

This species is apparently very closely allied to that figured by A. Milne-Edwards as "*Benthesicymus Bartletti* (Smith)?" (Recueil de figures de Crustacés nouveaux ou peu connus, 1883), and is probably specifically identical with it.

The carapax is similar to that of *Benthœcetes Bartletti* in general form, but is considerably narrower and less expanded posteriorly. The dorsum is carinated or slightly angulated to near the posterior border, and rising anteriorly projects forward in a rostrum almost exactly as in that species except that it is a very little longer, so as slightly to overreach the eyes, and the lower edge is more nearly horizontal. The inferior angle of the orbit is slightly more acute, the antennal spine a little larger and a little farther forward, and there is in addition a hepatic spine nearly as large as the antennal.

The eye-stalks are relatively short, and the very dark brown eyes, large, swollen, reniform, project over the ends of the stalks and extend proximally along their mesial sides more than half way to the bases ot the stalks, the greatest diameter of the eye being at least three-fourths of the whole length of the stalk. There is a small and inconspicuous tubercle on the mesial side of the stalk just back of the edge of the eye. The antennal scales are slightly narrower than in *Benthœcetes Bartletti*, but otherwise the antennæ and antennulæ are essentially as in that species. The flagella of the antennula are approximately equal in length, much longer than the body of the animal, and very slender, while the flagellum of the antenna is very much longer and almost equally slender.

The oral appendages are similar to those of *Benthœcetes Bartletti*, but show some important differences. The ventral process of the crown of the mandible, instead of being truncated at the anterior angle, is prolonged into an acute angular process which closes by a similar process of the opposite side. The palpus is very different in form; the proximal segment is narrow, about three times as long as broad, reaches to about the tip of the crown, and expands very slightly distally; the distal segment is only about half as long as the proximal and about as wide at the base, but the inner edge is obliquely truncated from just below the middle so that the obtuse tip is narrow. The first maxillæ differ only very slightly and unessentially. The endognath and epignath of the second maxillæ differ very little, but the four lobes of the protognath are very much more nearly alike, the distal lobe being only a very little broader than the others, while the proximal is very much like the others, being as long as the one next it and not narrowed toward the rounded tip. The endognath of the maxilliped is a little shorter and the small terminal segment either wanting or very obscure; the exopod is shorter and suddenly narrowed into a short and slender flagelliform tip. The exopod of the first gnathopod is very much smaller, being very slender and considerably shorter than the endopod. The endopod of the second gnathopod is more slender and armed with longer and stronger spines, and the dactylus is very different, being nearly two-thirds as long as the propodus, slender, subcylindrical, and strongly tapered distally, where it is armed with several slender spines nearly as long as itself.

The chelate peræopods are similar to those of *Benthœcetes Bartletti*, but considerably longer and more slender, the first pair reaching considerably by the tips of the second gnathopods. The fourth and fifth peræopods are very long, exceedingly slender, and the proximal portions nearly as in *Benthœcetes Bartletti.* The carpi in the fifth pair are considerably longer than the meri; the propodi in the fourth are much shorter than the carpi, and in the fifth not half as long as the carpi; the dactyli are slender, multiarticulate, flagelliform, and very long, being in the fourth pair fully three times as long as the propodi. The number and arrangement of the branchiæ and epipods are the same as in *Benthœcetes Bartletti*, but there are small rudimentary exopods at the bases of all the peræopods, as in *Benthesicymus ? carinatus.*

The pleon is similar to that of *Benthœcetes Bartletti* except that there is no spine on the fifth somite. The dorsum is evenly rounded on the first four somites, but on the fifth and sixth there is a sharp median carina which projects posteriorly in a very slight angle on each of these somites. The epimera are all somewhat smaller than in *Benthœcetes Bartletti*, and the posterior edges of the fourth and fifth project much less and are broadly rounded. The telson is narrowly triangular, transversely convex above at the base, but with a broad and shallow sulcus two-thirds of its length. The extreme tip is spiniform and acute, and just in front of it the edge each side is armed with three small spines. The sternum of the first somite is armed with a laterally compressed mesial process somewhat as in that species, but longer and obtuse. The pleopods have very long and slender rami, as in *Benthœcetes Bartletti*, but the appendage (petasma) of the first pair in the male is very different, being as long as the protopod to which it is attached, very narrow, and acutely triangular at the tip.

Measurements in millimeters.

Station	2235	2181
Sex	♂	♂
Length from tip of rostrum to tip of telson	82	63
Length of carapax, including rostrum	25.7	32.0
Length of rostrum	6.0	5.8
Height of carapax	12.8	9.6
Breadth of carapax	11.0	8.0
Length of eye stalk and eye	5.0	4.1
Greatest diameter of eye	3.7	3.3
Length of antennal scale	15.8	13.5
Breadth of antennal scale	5.1	4.0
Length of second gnathopod	24	20
Length of propodus	2.9	2.5
Length of dactylus	2.0	1.7
Length of first peræopod	27	21
Length of carpus	6.0	4.8
Length of chela	5.4	4.6
Breadth of chela	1.0	0.9
Length of dactylus	2.5	2.1
Length of second peræopod	34	27
Length of carpus	10.0	8.2
Length of chela	6.0	5.0
Breadth of chela	0.9	0.7
Length of dactylus	2.8	2.5
Length of third peræopod	44	32
Length of carpus	13.7	10.0
Length of chela	7.4	5.5
Breadth of chela	0.8	0.6
Length of dactylus	4.8	3.0
Length of fourth peræopod	67	50
Length of merus	13.3	12.0
Length of carpus	11.0	8.4
Length of propodus	7.5	6.0
Length of dactylus	25.0	18.5
Length of fifth peræopod	64+	....
Length of merus	13.0	....
Length of carpus	16.5	....
Length of propodus	7.7	....
Length of dactylus	15+	....
Length of sixth somite of pleon	13.8	11.0
Height of sixth somite of pleon	7.0	5.4
Length of telson	11.0	9.3
Length of inner lamella of uropod	11.5	9.2
Breadth of inner lamella of uropod	2.8	2.3
Length of outer lamella of uropod	16.4	14.8
Breadth of outer lamella of uropod	4.5	3.6

BENTHESICYMUS ? MORATUS, sp. nov.

Benthesicymus? sp. indet., Smith, Report U. S. Fish Com., x, for 1882, p. 397, pl. 10, figs. 3, 4, 5, 1884.

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.	
		N. lat.	W. long.	Fathoms.	°	Materials.		♂	♀
		° ′ ″	° ′ ″						
7117	2042	39 33 00	68 26 45	1,555	38	glb. O.	1883. July 30		1*f.*
8018	2174	38 15 00	72 03 00	1,594		gy. M.	1884. July 21		2*f.*
8590	2222	39 03 15	70 50 45	1,537	37	gy. O.	Sept. 6		1*f.*
10867	2575	41 07 00	65 26 30	1,710	37	gy. O.	1885. Sept. 1	1*f.*	

In the general form and areolation of the carapax this species is very similar to *Benthœcetes Bartletti*, but there is a distinct hepatic spine, as in *Benthonectes filipes*, though very much smaller. The dorsum is carinated or slightly angulated nearly to the posterior border, but anteriorly it does not rise at the base of the rostrum nearly as much as in the two species just mentioned. The rostrum is strongly compressed, broad vertically, and the upper edge is somewhat arcuate above and just back of the orbit, where it is armed with two teeth, but in front it tapers to an acute point, nearly or quite reaching to the tips of the eyes.

The eyes are in bad condition in all the specimens. They are similar to those of *Benthœcetes Bartletti*, but the cornea is apparently a little larger and more compressed vertically, and the pigment is apparently white or very light in color. The antennæ and antennulæ are essentially as in *Benthœcetes Bartletti*. The crowns of the mandibles are also very nearly as in that species, but the palpi are very much larger; the proximal segment is nearly as broad as long, and the distal nearly as long as the proximal and very narrow, much less than half as wide as long. The maxillæ are nearly as in *Benthœcetes Bartletti*. The ultimate segment of the endopod of the maxilliped is about a sixth as long as the penultimate segment and intermediate in form and size between that of *Benthœcetes Bartletti* and that of *Benthesicymus ? carinatus*, and the distal extremity of the exopod is suddenly narrowed into a slender flagellum, but otherwse the maxilliped agrees with that of *Benthœcetes Bartletti*.

The first gnathopod is intermediate in form between that of *Benthœcetes* and that of *Benthesicymus ? carinatus*; the mesial side of the merus is expanded into a thin lamella the whole length of the segment, which is two-fifths as broad as long, but not much broader distally than proximally and projects only very slightly beyond the articulation of the carpus; the terminal segments are nearly as in *Benthesicymus ? carinatus*. The second gnathopods reach beyond the middle of the antennal scales, and the relative proportion of the segments is about the same as in *Benthœcetes Bartletti*, but the form of the dactylus is different, though it is carried in the same position. This segment is a little longer and narrower than in *Benthœcetes Bartletti*, and obliquely truncated on the mesial side at the extremity, so that the triangular tip, which is armed with a single long spine, is at the outer edge; the outer and the truncated distal edges are setigerous.

There are minute rudimentary exopods at the bases of all the peræopods, of which the first three pairs are otherwise very much as in *Benthonectes filipes*. The number and arrangement of the branchiæ and epipods is the same as in *Benthœcetes Bartletti* and *Benthonectes filipes*.

The first and second somites of the pleon are evenly rounded above; the third is carinated posteriorly, the fourth and fifth for nearly the whole length, and on each of these somites the carina projects at the posterior margin in a small sharp tooth. The sixth somite is compressed laterally, more than twice as long as high, and armed with a sharp dorsal carina. The telson is about as long as the sixth somite, narrowly triangular, with a broad and shallow dorsal sulcus except near the base, terminates in a small spiniform point, with a spine either side, and is armed in front of these with three pairs of lateral spines. The uropods and pleopods are very nearly as in *Benthœcetes Bartletti*, except that the appendage (petasma) of the first pair of pleopods in the male is long and narrow, approaching in form that of *Benthonectes filipes*.

Measurements in millimeters.

Station	2174	2222	2575
Sex	♀	♀	♂
Length from tip of rostrum to tip of telson	95	100	105
Length of carapax, including rostrum	37.5	40.0	41.0
Length of rostrum	5.5	6.8	7.5
Height of carapax	17.0	....	....
Length of eye-stalk and eye	6.2	6.4	7.0
Greatest diameter of eye	2.6	2.8	3.0
Length of antennal scale	....	23.5	25.0
Breadth of antennal scale	6.6	7.0	7.1
Length of first peræopod	....	30.0	30.0
Length of chela	....	7.0	7.3
Breadth of chela	....	1.6	1.7
Length of dactylus	....	3.1	3.3
Length of second peræopod	44.0	46.0	46.0
Length of chela	6.6	....	7.8
Breadth of chela	....	....	1.0
Length of dactylus	....	....	3.6
Length of third peræopod	....	64.0	....
Length of chela	....	9.5	....
Breadth of chela	....	1.0	....
Length of dactylus	....	5.0	....
Length of sixth somite of pleon	15.6	16.0	17.0
Height of sixth somite of pleon	7.2	7.8	8.2
Length of telson	16.0	17.0	....
Length of inner lamella of uropod	15.5	16.4	16.8
Breadth of inner lamella of uropod	3.9	4.1	4.4
Length of outer lamella of uropod	21.0	22.5	23.0
Breadth of outer lamella of uropod	5.4	5.8	6.0

SERGESTIDÆ.

SERGESTES ARCTICUS Kröyer.

(Plate XX, Figs. 1, 2.)

Specimens examined.

Catalogue number.	Station number.	Locality.		Depth, temperature, and nature of bottom.			Date.	Specimens.		
		N. lat.	W. long.	Fathoms.	°	Materials.				
		° ′ ″	° ′ ″				1884.	♂		♀
7982	2180	39 29 50	71 49 30	523	39	bk. M.	July 23			2
7983	2182	39 25 30	71 44 00	861	39	gn. M.	....	1		1
8088	2187	39 49 30	71 10 00	420	40	gn. M., S.	Aug. 3	7		8
8430	2187	....	....	....	....	....	....		1*y*.	
8425	2188	39 54 30	71 08 00	235	43	....	....		5*y*.	
8426	2192	39 46 30	70 14 45	1,060	39	gy. O.	Aug. 5		2*y*.	
8136	2201	39 39 45	71 35 15	538	39	bu. M.	Aug. 19	1		3
8532	2223	37 48 30	69 43 30	2,516	37	glb. O.	Sept. 7			1
8524	2236	39 11 00	72 08 30	636	39	gn. M.	Sept. 13		3*y*.	
8605	2237	39 12 17	72 09 30	520	39	....	....	1		1
[Locality: Off Cape Hatteras.]										
8805	2299	35 40 00	74 51 30	296	....	bk. M.	Oct. 20			2

SERGESTES ROBUSTUS Smith.

(Plate XX, Fig. 6.)

Specimens examined.

Catalogue number.	Station number.	Locality. N. lat.	Locality. W. long.	Depth, temperature, and nature of bottom. Fathoms.	°	Materials.	Date.	Specimens. ♂	Specimens. ♀
		° ′ ″	° ′ ″				1884.	♂	♀
7981	2174	38 15 00	72 03 00	1,594	....	gy. M.	July 21	1	
8135	2202	39 38 00	71 39 45	515	39	gn. M.	Aug. 19		1
8547	2224	36 16 30	68 21 00	2,574	37	glb. O.	Sept. 8	1s.	
8599	2237	39 12 17	72 09 30	520	39	gn. M.	Sept. 13		2

SERGESTES MOLLIS Smith.

(Plate XX, Figs. 3, 3*a*, 4, 5.)

Specimens examined.

Catalogue number.	Station number.	Locality. N. lat.	Locality. W. long.	Depth, temperature, and nature of bottom. Fathoms.	°	Materials.	Date.	Specimens. ♂		Specimens. ♀
		° ′ ″	° ′ ″				1884.	♂		♀
......	2190	39 40 00	70 20 15	1,180	...	glb. O	Aug. 4		1*f*.	
8089	2193	39 44 30	70 10 30	1,122	38	gn. M.	Aug. 5	1	2	
8231	2194	39 43 45	70 07 00	1,140	38	O.	Aug. 5	1		
8129	2206	39 35 00	71 24 30	1,043	38	gn. M.	Aug. 20			1
8130	2209	39 34 45	71 21 30	1,080	39	glb. O.	Aug. 21	1s.		
8131	2210	39 37 45	71 18 45	991	38	gy. glb. O.	Aug. 21	1		
8132	2215	39 49 15	70 31 45	578	....	....	Aug. 22			1
8133	2219	39 46 22	69 29 00	948	39	gy. M.	Aug. 23			1
8539	2229	37 38 40	73 16 30	1,423	38	glb. O.	Sept. 11	1		

NEW HAVEN, CONN., *December* 4, 1885.

EXPLANATION OF PLATES.

All the figures on Plates I, II, IV, VII, VIII, IX, X, XIII, XIV, XVII, and XVIII; Fig. 1, Plate III; Fig. 2, Plate V; Figs. 1 and 1*a*, Plate VI; Figs. 1, 1*a*, 3, 3*a*, 4, 6, 6*a*, and 7, Plate XI; Figs. 4 and 6, Plate XII; Figs. 2 and 3, Plate XIX; and Figs. 1, 2, 3, 3*a*, 5, and 6, Plate XX, were drawn by J. H. Emerton. Fig. 2, Plate III, and Fig. 1, Plate V, were drawn by J. H. Blake. All the other figures were drawn by the author.

PLATE I.

FIG. 1.—*Lispognathus Thomsoni.* Dorsal view of a male from station 951, enlarged two diameters.

FIG. 1*a*.—Lateral view, the peræopods omitted, of the same specimen, enlarged the same amount.

FIG. 2.—*Anamathia Agassizii.* Dorsal view, the peræopods omitted, of the originally described male from the Blake collection, natural size.

FIG. 3.—Dorsal view of a female (5693), from station 2109, one-half natural size.

FIG. 3*a*.—Ventral view of the front and oral region of the same specimen, natural size.

FIG. 4.—*Anamathia Tanneri.* Dorsal view of one of the originally described males, from station 1043, natural size.

PLATE II.

FIG. 1.—*Homola barbata.* Dorsal view of a male, from station 940, natural size.

FIG. 2.—*Lambrus Verrillii.* Dorsal view of a female, from station 872, natural size.

PLATE III.

FIG. 1.—*Lithodes Agassizii.* Dorsal view, the peræopods omitted, of a male, from station 2115, one-half natural size.

FIG. 2.—Dorsal view of a male (8048), from station 2196, one-half natural size.

PLATE IV.

Munidópsis crassa. Dorsal view of the female (8563), from station 2224, natural size.

PLATE V.

FIG. 1.—*Munidopsis similis.* Dorsal view of the female (8255), from station 2192, natural size.

FIG. 1*a*.—Second maxilla of the right side of the same specimen, enlarged eight diameters.

FIG. 1*b*.—First gnathopod of the right side of the same specimen, enlarged eight diameters.

FIG. 1*c*.—Second gnathopod of the right side of the same specimen, enlarged four diameters.

FIG. 2.—*Munidopsis Bairdii.* Dorsal view of a female (5717), from station 2106, natural size.

PLATE VI.

FIG. 1.—*Munidopsis rostrata.* Dorsal view of a male, from the Blake collection of 1880, station 341, natural size.

FIG. 1*a*.—Lateral view of the carapax of the same specimen, natural size.

FIG. 2.—*Munidopsis similis.* First maxilla of the right side of the specimen figured on Plate V, enlarged eight diameters.

FIG. 2*a*.—Maxilliped of the right side of the same specimen, enlarged the same amount.

PLATE VII.

FIG. 1.—*Pentacheles nanus.* Dorsal view of a female (8238), from station 2206, natural size.

FIG. 1*a*.—Lateral view of the carapax and pleon of the same specimen, natural size.

FIG. 2.—*Pentacheles debilis.* Dorsal view, the peræopods omitted, of a male (7145) from station 2074, enlarged two diameters.

PLATE VIII.

FIG. 1.—*Glyphocrangon longirostris.* Lateral view of the small female originally described from the Blake collection, station 330, enlarged two diameters.

FIG. 2.—Lateral view of an adult female (8256), from station 2205, natural size.

FIG. 3.—*Glyphocrangon sculptus.* Lateral view of the originally described female, from the Blake collection, station 330, natural size.

PLATE IX.

FIG. 1.—*Glyphocrangon sculptus.* Dorsal view of the specimen figured on Plate VIII, natural size.

FIG. 2.—Dorsal view of the carapax and anterior appendages of a male (7182), from station 2051, natural size.

FIG. 3.—*Glyphocrangon longirostris.* Dorsal view of the adult female (8256) figured on Plate VIII, natural size.

FIG. 4.—Dorsal view of carapax and anterior appendages of a male (8257), from station 2206, natural size.

FIG. 5.—Dorsal view of the carapax and anterior appendages of the small female from the Blake collection, figured on Plate VIII, enlarged two diameters.

PLATE X.

FIG. 1.—*Sabinea princeps.* Lateral view of one of the originally described females, from the Blake collection, natural size.

FIG. 1*a*.—Dorsal view of the carapax and anterior appendages of the same specimen, natural size.

FIG. 1*b*.—Dorsal view of the terminal portion of the pleon of the same specimen, natural size.

FIG. 2.—Dorsal view of the carapax and anterior appendages of a male (7954), from station 2180, natural size.

FIG. 3.—*Sabinea Sarsii.* Dorsal view of female, from station 2063, natural size.

FIG. 3*a*.—Lateral view of the carapax of the same specimen, enlarged two diameters.

FIG. 4.—Dorsal view of the carapax and anterior appendages of a male, from station 2063, enlarged two diameters.

PLATE XI.

FIG. 1.—*Pontophilus gracilis.* Dorsal view of the female originally described, from the Blake collection, station 315, enlarged two diameters.

FIG. 1*a*.—Lateral view of the carapax of the same specimen, enlarged two diameters.

FIG. 2.—Left chela of a male, from station 1029, enlarged four diameters.

FIG. 3.—*Pontophilus abyssi.* Dorsal view of a female (8600), from station 2226, natural. size.

FIG. 3*a*.—Lateral view of the carapax of the same specimen, enlarged two diameters.

FIG. 4.—Dorsal view of the carapax and anterior appendages of a male (8600), from station 2226, enlarged two diameters.

FIG. 5.—Left chela of a male (8600), from station 2226, enlarged four diameters.

FIG. 6.—*Pontophilus Norvegicus.* Dorsal view of a female, from station 946, natural size.

FIG. 6*a*.—Lateral view of the carapax of the same specimen, enlarged two diameters.

FIG. 7.—Dorsal view of the carapax and anterior appendages of a male, from station 947, enlarged two diameters.

PLATE XII.

FIG. 1.—*Bythocaris Payeri.* Dorsal view of the front of the carapax and the anterior appendages of a female, from the Faröe Channel, enlarged four diameters.

FIG. 2.—*Bythocaris nana.* Dorsal view of the front of the carapax and the anterior appendages of a female, from station 878, enlarged four diameters.

FIG. 3.—*Bythocaris gracilis.* Dorsal view of the front of the carapax and the anterior appendages of the female (7132), from station 2116, enlarged four diameters.

FIG. 4.—Lateral view of the female (8258), from station 2206, enlarged two diameters.

FIG. 5.—*Notostomus robustus.* Lateral view of the front of the carapax and the eye of the young specimen (8543), from station 2228, enlarged four diameters.

FIG. 6.—*Hymenodora gracilis.* Lateral view of a male (7158), from station 2036, enlarged three diameters.

PLATE XIII.

FIG. 1.—*Pandalus propinquus.* Lateral view of a female, from station 1045, natural size.

FIG. 2.—*Pandalus Montagui.* Lateral view of a female taken off Massachusetts Bay in 1877, natural size.

FIG. 3.—*Acanthephyra microphthalma.* Lateral view of a male (8584), from station 2224, natural size.

PLATE XIV.

FIG. 1.—*Acanthephyra eximea.* Lateral view of the male (5644), from station 2111, natural size.

FIG. 2.—*Acanthephyra brevirostris.* Lateral view, with most of the appendages omitted, of a male (5673), from station 2105, enlarged two diameters.

FIG. 3.—*Ephyrina Benedicti.* Lateral view of the female (7156), from station 2083, enlarged two diameters.

PLATE XV.

All the figures on this plate are enlarged eight diameters.

FIG. 1.—*Acanthephyra Agassizii.* First maxilla of the left side of one of the originally described males, from the Blake collection, station 330.

FIG. 2.—*Acanthephyra brevirostris.* First maxilla of the right side of a female (5448), from station 2099.

FIG. 3.—*Hymenodora glacialis.* First maxilla of the right side of a male, from the Faröe Channel.

FIG. 4.—*Meningodora mollis.* First maxilla of the right side of the female originally described, from the Blake collection.

FIG. 5.—Distal portion of the right mandible of the same specimen, seen from above.

FIG. 6.—*Acanthephyra Agassizii.* Distal portion of the left mandible, from the same specimen as Fig. 1, seen from beneath.

FIG. 6*a*.—The same mandible seen from above.

FIG. 7.—Second maxilla of the left side, from the same specimen as Figs. 1 and 6.

FIG. 8.—*Acanthephyra brevirostris.* Second maxilla of the right side, from the same specimen as Fig. 2.

FIG. 9.—*Meningodora mollis.* Second maxilla of the right side, from the same specimen as Fig. 4.

FIG. 10.—*Hymenodora glacialis.* Second maxilla of the right side, from the same specimen as Fig. 3.

PLATE XVI.

All the figures on this plate are enlarged eight diameters.

FIG. 1.—*Acanthephyra brevirostris.* Maxilliped of the right side, from the same specimen as Figs. 2 and 8, Plate XV.

FIG. 2.—*Acanthephyra Agassizii.* Maxilliped of the left side, from the same specimen as Figs. 1, 6, 6*a*, and 7, Plate XV.

FIG. 3.—*Meningodora mollis.* Maxilliped of the right side, from the same specimen as Figs. 4, 5, and 9, Plate XV.

FIG. 4.—*Ephyrina Benedicti.* Maxilliped of the right side, from the specimen figured on Plate XIV.

FIG. 5.—*Hymenodora glacialis.* Maxilliped of the right side, from the same specimen as Figs. 3 and 10, Plate XV.

FIG. 6.—*Acanthephyra brevirostris.* First gnathopod of the right side, from the same specimen as Figs. 2 and 8, Plate XV, and Fig. 1, this plate.

FIG. 7.—*Hymenopenæus debilis.* Appendage (petasma) of the protopod of the first pleopod of the right side of a male (8336), from station 2187, seen from in front.

FIG. 8.—*Hymenopenæus microps.* Appendage of the protopod of the first pleopod of the right side of a male (8604), from station 2224, seen from in front.

PLATE XVII.

FIG. 1.—*Nematocarcinus cursor.* Lateral view of a female (8149), from station 2202, natural size.

FIG. 1*a*.—Dorsal view of the carapax and anterior appendages of the same specimen.

FIG. 2.—*Nematocarcinus ensiferus.* Lateral view of a female, from station 2035, natural size. This is a corrected copy of Fig. 1, Plate VII, of the Report on the Decapod Crustacea of the Albatross dredgings in 1883.

PLATE XVIII.

FIG. 1.—*Benthonectes filipes.* Lateral view of a male (7163), from station 2235, natural size.

FIG. 1*a*.—Dorsal view of the carapax and anterior appendages of the same specimen.

FIG. 2.—*Benthœcetes Bartletti.* Lateral view of a female (8263), from station 2215, natural size.

FIG. 2*a*.—Dorsal view of the carapax and anterior appendages of the same specimen.

FIG. 2*b*.—Dorsal view of the posterior somites of the pleon of the same specimen.

PLATE XIX.

FIG. 1.—*Benthonectes filipes.* Maxilliped of the right side of a male, from station 2181, enlarged eight diameters.

FIG. 1*a*.—First gnathopod of the right side of the same specimen, enlarged eight diameters.

FIG. 1*b*.—Terminal portion of the endopod of the second gnathopod of the same specimen, enlarged eight diameters.

FIG. 2.—*Aristeus? tridens.* Maxilliped of the right side of a female, from station 2043, natural size.

FIG. 2*a*.—Tip of endopod of the same appendage to show the minute terminal segment, enlarged four diameters.

FIG. 3.—*Hepomadus tener.* Lateral view of female (8585), from station 2226, natural size.

FIG. 3*a*.—Maxilliped of the right side of the same specimen, enlarged four diameters.

PLATE XX.

FIG. 1.—*Sergestes arcticus.* Lateral view of a male, from station 937, enlarged two diameters.

FIG. 2.—Dorsal view of the carapax and anterior appendages of a female, from station 937, enlarged three diameters.

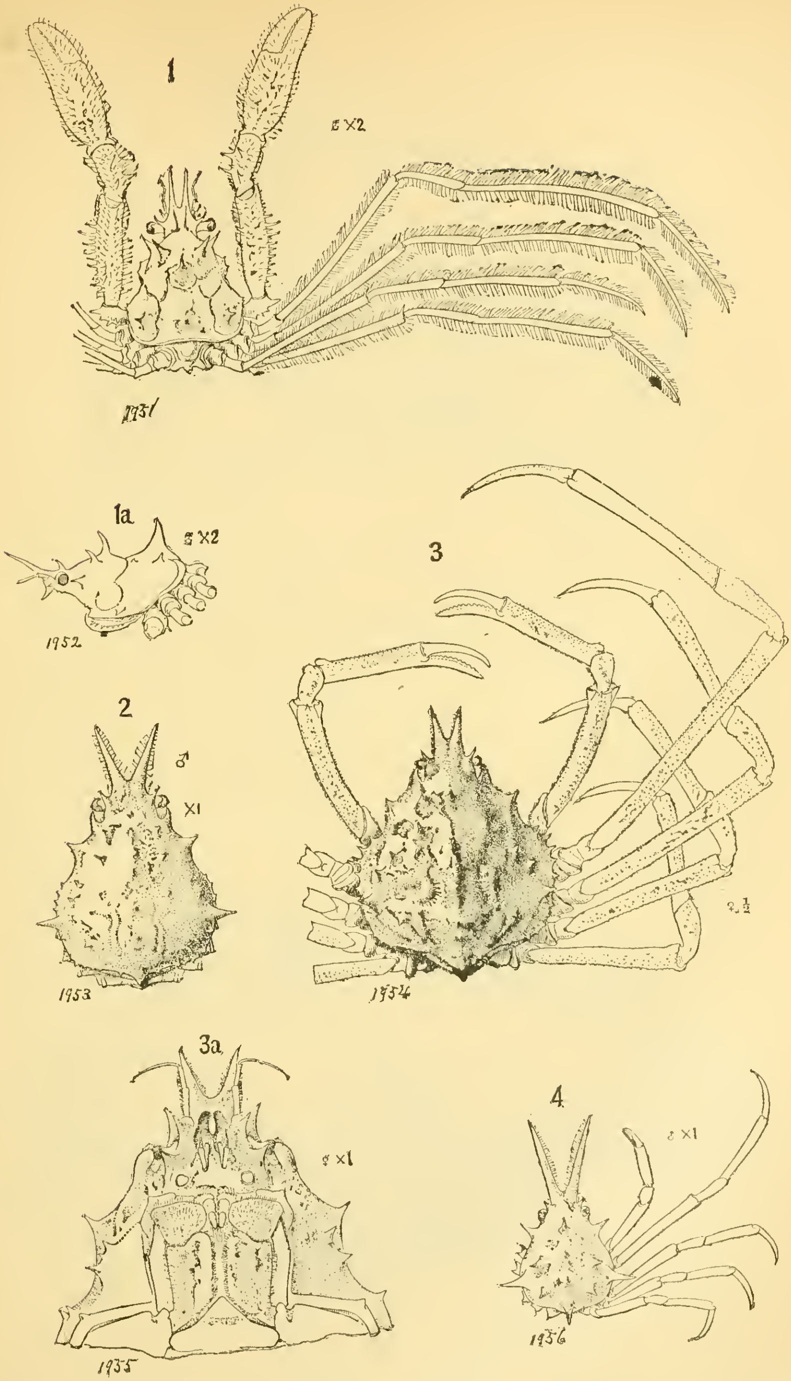
FIG. 3.—*Sergestes mollis.* Dorsal view of front of carapax and anterior appendages of a male (8539), from station 2229, enlarged three diameters.

FIG. 3*a*.—Lateral view of the same part of the same specimen, enlarged three diameters.

FIG. 4—Tip of the left antennal scale of a male (7106), from station 2051, enlarged eight diameters.

FIG. 5.—Lateral view of the left side of the peræon, with the carapax removed to show the branchiæ, &c., of a female (7106), from station 2151, enlarged three diameters: *h*, *i*, bases of the gnathopods; *k*, *l*, *m*, *n*, *o*, bases of the peræopods; *ep*, epipod; and *po*, podobranchia, of the first gnathopod; *pl*, anterior pleurobranchiæ of the ninth to thirteenth somites; *pl′*, posterior pleurobranchiæ, represented by simple lamellæ on the eighth to twelfth somites, and by a small compound branchia on the thirteenth.

FIG. 6.—*Sergetes robustus.* Lateral view of the left side of the peræon, with the carapax removed to show the branchiæ, &c., of a male (5516), from station 2003, enlarged three diameters: *f*, scaphognath of second maxilla; *g*, base of maxilliped; *h*, *i*, *k*, *l*, *m*, *n*, *o*, *ep*, *po*, *pl*, *pl′*, as in Fig. 5, except that the posterior pleurobranchia on the twelfth somite is a large compound branchia in place of a simple lamella.


1
♂ × 2
1951
1a
♂ × 2
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♂
× 1
1953
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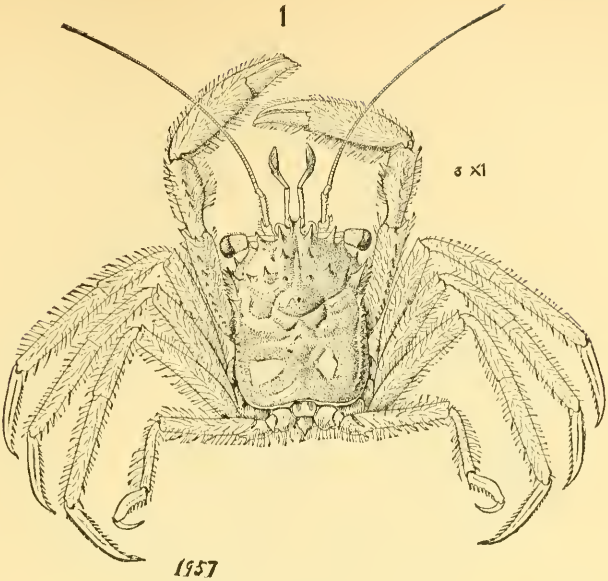
♀ ½
1954
3a
♀ × 1
1955
4
♂ × 1
1956

1



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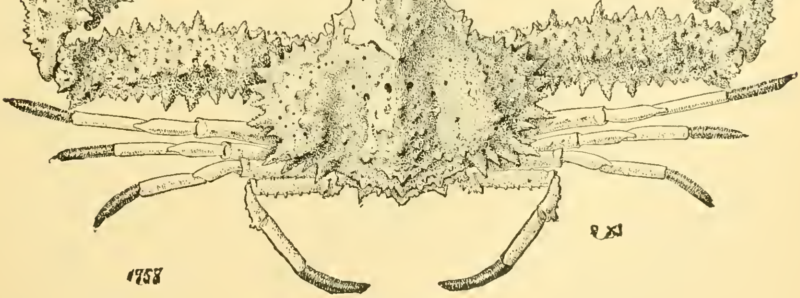

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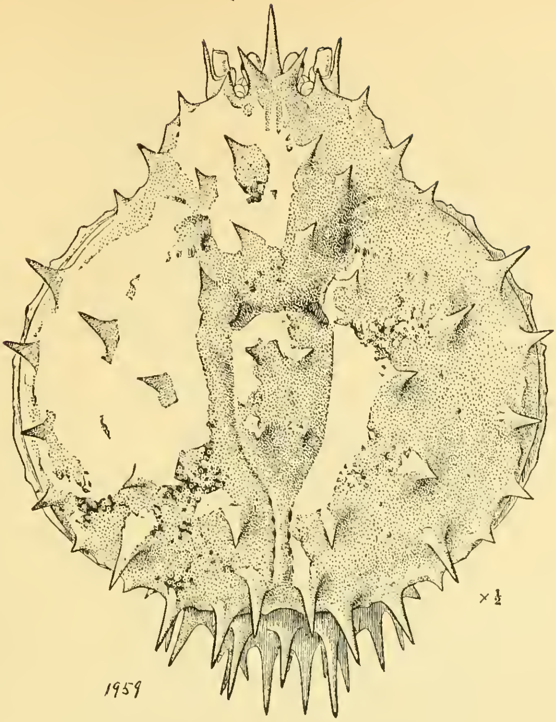

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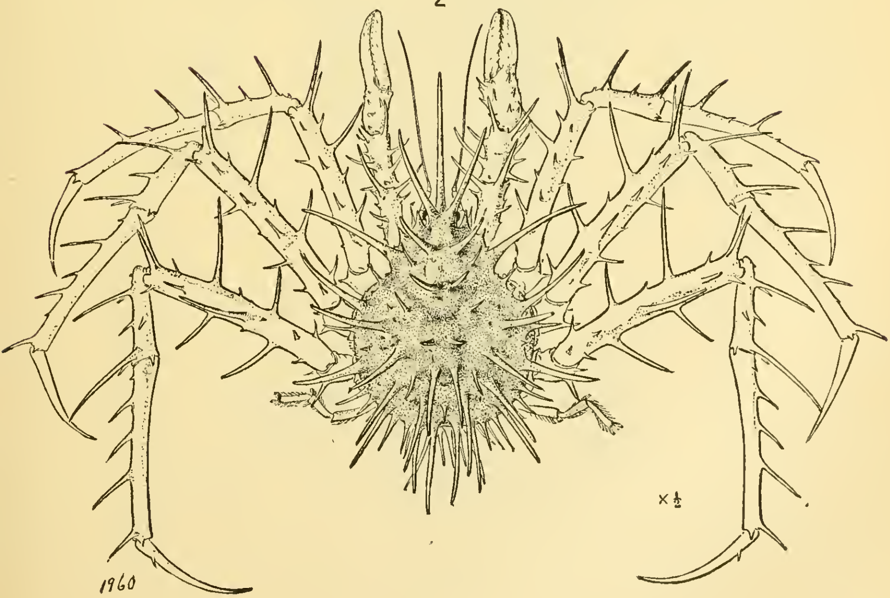

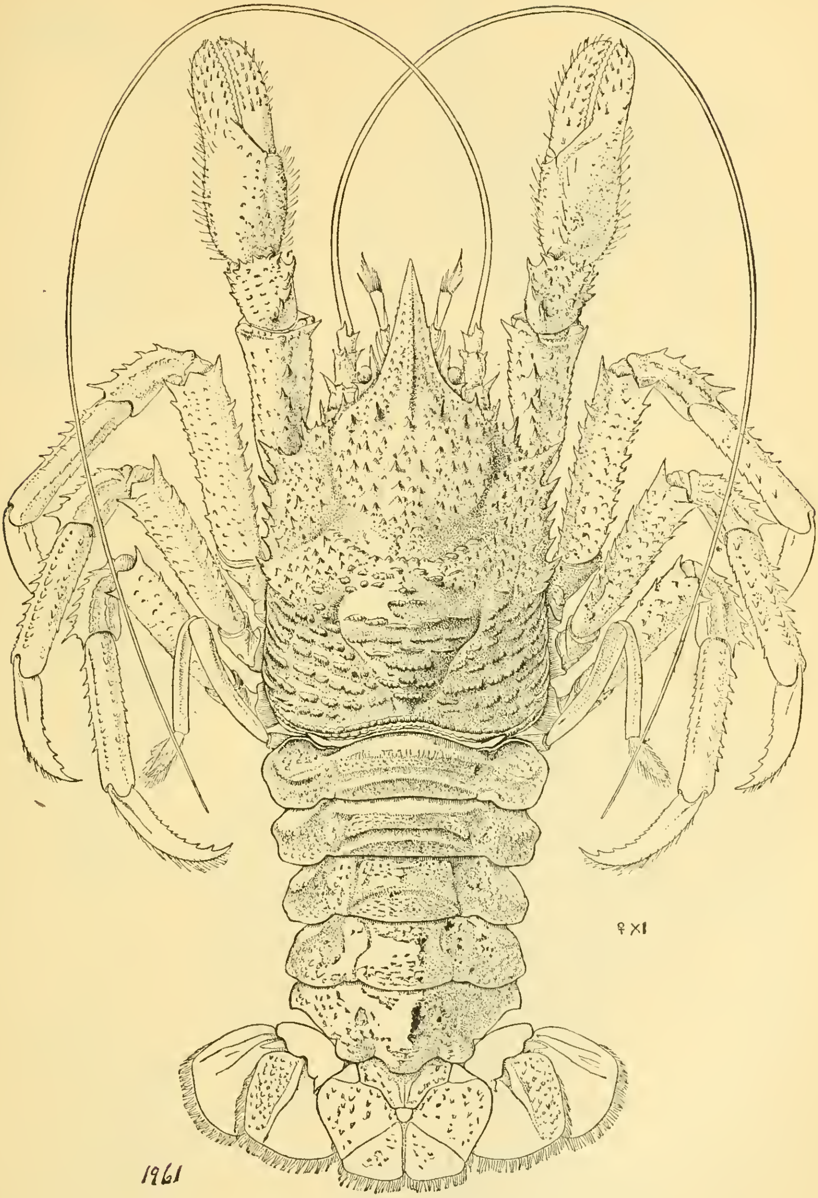
♀ ×1
1961

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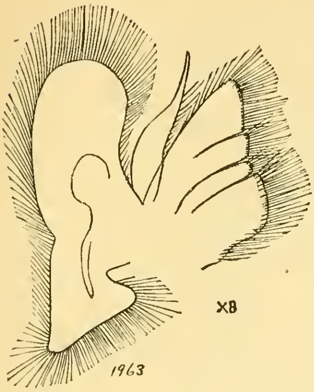

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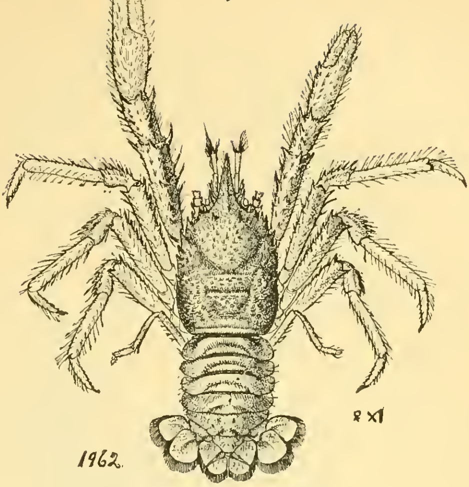

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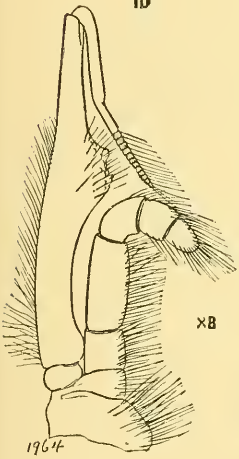

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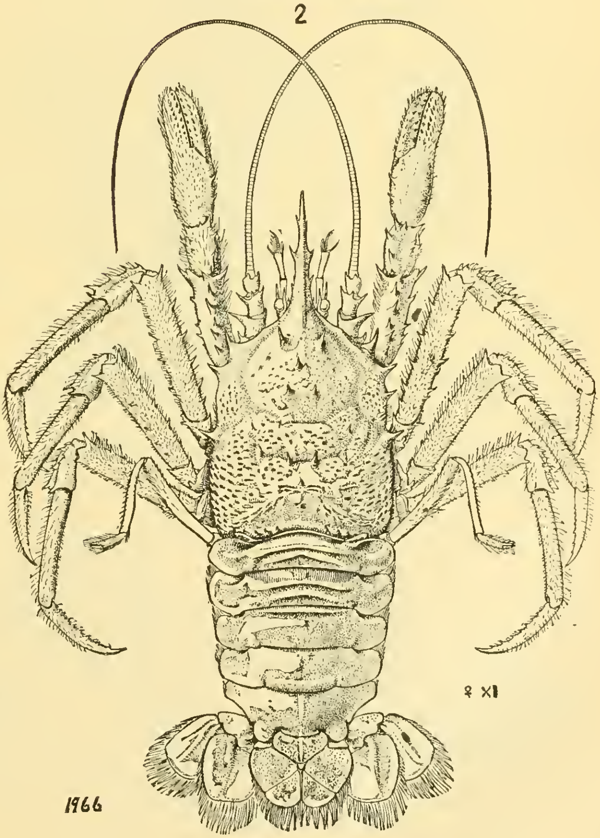

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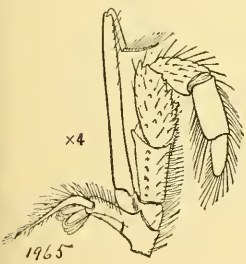

PLATE VI.

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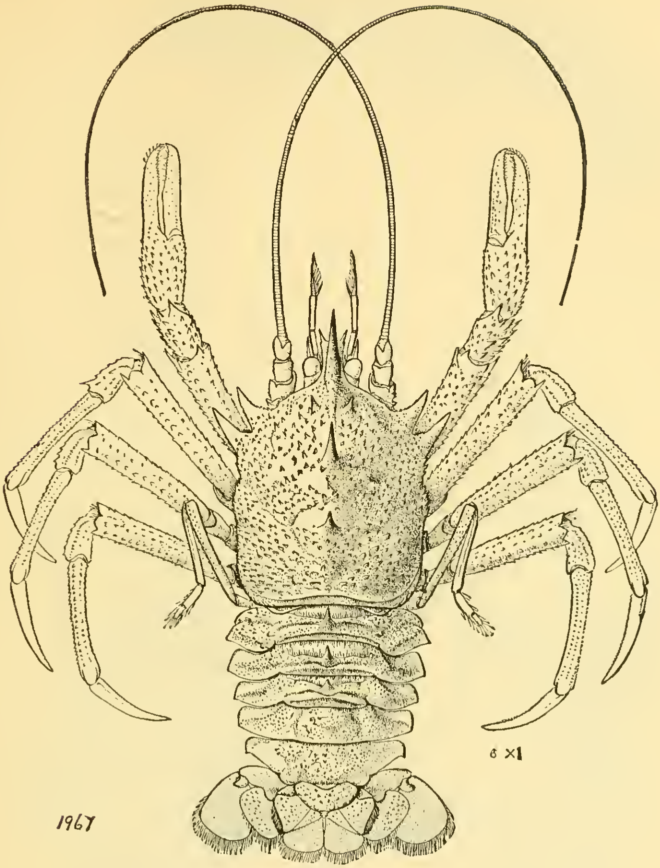

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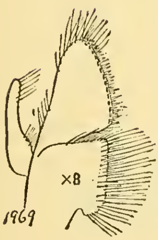

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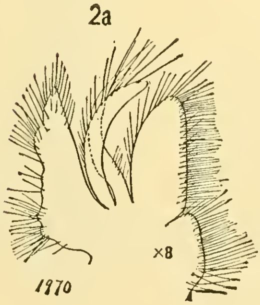

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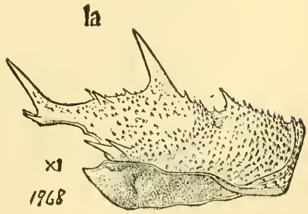

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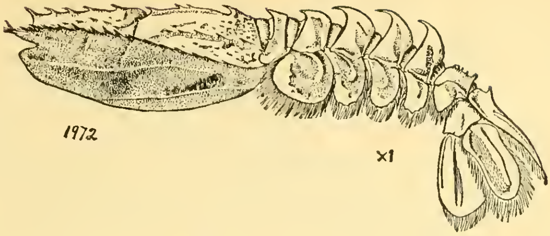

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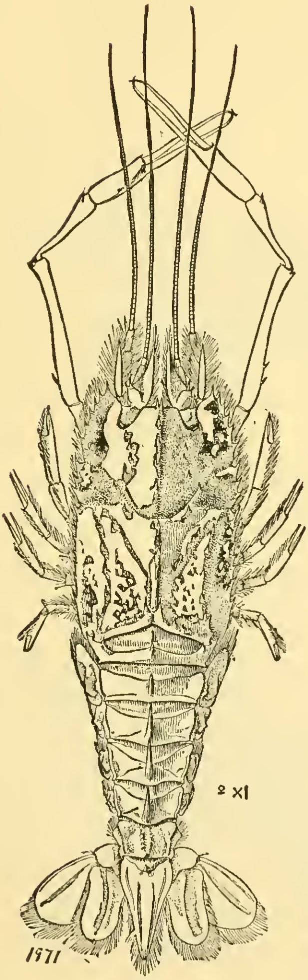

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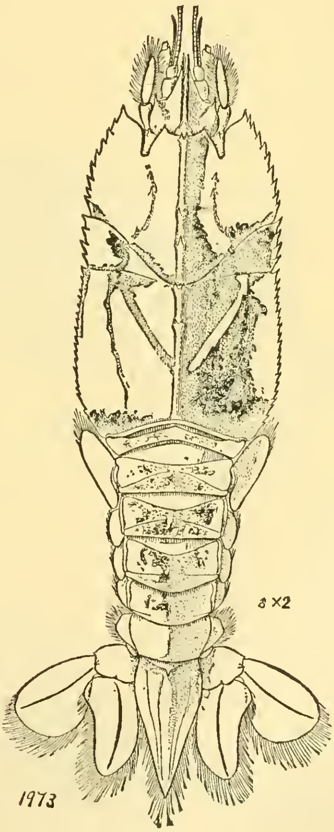

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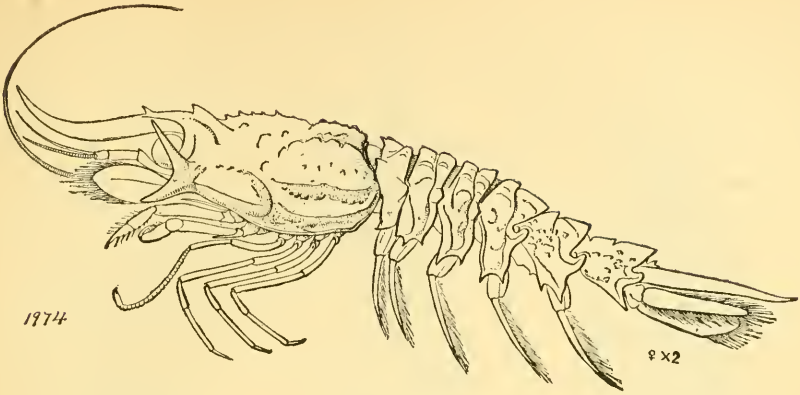

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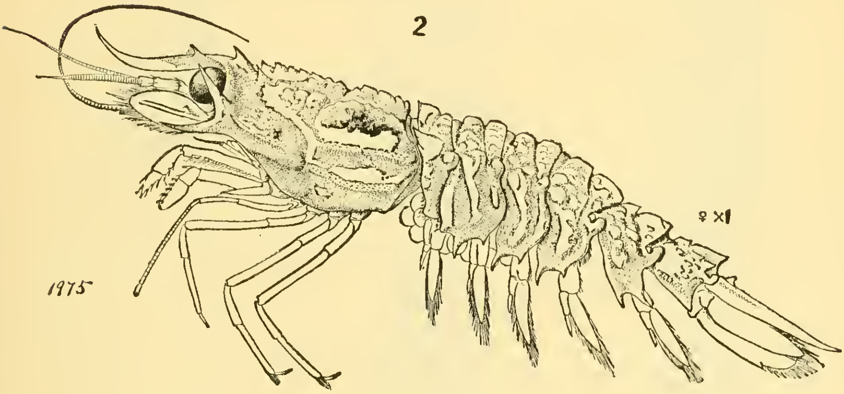

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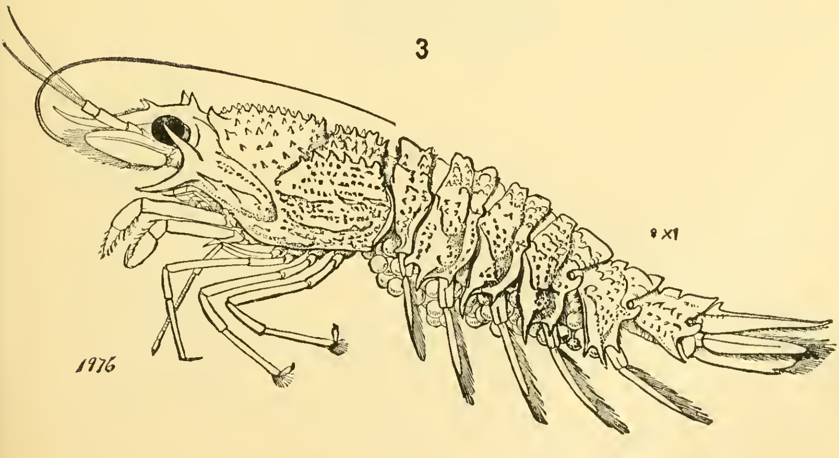

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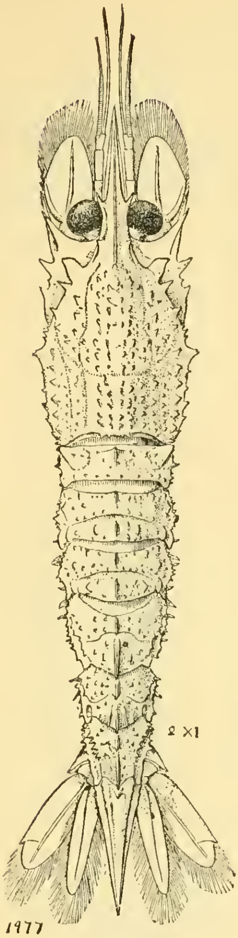

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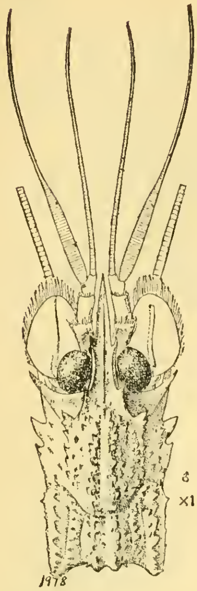

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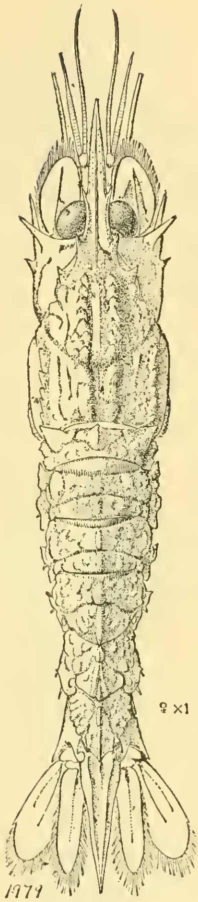

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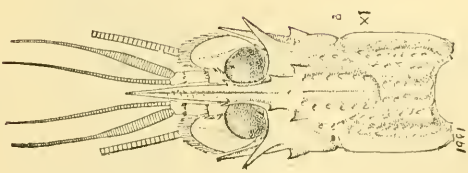

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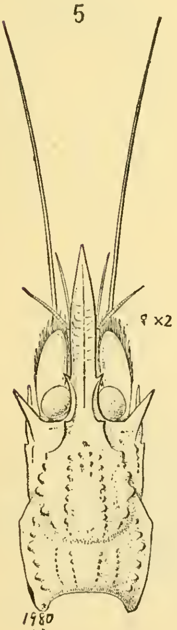

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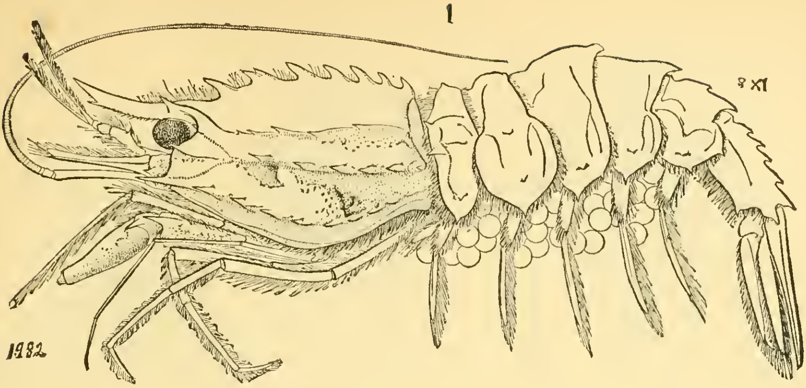

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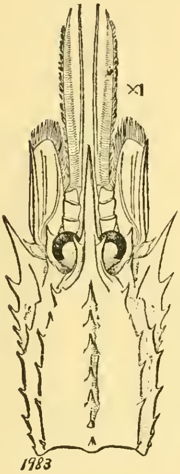

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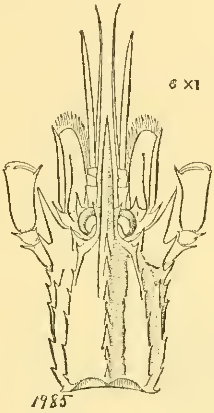

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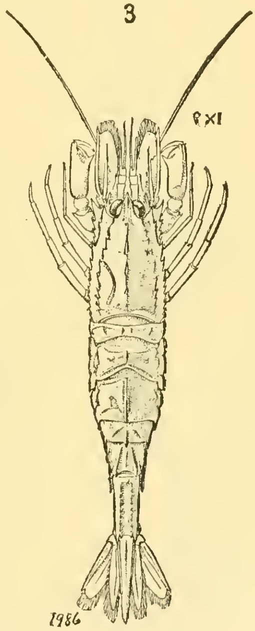

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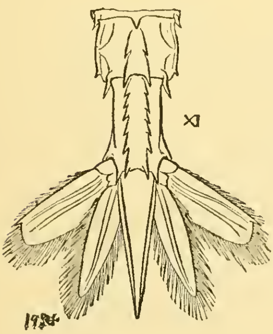

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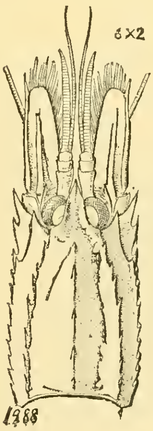

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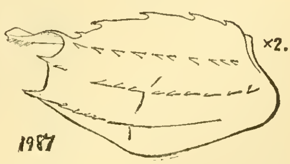

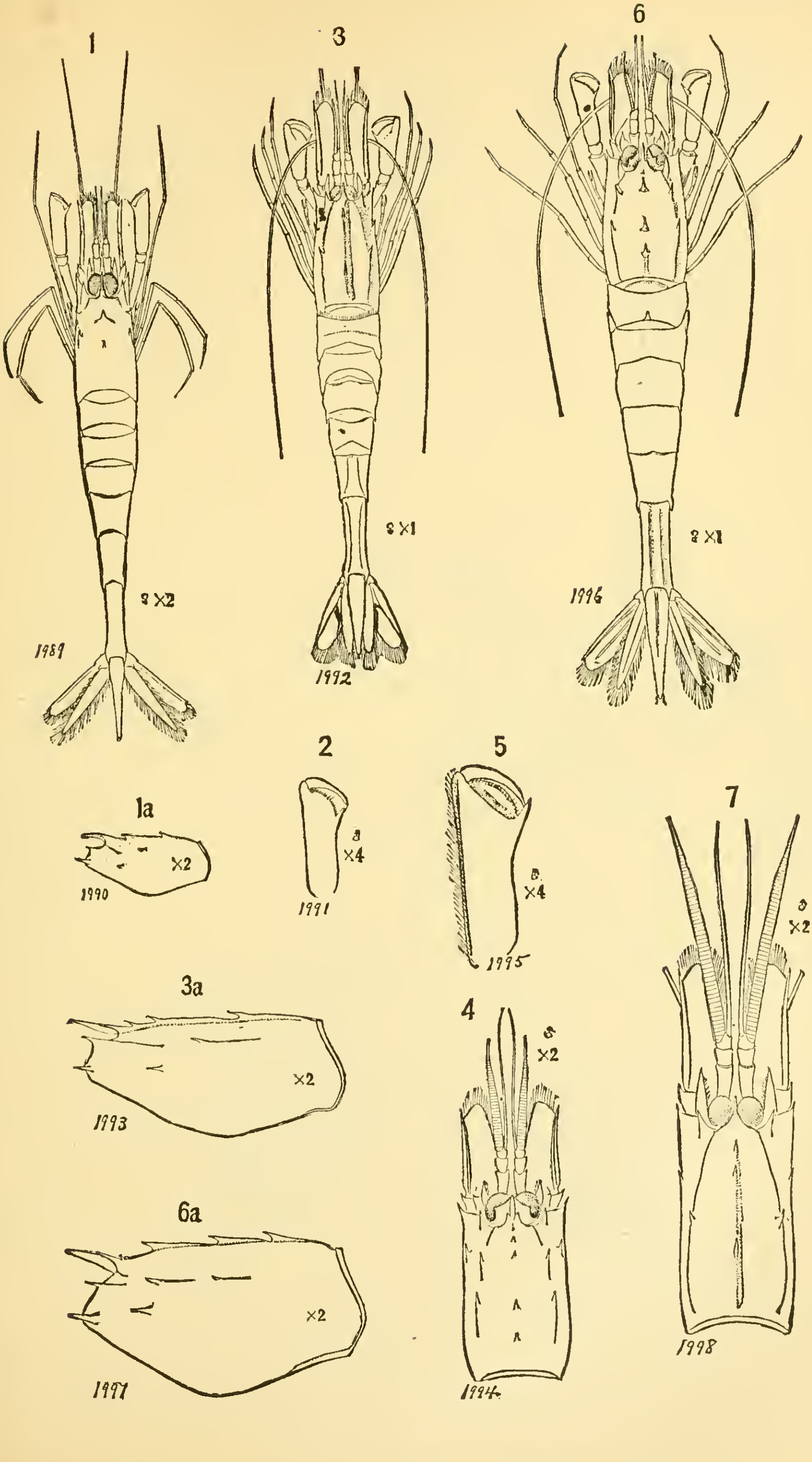
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♀ ×2
♀ ×1
♀ ×1
1989
1992
1996
2
5
1a
×2
1990
♂ ×4
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×2
1993
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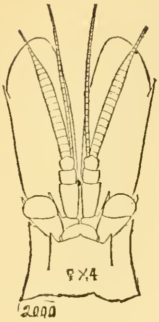
♂ ×2
1994
6a
×2
1997
1998

2



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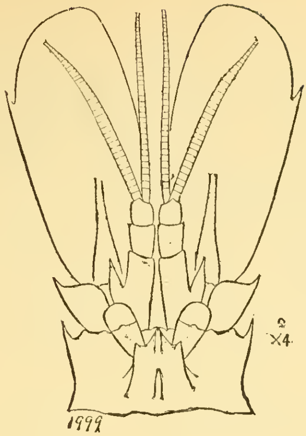

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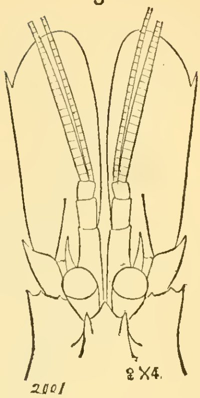

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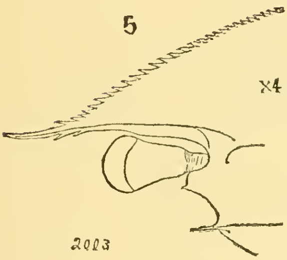

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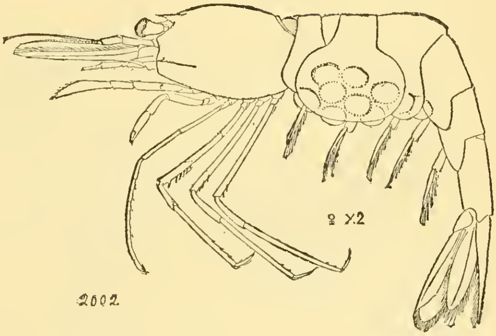

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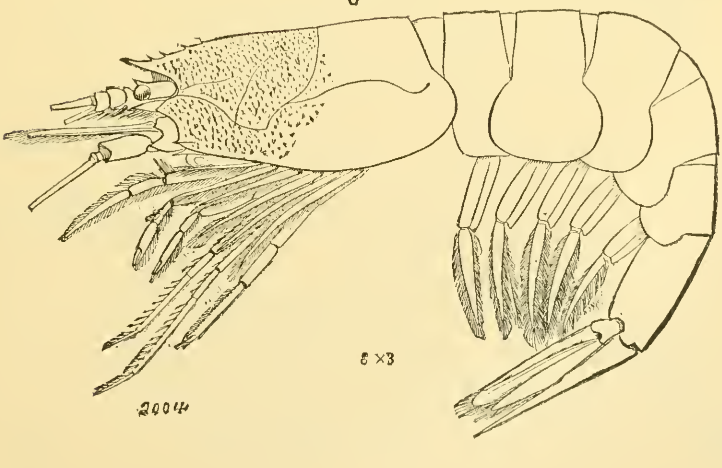

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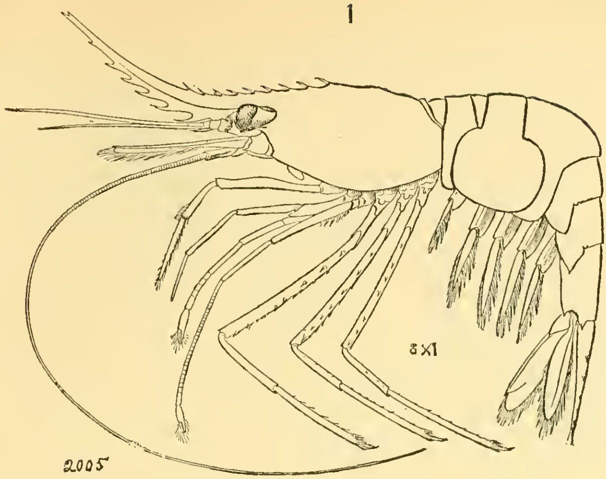

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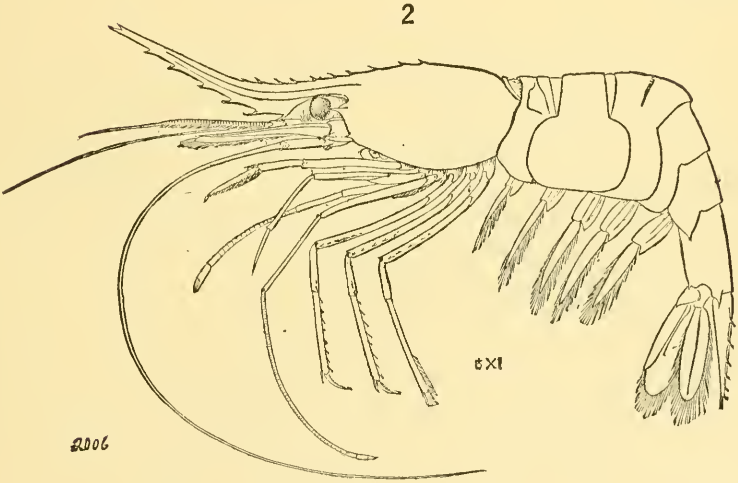

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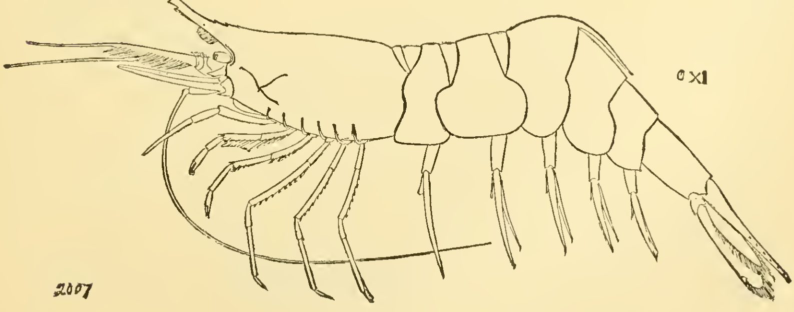

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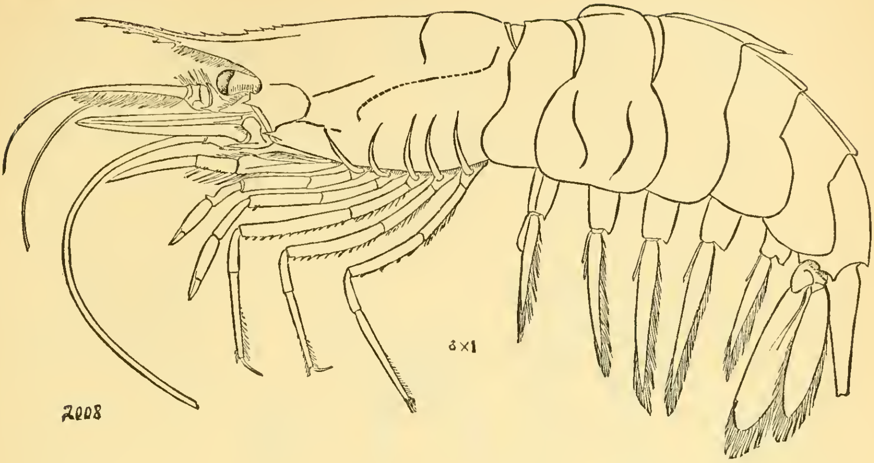

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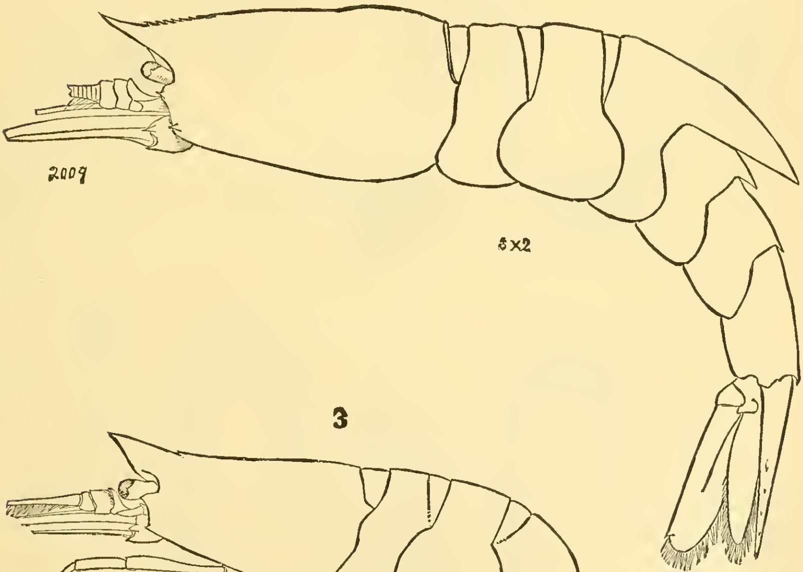

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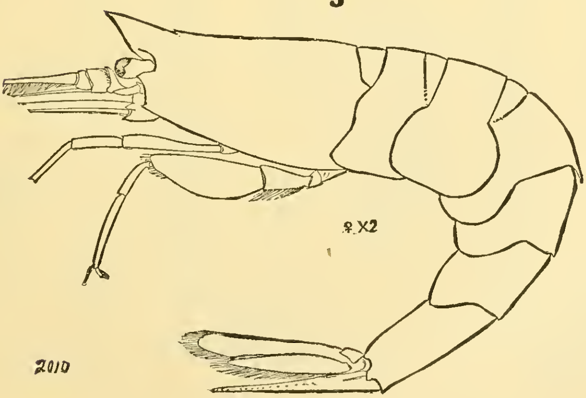

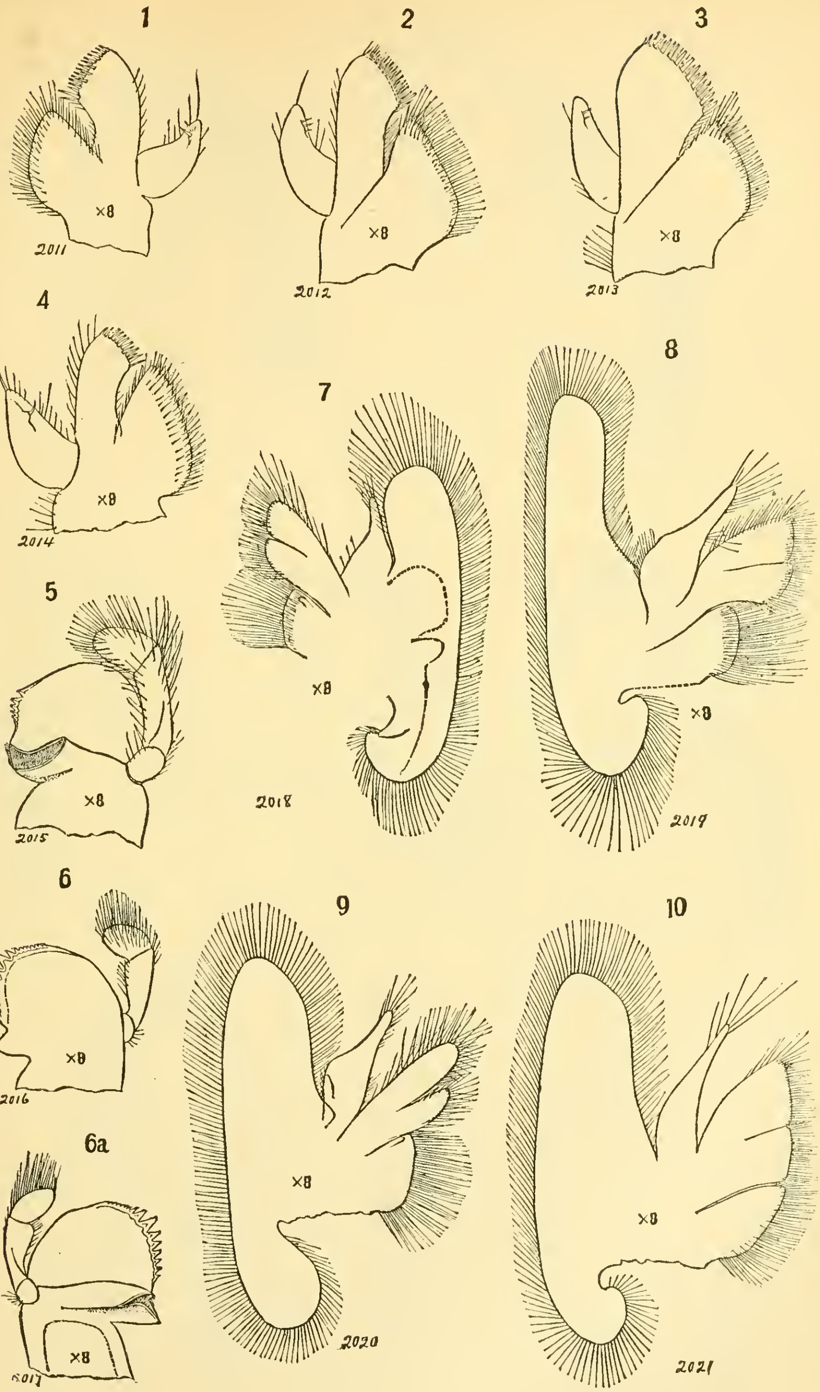
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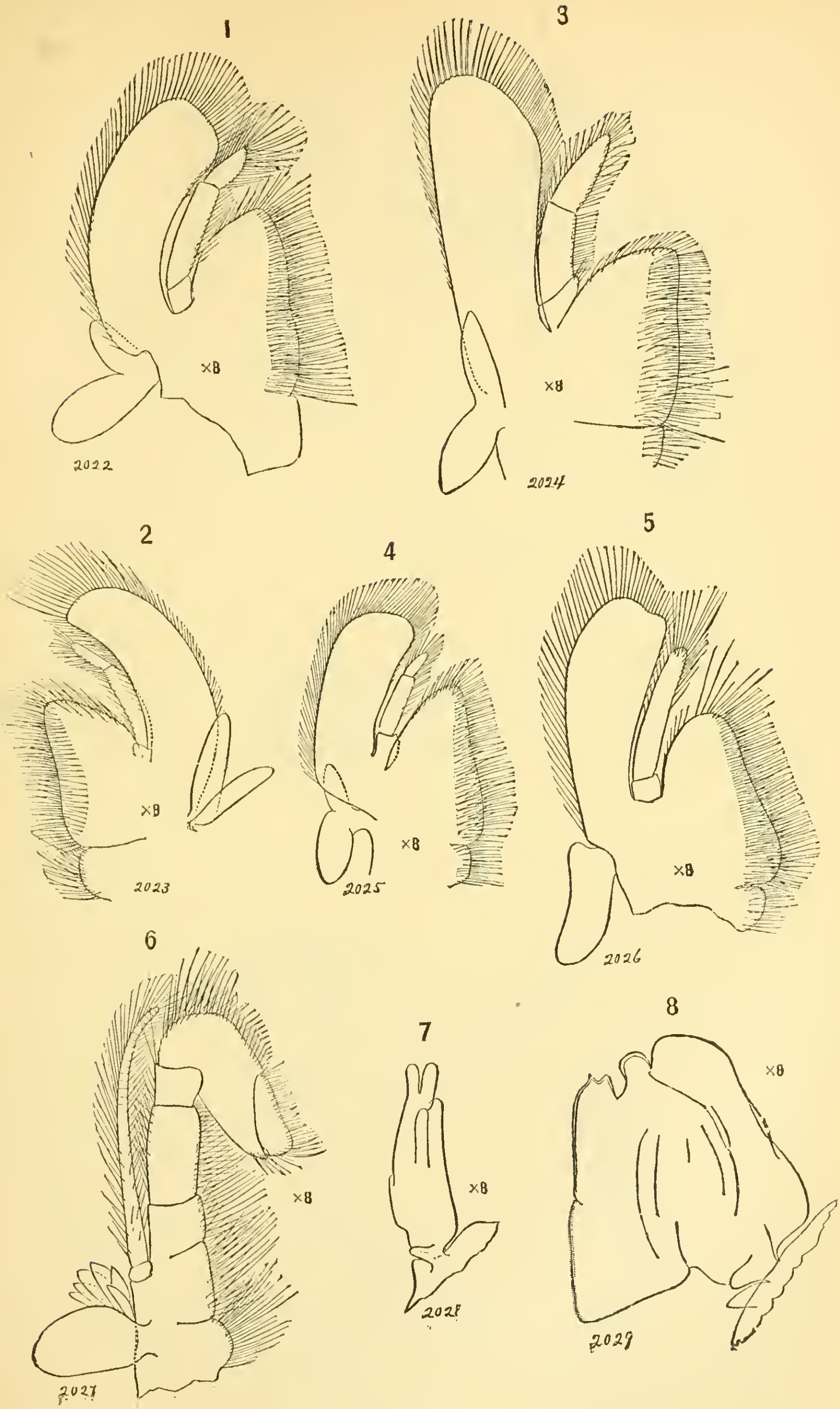
×8
2012
3
×8
2013
4
×8
2014
5
×8
2015
6
×8
2016
6a
×8
7
×8
2018
8
×8
2019
9
×8
2020
10
×8
2021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×8
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2024
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4
5
×8
×8
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2026
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7
8
×8
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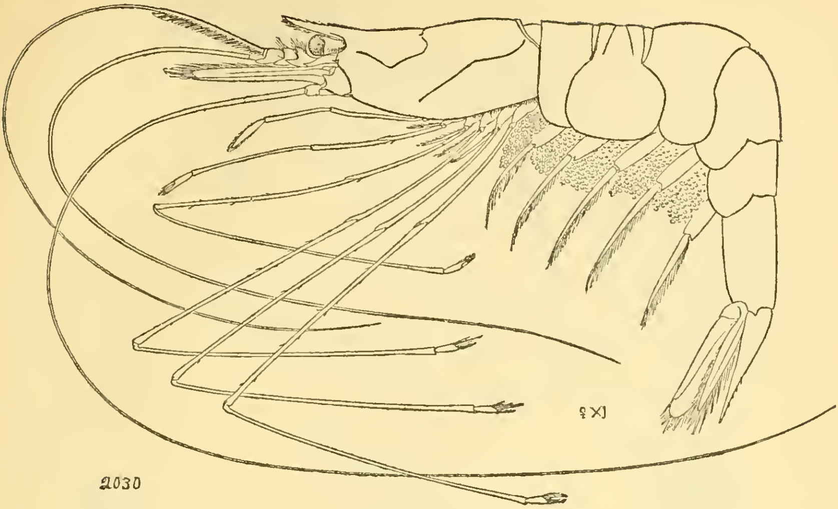
2027
2028
2029

PLATE XVII.

1



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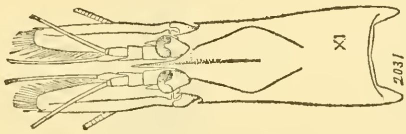

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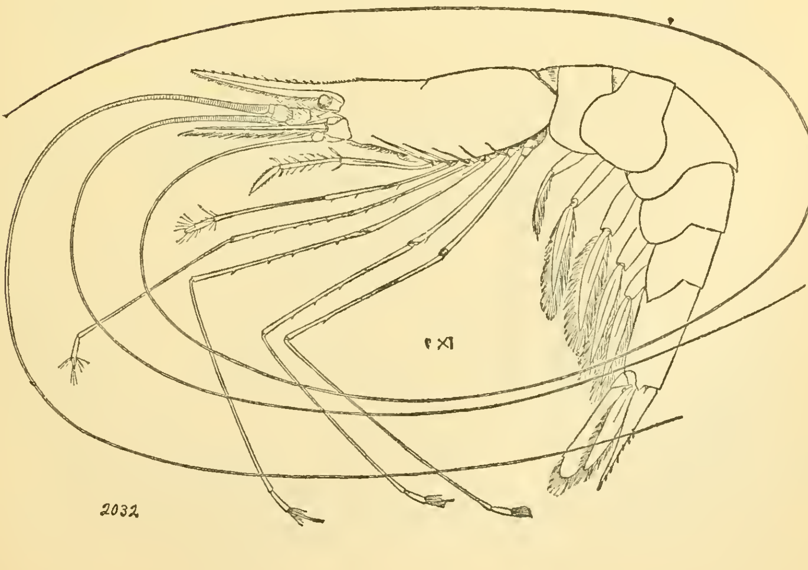

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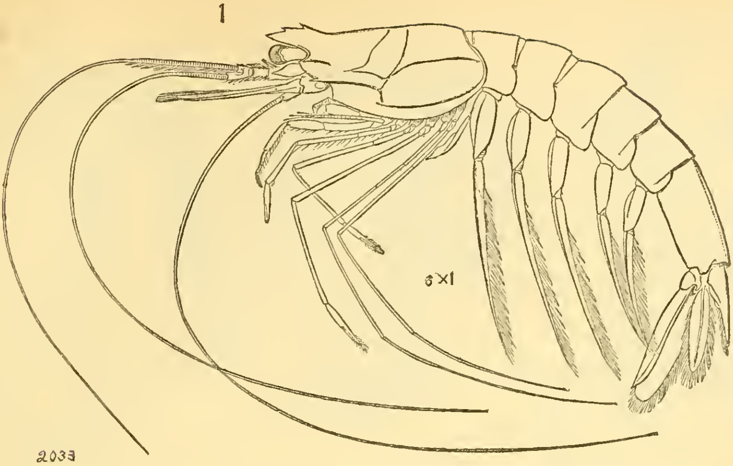

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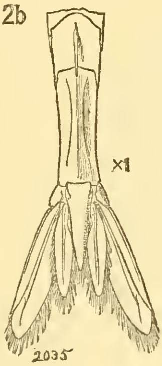

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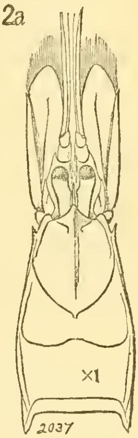

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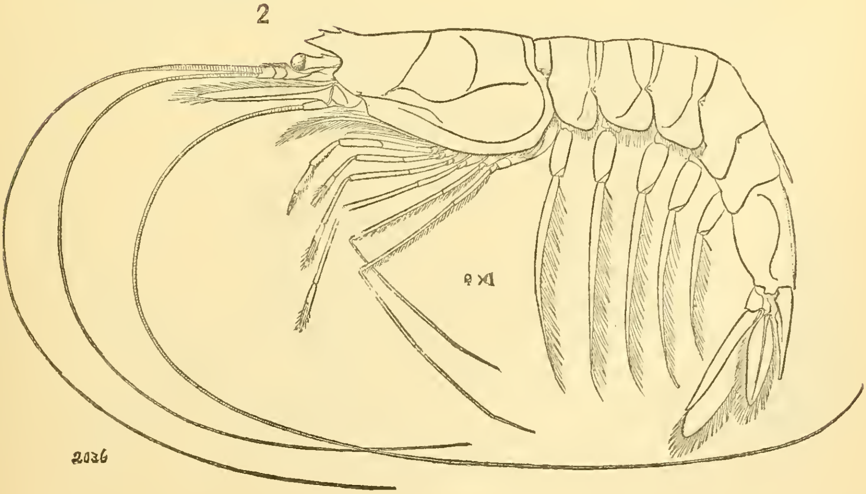

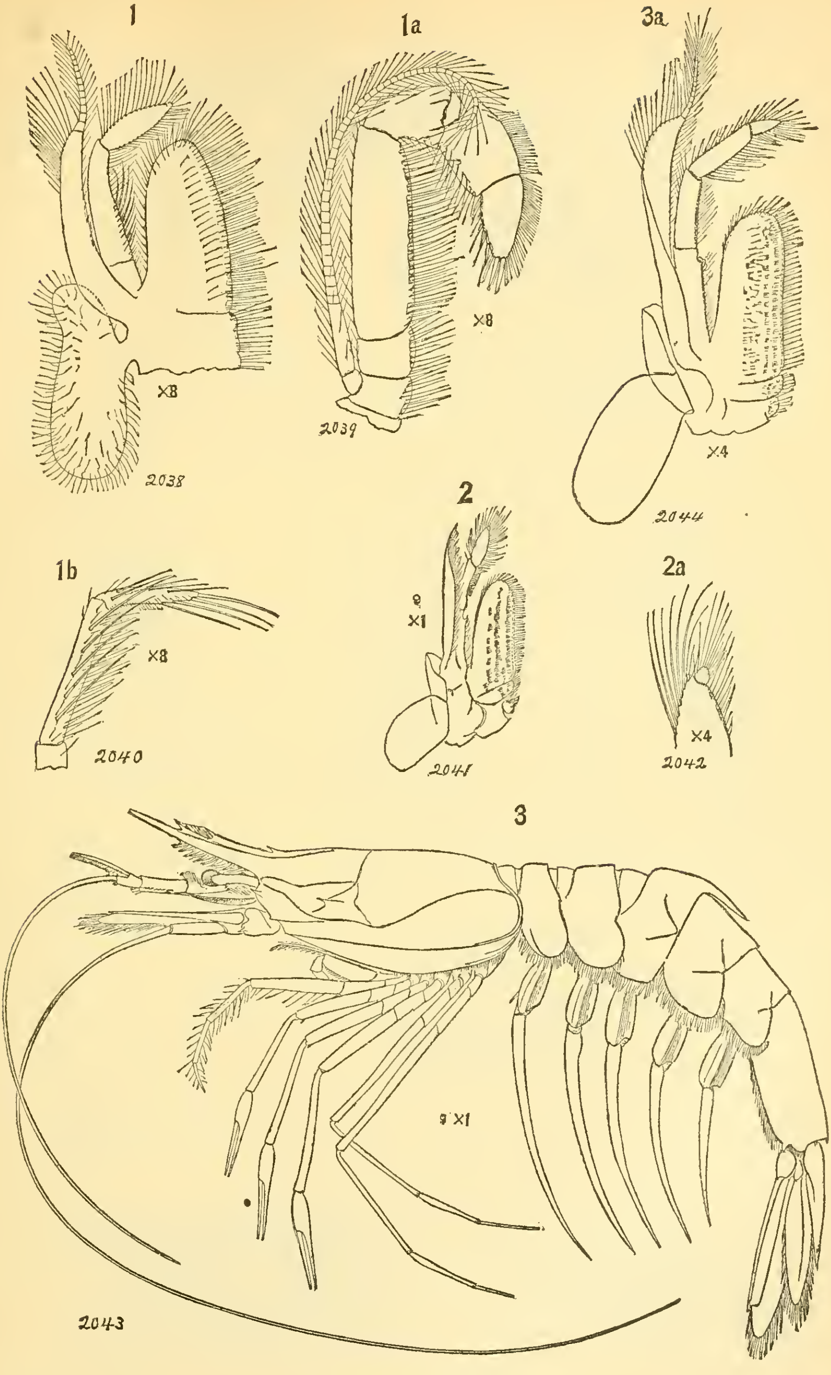
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×8
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×8
2039
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×4
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2
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×1
2041
1b
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×4
2042
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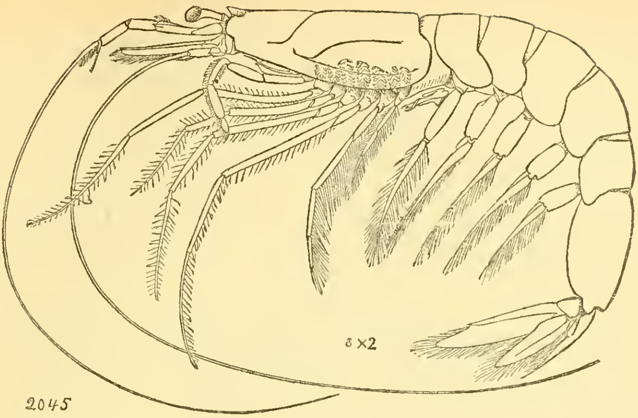
♀ ×1
2043

1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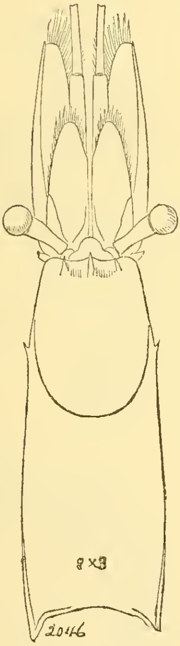
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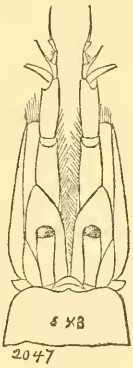
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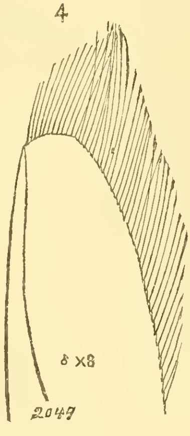
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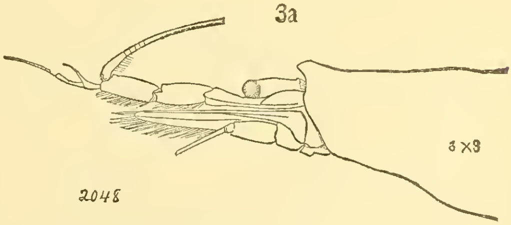
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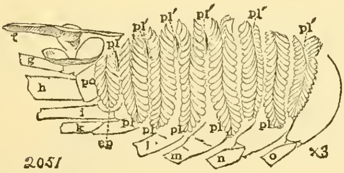
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h
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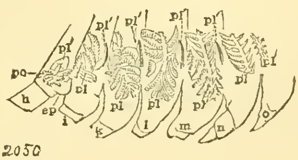
pl′
pl
po
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ep
2050

INDEX.

[NOTE.—The references are to page-figures in brackets.]

XXII.—THE ANNELIDA CHÆTOPODA, FROM EASTPORT, MAINE.

By Prof. H. E. Webster and James E. Benedict.

The following paper contains a list of the Chætopod Annelids, with descriptions of the new species collected in 1880 by the Union College zoological expedition at Eastport, Me. This paper constitutes the fourth in a series descriptive of the Annelids of the eastern coast.

The first in the series, the *Annelida Chætopoda* of the Virginian Coast, by Prof. H. E. Webster, was published in Vol. IX of the Transactions of the Albany Institute. The number of families represented is 23; number of genera, 49; number of species, 59; of which 4 genera and 27 species were new.

The second paper, the *Annelida Chætopoda* of New Jersey, by Prof. H. E. Webster, was published in the Thirty-second Annual Report of the New York State Museum of Natural History.

Number of families represented, 23; number of genera, 50; number of species, 57; of which 2 genera and 14 species were new.

The third paper, on the *Annelida chætopoda* of Provincetown and Wellfleet, Mass., by Prof. H. E. Webster and James E. Benedict, was published in the Fish Commission Report for 1881.

Number of families represented, 25; genera, 70; species, 90; of which 3 genera and 16 species were new.

In the present paper 29 families are represented, 89 genera, and 111 species; of which 7 genera and 26 species are new.

The Fish Commission is in possession of a set of types from these several investigations, through the courtesy of Union College.

Family EUPHROSYNIDÆ.

SPINTHER *Johnston.*

Spinther citrinus (*Stimpson*) *Verrill.*

Cryptonota citrina Stimpson. Marine Invertebrata of Grand Manan, p. 36, in Smithson. Contrib. 1854.
Spinther citrinus Verrill. Check List. 1879.

Not common. Ten to thirty fathoms, on sponges; bottom with coarse gravel or rocks.

EUPHROSYNE *Sav.*

EUPHROSYNE BOREALIS *Œrsted.*

ŒRSTED. Grönlands Annulata Dorsibranchiata, p. 18. 1843.
STIMPSON. Invert. Fauna of Grand Manan, &c., p. 36. 1854.

Not common. Our specimens were taken in about 20 fathoms; bottom rocky.

Family APHRODITIDÆ.

APHRODITA *Linn. sens. str.*

APHRODITA ACULEATA *Linn.*

LINNÆUS. Systema Naturæ, ed. xii, vol. i, p. 1084. 1767.
STIMPSON. Loc. cit., p. 36. 1854.
VERRILL. Invertebrate Animals of Vineyard Sound, &c., in Report of U. S. Commissioner of Fish and Fisheries, Part I, p. 581. 1874.

Small specimens were common on muddy bottoms.

LÆTMATONICE *Kinberg.*

LÆTMATONICE ARMATA *Verrill.*

Only one specimen, and that immature, was found. Station not noted.

Family POLYNOIDÆ.

LEPIDONOTUS (*Leach*) *Kinberg.*

LEPIDONOTUS SQUAMATUS *Kinberg.*

Very common, both at low-water and in nearly all dredgings.

NYCHIA *Malmgren.*

NYCHIA CIRROSA *Malmgren.*

MALMGREN. Nord. Hafs-Ann. p. 58, pl. viii, fig. 1. 1865. Annulata Polych., p. 5. 1867.

A few specimens of this species were dredged in sandy mud, 6–12 fathoms, but by far the greater number were taken on mud flats, at low-water, living in the tubes of *Amphitrite brunnea* STIMPSON.

EUNOA *Malmgren.*

EUNOA NODOSA *Malmgren.*

MALMGREN. Nord. Hafs-Ann., p. 64, pl. viii, fig. 4. 1865. Annulata Polych., p. 6. 1867.

Very fine specimens were dredged among rocks, shells, hydroids, &c. Common.

LAGISCA *Malmgren.*

LAGISCA RARISPINA *Malmgren.*

Not very common; at least, we did not obtain many specimens. Station not noted.

HARMOTHOË (*Knbg.*) *Malmgren.*

HARMOTHOË IMBRICATA *Malmgren.*

Aphrodita imbricata LINN. Syst. Nat., vol. xii, p. 1804. 1767.
Lepidonote cirrata ŒRSTED. Grönlands Annul. Dorsibr., p. 14, figs. 1, 5, 6, 11, 14, 15. 1843.
Harmothoë imbricata MGRN. Nord. Hafs.-Ann., p. 67, pl. ix, fig. 8. 1865.

Very common, both at low water and in nearly all dredgings.

Family SIGALIONIDÆ.

PHOLOË *Johnston.*

PHOLOË MINUTA *Œrsted.*

Pholoë minuta ŒRSTED. Grönl. Annu. Dorsibr., p. 17, figs. 3, 4, 8, 9, 16. 1843.
Pholoë tecta STIMPSON. Marine Invert. Grand Manan, p. 36. (Young of *P. minuta.*)

Very common. Low-water and shallow dredgings, sand and shells, and sandy mud.

Family NEPHTHYDIDÆ.

NEPHTHYS *Cuvier.*

NEPHTHYS CILIATA *Rathke.*

Nephthys ciliata RATHKE. Beiträge zur Fauna Norwegens, p. 170. 1840.
Nephthys borealis ŒRSTED. Ann. Dan. Consp., p. 43. 1843.

Common. Low-water and shallow dredgings; sand and sandy mud.

NEPHTHYS CÆCA *Œrsted.*

Nephthys cæca JOHNSTON. Cat. British Mus., p. 167. 1865.
Nephthys cæca ŒRSTED. Grönl. Ann. Dorsibr., p. 41, figs. 73, 74, 77, 79–86. 1843.
Nephthys cæca MALMGREN. Nord. Hafs-Ann., p. 104, pl. xii, fig. 18.

Found in the same stations as the last, but more common.

NEPHTYS INCISA *Mgrn.*

MALMGREN. Nord. Hafs-Ann., p. 105. 1865.

Common on muddy bottoms.

NEPHTHYS DISCORS *Ehlers.*

EHLERS. Die Borstenwürmer, p. 626, pl. xxiii, figs. 39, 40. 1868.

Common on muddy bottoms.

Family PHYLLODOCIDÆ

ANAITIS *Malmgren.*

ANAITIS SPECIOSA *Webster.*

WEBSTER. Annelida Chæt. of New Jersey, p. 4, pl. i, figs. 8, 9. 1879.
WEBSTER & BENEDICT. Annel. Chæt. from Provincetown and Wellfleet, Mass. U. S. Fish Commission Report for 1881. 1884.

Only three specimens were found at Eastport. They were larger than those collected at Great Egg Harbor, N. J., but did not differ from them in other respects.

PHYLLODOCE (*Sav.*) *Malmgren.*

PHYLLODOCE GRÖNLANDICA *Œrsted.*

ŒRSTED. Grönl. Annul. Dorsibr, p. 40, figs. 19, 21, 22, 29–32. 1843.
MALMGREN. Nord. Hafs.-Ann., p. 96. 1865. Annulata Polych., p. 143, pl. iii, fig. 9. 1867.

Not common. Various depths, on shells, rocks, &c.

PHYLLODOCE BADIA *Malmgren.*

MALMGREN. Annulata Polych., p. 144, pl. iii, fig. 6. 1867.

Common. Found with the last species; also at low water, under rocks.

PHYLLODOCE MUCOSA *Œrsted.*

ŒRSTED. Ann. Dan. Consp., p. 31, figs. 25, 79, 83, 89. 1843.
MALMGREN. Ann. Polych., p. 21, pl. ii, fig. 7. 1867.

Quite common. Found with the last two species.

EULALIA *Savigny.*

EULALIA BILINEATA *n. sp.*

(PL. I, FIGS. 1–3; PL. II, FIG. 4.)

Eulalia gracilis VERRILL. WEBSTER & BENEDICT: Annel. Chæt. from Provincetown and Wellfleet, Mass., in U. S. Fish Commission Report for 1881, p. 703. 1884.

Head strongly convex, constricted at anterior fifth (fig. 1); anterior margin with a shallow median emargination; length and breadth, in preserved specimens, about equal.

Paired antennæ about one-half as long as the head; median antenna a little shorter, arising just in front of the eyes.

Eyes large, black, circular, posterior, widely separated.

Tentacular cirri tapering slightly; posterior pair and the superior pair of the second segment about as long as the first four segments; remaining pairs one-half to two-thirds as long.

The dorsal cirri on the anterior segments (fig. 2) arise near the foot from stout basal articles; further back (fig. 3) they are much elongated, a little wider, and more remote from the foot. This form and position they retain on the posterior segments, falling off a little in size. The ventral cirri are at first nearly as large as the dorsal and much like them in every respect. They retain nearly the same form and size throughout.

The setæ (fig. 4) are quite long; the stem terminates in two long, sharp, curved points, and the edge of the shorter one is furnished with a series of small, sharp teeth. The appendix is much shorter than the stem; it tapers rapidly from a wide base.

The general color is gray with two lateral dorsal brown bands, and with brown specks at the base of the feet, both above and below.

The body is strongly convex above, flat or slightly convex below; width nearly uniform throughout.

Length, 75^{mm} to 100^{mm}.

Width, about 1^{mm}.

This is the species which in the paper on the Annelids of Provincetown, Mass., we regarded as *Eulalia gracilis* VERRILL. It quite certainly is not that species. For notes on sexual form see the Provincetown paper.

Found on dredged shells. Not common.

EULALIA DUBIA *Webster and Benedict.**

Common at low water and in shallow dredgings, on stones, shells, &c.

ETEONE (*Sav.*) *Œrsted.*

ETEONE SARSI *Œrsted.*

ŒRSTED. Ann. Dan. Consp., p. 29, fig. 77. 1843.
MALMGREN. Ann. Polych., p. 28, pl. ii, fig. 14. 1867.

This species, judging by the description and figures given by Malmgren, would seem to be closely related to *Eteone depressa* MALMGREN.

Some of our specimens seem more like the one; others, more like the other; while they do not exactly agree with either. In living specimens the length of the head exceeds the width; in preserved specimens the reverse is the case. The form of the dorsal cirri is the same as in *Eteone Sarsi*, but they do not arise so near the foot; but in this respect there is a marked difference in different specimens.

Malmgren figures both dorsal and ventral cirri without basal articles. Our specimens have basal articles with both, but with only a very shallow constriction, which, in alcoholic forms, might easily escape detec-

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* This species has been described and figured in a paper on the Provincetown Annelids, and it does not seem necessary to repeat the description, although the paper is not published at the time of this writing. (To be published by the U. S. Fish Commission.)

tion. The basal article of the ventral cirri forms at least one-half the entire length of the ventral cirri. The eyes are small, red, posterior. The general color is grayish-green, or greenish-gray. Low water and shallow dredging; sand and mud.

ETEONE TRILINEATA *n. sp.*

(PL. I, FIGS. 5–8; PL. II, FIG. 9.)

The length of the head is about equal to its greatest width (fig. 5); antennæ stout, tapering, equal, their length a little more than half the length of the head; eyes large, posterior, circular, black.

First segment longer and wider than the second; tentacular cirri very long for the genus; upper pair reaching back to the middle or to the posterior margin of the fourth setigerous segment, quite large at origin, tapering at first rapidly, then more gradually, the outer third quite delicate; the lower pair are about one-half as long as the upper and relatively stouter.

The dorsal cirri on the anterior segments (fig. 7) are in contact with the feet, are very wide, outer and lateral margins regularly rounded, attached margin concave, basal article short and stout; the feet are wide and stout, of the usual form; the ventral cirri project beyond the feet, are bluntly rounded at apex, and have cylindrical or slightly flattened basal articles as long as themselves; on the middle segments the dorsal cirri are relatively a little longer; the ventral cirri wider at apex; no change on the posterior segments, save a slight decrease in size. The anal cirri (fig. 6) are long, stout, usually closely applied to each other, outer margin convex, inner margin straight, or nearly so; on some specimens they are cylindrical to near the apex and then taper rapidly.

There is a gradual diminution in width along the posterior half; also along a few of the anterior segments. The body is convex above, with a narrow depressed area along the sides of each segment; flattened below, or very slightly convex.

The general color is yellowish-white, with a narrow median and wide lateral bands of dark brown.

This species is readily distinguished from any previously described from our coast by its long tentacular cirri and brown bands. Low-water and shallow dredgings; sandy mud and shells. Not uncommon.

MYSTIDES *Théel.**

MYSTIDES VIRIDIS *n. sp.*

(PL. I, FIGS. 10, 11, 13; PL. II, FIG. 12.)

In living specimens, in extension, the head is longer than shown in the figure (fig. 10) and the sides lose their curvatures in great part; at

* Langerhans gives the following diagnosis of this genus: *Phyllodocidæ with four antennæ; three pairs of tentacular cirri; one bundle of setæ.* (Zeitschrift für wissenschaftliche Zoologie, Vol. iii, p. 310, 1879.) We have not seen Théel's paper.

rest, or in preserved specimens, the form and relative dimensions are those shown in the figure. The apex of the head is bluntly rounded and with a slight median emargination.

The antennæ are delicate; the superior as long, or even a little longer, than the head; the inferior about two-thirds as long as the superior and a trifle stouter.

The eyes are large, oval, black, situated just back of the origin of the superior antennæ.

The tentacular cirri are swollen at base, fusiform; outer two-thirds tapering rapidly; outer third very delicate, filiform; they arise from stout, elongated basal articles, which increase somewhat in diameter from their origin outward. The superior cirri of the second segment are the longest, reaching back to the anterior margin of the fifth setigerous segment; the inferior cirri of the same segment are from one-half to two-thirds as long; the cirri of the first segment about three-fourths as long.

The dorsal cirri are broad, heart-shaped (fig. 11), swollen, sessile, remote from the foot. The ventral cirri are oval, arise from the lower surface of the foot near its base; the line of union with the foot is really short, but when seen from behind they appear to be attached along their entire upper margin, having only a short projecting free part at the apex; they are swollen like the dorsal cirri. The form and relative position of feet, dorsal and ventral rami, remain the same throughout, but they are slightly smaller on a few of the anterior and posterior segments. The anal cirri (fig. 13) are every way similar to the ventral cirri.

The setæ are not numerous; all have the form shown in the figure (fig. 12). The first segment is a little longer than the second; second and third equal; fourth, double the second; remaining segments about the length of the fourth, except that a few of the posterior segments become progressively a little shorter.

Some specimens were colorless, others light green. Length of largest specimen, 7^{mm}. Width, 0.6^{mm} to 0.8^{mm}.

Six to twelve fathoms; mud, sand, and shells.

Family HESIONIDÆ.

PODARKE *Ehlers.*

PODARKE ABERRANS *n. sp.*

(PL. I, FIGS. 14–18; PL. II, FIGS. 19, 20.)

It is with some hesitation that we refer this form to PODARKE. It differs from that genus in the position of the median antenna, in the absence of eyes (in the adult), but especially in the peculiar fan-shaped appendage attached to the anal segment. We found the same form at Provincetown, Mass., in 1879, but the specimens were too much injured for description. At Eastport we found but one adult specimen, and before figures were made the anterior part was accidentally lost; but a number of half-grown specimens, evidently of the same species, were taken.

In the adult form the head is somewhat more quadrangular than in fig. 16 (young); the antennæ relatively a little longer, and there are no eyes. The unpaired antenna arises near the posterior margin of the head, and is a little shorter than the superior paired antennæ.

The first segment is shorter than the second and third and is hardly visible dorsally, except at the sides. The tentacular cirri have long basal articles, are from two to three times the width of the body in length, taper uniformly, becoming quite delicate near their outer end.

The dorsal cirri (fig. 14) are in all respects similar to the tentacular cirri and nearly as long. The dorsal ramus is a small but well defined papilla. The ventral ramus is large, its inner two-thirds (fig. 14) cylindrical, outer third bluntly conical. The ventral cirrus arises at the outer third of the ventral ramus, is stout, conical, and projects beyond its ramus.

The chief peculiarity of this species is in the structure of the anal segment. The anal opening is large, dorsal, surrounded by a thin membrane, with scolloped margin. Attached to the posterior ventral margin of this segment (fig. 15) is a membranous, horizontal plate, nearly double the width of its segment, and with its lateral margins rounded. The free margin has a series of lateral papillæ or digitations, bluntly rounded at apex, better defined at the sides than behind. In the young forms there are two anal cirri which arise at the outer posterior angles of the anal segment, run across the anal plate (fig. 17), and extend far beyond it. There were no anal cirri on our adult form, but it seems probable that they had fallen off.

The form of the ventral setæ is shown in fig. 20; their arrangement in fig. 18. The dorsal setæ (fig. 19) are short, stout, simple, six to eight in each bundle.

The anterior division of the alimentary canal extends back to the sixth or seventh segment, where it suddenly passes into a much wider tube, which nearly fills the cavity of the body. The proboscis ends in a circle of conical papillæ.

The body is convex above, nearly flat below; the segments increase in width and slightly in length to the middle of the body, after which they gradually become smaller, the posterior segments being very short.

Head and body, white; appendages, colorless; alimentary canal, white, the anterior, narrow part margined, with a wide, colorless band.

Length, 9^{mm}.

Width, 1^{mm}.

Most of our specimens appear to be about half-grown. In these the head is rounded (fig. 16); there are two minute, lateral, red eyes; the tentacular, dorsal, and ventral cirri are much shorter than in the adult;

the anal plate is a thin membrane, with simple margin, projecting only a short distance beyond the anal segment, and not wider than that segment, and the posterior segments are much longer than in the mature form.

Length, 3–6mm.

Width, 0.2mm, 0.6mm.

Coarse sand and gravel and muddy sand; not uncommon.

GYPTIS *Marion and Bobretzky.*

GYPTIS VITTATA, *n. sp.*

(PL. I, FIGS. 21, 22; PL. II, FIG. 23.)

The head is somewhat quadrangular (fig. 21), the lateral and anterior margins being slightly convex, the posterior margin concave, all the angles widely rounded.

Superior paired antennæ cylindrical to near the end, then suddenly conical; median antennæ short, fusiform; inferior antennæ (palpi) composed of two articles, about equal in length; they arise well back on the inferior surface of the head, and are nearly as long as the superior antennæ, but the part visible in a dorsal view is only about one-half as long; both articles are cylindrical, the inner larger than the outer.

There are two pairs of eyes situated on the middle line; the outer pair crescentic, large, lateral; the inner pair almost in contact with the outer, oval, small.

The first segment seen dorsally is very short; it bears two pairs of tentacular cirri; the second segment a little longer than the first, shorter than the second. The tentacular cirri taper slightly from their origin; they are composed of numerous articles, of which those along the inner third are shorter and less distinctly separated from each other than the others. The upper cirri are from two to three times the width of the body in length; the lower from one-half to two-thirds as long as the upper.

The dorsal cirri are similar to the tentacular cirri, but a little shorter and not so stout. The feet begin on the fifth segment; they are composed of two distinct rami (fig. 22). The dorsal ramus arises from the inner part of the foot, just below (outside) the origin of the dorsal cirrus; it is small but well defined, somewhat compressed, more convex above than below, pointed; the lower ramus (fig. 22) is stout, elongated, inner three-fourths irregularly convex, outer fourth conical; the ventral cirrus arises from the under surface of the foot, near its base, is stout, conical, apex bluntly rounded, from one-half to two-thirds the length of the foot.

There are three anal cirri, two long, lateral similar in all respects to the dorsal cirri, and one short median style.

The body is convex above, nearly flat below, widest in the middle.

The dorsal setæ are simple, straight, as long as the stem of the ventral setæ, or even a little longer. The ventral setæ are quite long, numerous (figs. 22, 23), stem much longer than the appendix.

The proboscis when fully extended shows a circle of rather long, slender, acute papillæ, a little behind the anterior end.

Some specimens were without color, except that back of the eighth segment they had a yellowish tint due to the internal organs; others had the anterior segments crossed by a narrow band of light yellowish brown, with a patch of the same color at the base of each foot.

Length, 4–6^{mm}.

Width, 0.5–1^{mm}.

Low water, rocks; 25–30 fathoms, shells.

TAPHUS, *n. g.*

Hesionidæ with three antennæ, two palpi, no tentacular cirri. Dorsal setæ simple; ventral setæ compound. Two maxillary pieces in the form of stylets.

TAPHUS HEBES, *n. sp.*

(PL. VIII, FIGS. 113–118.)

The width of the head (fig. 113) is nearly double its length; anterior margin slightly convex; anterior angles bluntly rounded; posterior margin straight.

Eyes minute, anterior, just back of the origin of the lateral antennæ, not visible in alcoholic specimens.

The antennæ are stout, elliptical; the median, arising from the anterior margin of the head, is as long as the head; the lateral, arising from the lower surface, but very close to the anterior margin of the head, are a trifle shorter than the median. The palpi (fig. 114) are placed near the posterior margin of the head; they are short, stout, nearly spherical, sometimes in contact, sometimes remote from each other. Just back of the palpi, on the anterior margin of the first segment, is a pair of conical cirri; their function or homology we do not understand.

The first segment encroaches on the sides of the head, but otherwise is not visible dorsally; it bears setæ only.

The dorsal setæ (figs. 113–117) arise directly from the dorsal surface, near the lateral margin; they are numerous, stout, long (fig. 117), and with a few stout spines or teeth, remote from each other along one margin of their outer half; they stand erect, much crowded at origin, but diverging at summit, owing to their curved form. Below (outside) this bundle of setæ is a cirrus nearly as long as the setæ themselves, stout, swollen basal article; these cirri grow progressively longer, those on the last setigerous segment being a third longer than those on the anterior segments.

The ventral ramus (fig. 116) is stout, somewhat compressed; near its base arises a conical or somewhat fusiform ventral cirrus, which projects slightly beyond the ramus.

The ventral setæ (fig. 118) are a little longer than the dorsal setæ, compound, terminal article very delicate; they are arranged in a fan pointing outward and a little downward.

The body is widest in the middle, very slightly convex above, flattened below, its form closely resembling *Aphrodita aculeata.*

The anal segment is small and prolonged into a conical cirrus-like structure.

Number of setigerous segments, 13.

Length, 1.5mm.

Width, 0.5mm.

Sandy bottom; 6–12 fathoms. Rare.

SYLLIDÆ.

SYLLIS *Savigny.*

SYLLIS PALLIDA *Verrill.*

VERRILL. American Journal of Science and Arts, vol. x, p. 39, pl. iii, fig. 6, 1875.

Professor Verrill gives as the length of this species 15mm; some of our specimens had a length 45mm. The ventral cirri are longer than the feet; on the posterior segments twice as long. Anal cirri three, the lateral longer than any other of the appendages; median a short style.

Low water, mud and sand; on shells and stones to thirty fathoms, sand. Common.

SYLLIDES *Œrsted.*

SYLLIDES CONVOLUTA *Webster & Benedict.*

WEBSTER & BENEDICT. Annel. Chaet. from Provincetown and Wellfleet, Mass. U.S. F. C. Report for 1881, p. 709, pl. ii, figs. 12–16. 1884.

The Eastport specimens are much larger than those found at Provincetown, but otherwise agree with them perfectly.

Length, 5–7mm.

Width, with feet, 0.5–1mm.

Sand; low water. Not uncommon.

SYLLIDES LONGOCIRRATA *Œrsted.*

Syllides longocirrata ŒRSTED. Kroyer's Tidskrift (*teste* Langerhaus). 1845.

Anopllosylis fulva MARION AND BROBRETZKY. Annales des Sciences Natur., sér. vi, vol. ii, p. 28, pl. ii, fig. 8, pl. iii, fig. 8. 1875.

Syllis ochracea MARENZELLER. Zur Kenntniss der Adriatischen Anneleden, p. 27, pl. iii, fig. 1. 1875.

Syllides longocirrata LANGERHAUS. Zeitschrift für wissens. Zoologie, p. 548. 1879.

This form was met with more frequently than the last, though neither was common; yet in certain localities they could always be found.

The cirri and antennæ fall off very readily.

We found small projecting papillæ on the lower surface of the palpi, at about the middle point, as in a *Syllides convoluta;* in preserved specimens they can be seen only with difficulty.

The contents of the intestines were dark brown to black.

The setæ of the anterior segments are very numerous, forming dense bundles; they decrease rapidly in number after the fifth segment. The simple seta of the first five segments is recurved at the end, flattened and denticulated along the recurved edge as figured by Marion and Bobretzky; but after the fifth segment this seta is replaced by a long capillary seta, as long as the longest compound setæ. We have already pointed out the differences in the setæ of this species as figured by Marion and Bobretzky and Marentzeller (see Provincetown paper). In fact if one were to follow these descriptions and figures carefully, it would be necessary to regard them as representing distinct species, and our specimens would then stand for still another species. This may well be the case, but if Langerhaus's identification is correct, it is probable that our form will fall in with the others.

Sand, gravel, mud; low water to 25 fathoms.

STREPTOSYLLIS *Webster & Benedict.*

STREPTOSYLLIS VARIANS, *n. sp.*

(PL. II, FIGS. 24–31; PL. III, FIGS. 32–34, *a b*.)

Head, quadrangular (fig. 24) width nearly double the length; the line of separation between the head and palpi very indistinct; posterior margin slightly concave. There are four eyes, dark red; posterior pair largest, a little behind the middle line, lateral, circular; this pair may be divided so as to give two or even three pairs, but one pair is the normal number; anterior pair minute, just outside the bases of the lateral antennæ.

The lateral antennæ are club-shaped; their length is about equal to the width of the head. Median antenna from two to three times as long as the lateral; they may be club-shaped or cylindrical.

The buccal segment is nearly as long as the second segment; it encroaches slightly on the head.

The tentacular cirri are like the lateral antennæ, but a little shorter, the inferior shorter than the superior.

The palpi are free in front of the head, otherwise coalesced; the free part long, outer half conical, almost pointed; often they are turned directly downward; from the middle of the lower surface a small, cylindrical or slightly clavate papilla projects (fig. 33).

The dorsal cirri on the anterior segments (fig. 24) are similar to the lateral antennæ. Further back they may be club-shaped, or cylindrical and irregularly wrinkled, or they may be moniliform with articles of varying length (fig. 34, *a b*). The ventral cirri are but little shorter than the dorsal (figs. 25–27), very stout at base, conical, acute, wrinkled; they arise near the base of the foot and project beyond it, or they may be turned backward. The setæ are compound, with one, or rarely two, simple setæ in each bundle. The compound setæ of the anterior feet have very short terminal articles (figs. 25, 28). Both the stem and the appendix become somewhat longer, going backward, and retain their length on the posterior segments (figs. 26, 29, 30). The appendix is truncate, with two minute terminal teeth.

The simple setæ (fig. 31) are longer on the segments back of the first third than on the anterior segments, while the curvature is greater on the anterior than on the posterior segments, and on the posterior segments they are nearly straight. There is a single acicula in each foot (figs. 25, 27, 32), very stout, and with a large terminal button, which barely projects from the foot.

The appendix of the compound setæ in this species lacks the covering membrane found on the setæ of *Streptosyllis arenæ* W. & B.

The pharynx occupies six segments, and terminates in front in a circle of triangular papillæ. The stomach is narrow, occupies eight segments, narrows slightly behind and passes into the intestine without the intervention of any peculiar glands; but the intestine in the first segment back of the stomach is colorless. The body is convex above, flattened below; middle third of uniform width, tapering uniformly but gradually along the anterior and posterior thirds.

The body is colorless; the intestine dark brown to black; pharynx, light brown; stomach, white.

♂. The capillary (sexual) setæ begin on the male on the twenty-first setigerous segment; they are short (fig. 27), not reaching beyond the dorsal cirri, delicate; they fail only on two or three of the posterior segments. The body back of the stomach is much swollen, pure white, but retaining the median, intestinal, brown band.

♀. The sexual setæ of the female also begin on the twenty-first setigerous segment, but they are very long and delicate (fig. 26). The eggs are few, large, irregularly polygonal, pure white.

Dimensions of adult non-sexual forms: Length, 6–8^{mm}; width, 0.6–0.8^{mm}.

We found this species at West Quoddy in coarse sand and gravel, at low water. The area over which it occurred was small, and although diligently looked for, it was not found in any other locality.

EUSYLLIS *Malmgren.*

Quite a number of specimens of some species of this genus were taken. They did not seem to agree perfectly with any described species, but were not described while living and are not now in a condition to admit of accurate description.

PTEROSYLLIS *Claparède.*

Gattiola cincinnatta VERRILL. Proc. A. A. A. S., p. 394, pl. 2, fig. 1 (no description). 1874.

Pterosyllis cincinnatta VERRILL. Trans. Conn. Acad., p. 308.

Rare; 20–30 fathoms; rocks and shells.

SPHÆROSYLLIS *Claparède.*

SPHÆROSYLLIS BREVIFRONS *Webster & Benedict.*

Only one specimen was found. Sand; low water.

SPHÆROSYLLIS LONGICAUDA, *n. sp.*

(PL. III, FIGS. 35–39.)

The sides and front of the head are regularly rounded, posterior margin nearly straight; the width almost double the length. The palpi project slightly beyond the head (fig. 35); there is a shallow anterior emargination, and an impressed line above and below.

The antennæ and tentacular cirri are short, stout, fusiform, suddenly acuminate near the end. The buccal segment is short, but perfectly well defined.

There are six eyes; posterior pair largest, situated on the median line in advance of the median antenna, lateral, oval; middle pair well within and just in front of the posterior pair, small, circular; anterior pair on the front margin of the head, within the base of the lateral antennæ, minute, circular.

The dorsal cirri of a few of the anterior segments are shaped like the antennæ, but longer (fig. 35); further back the basal swelling becomes less (fig. 37) and the length greater, while on the extreme posterior segments they again become enlarged at base without falling off in length (fig. 36).

The anal segment is a little longer than the one preceding it, hexagonal (fig. 36); it bears three cirri, of which the lateral pair have the form of the median dorsal cirri, but are longer; the median cirrus is short, cylindrical. In each bundle of setæ is a long, pointed, simple seta; the compound setæ have long stems, and for the genus long terminal articles (figs. 38, 39).

Scattered over the body and feet (fig. 37) are numerous cylindrical papillæ. The body is convex above, flattened below, widest in the middle, tapering slightly in both directions, colorless or yellowish white.

The females were found carrying eggs during the entire time of our stay in Eastport (from the middle of June to September). The eggs were arranged in four series on the dorsum, one between the feet and the dorsal cirri, another just within the dorsal cirri, on each side, leaving a narrow, naked, median space; they were spherical, white. The sexual setæ begin in both sexes on the sixth setigerous segment; in the female, their length was four times the width of the body; in the male, one-half this length.

Length, 2.5–4^{mm}.

Width, 0.25–0.35^{mm}.

Low water, sand; 20–30 fathoms, shells and rocks.

PÆDOPHYLAX *Claparède.*

PÆDOPHYLAX HEBES *Webster & Benedict.*

The bidentate simple setæ described for this species were not so well marked as in the Provincetown specimens. The statement that the pointed simple setæ are replaced by these must be corrected so as to read that there are two simple setæ, dorsal and ventral, on the posterior segments; the ventral shorter than the dorsal, somewhat curved near the apex, and sometimes bidentate.

In front of the stomach the body is colorless; behind it a golden yellow.

Rare; sand, low water. Found only at West Quoddy.

PÆDOPHYLAX BREVICORNIS, *n. sp.*

(PL. II, FIGS. 40, 41; PL. III, FIGS. 42–45.)

In this species the line of the division between the head and palpi is indistinct; the head is oval (fig. 40), the width far exceeding the length; the palpi are united, but have a well-marked terminal emargination; there are four or sometimes six eyes, dark reddish-brown; the antennæ are minute, equal, or nearly so, fusiform, situated between the posterior eyes.

Buccal segment about one-half as long as the second segment. Tentacular cirri minute. Dorsal cirri larger than the tentacular cirri, but very small (fig. 41), remote from the foot. Ventral cirri nearly as large as the dorsal. Anal cirri delicate, slightly enlarged along their middle third, three to four times as long as the anal segment, by far the longest appendages of the body.

The setæ are most numerous on the anterior segments; there are three kinds. In the upper part of each bundle a simple curved seta (figs. 44, 45); on the posterior segments two of these simple setæ, one dorsal, one ventral; also in the upper part of each bundle from one to three compound setæ with quite long and very delicate terminal articles (fig. 42); seen in certain positions these setæ appear to be simple, with suddenly diminished diameter at what is really the articulation; in the lower part of each bundle from two to six short, stout setæ, with short terminal articles (fig. 42).

The body is convex above and below (fig. 41); colorless; stomach, white.

The pharynx occupies seven segments; the stomach two to three.

Sexual setæ on the males begin on the eighteenth setigerous segment; they are very long and delicate.

Length, 1.5–2^{mm}.

Width, 0.25–0.3^{mm}.

Not uncommon. Sand, low water; 8–30 fathoms, sand and sandy mud.

PÆDOPHYLAX LONGICIRRIS, *n. sp.*

(PL. III, FIGS. 46–50.)

In this form the head is oval, the width double the length. The palpi have a shallow anterior emargination, a deep triangular excavation below, the apex of which reaches nearly to the anterior margin of the palpi (fig. 46).

There are two pairs of dark-red eyes, large, oval, directed forward and inward; often not so regular as shown in the figure.

The antennæ are cylindrical, or sometimes a little enlarged along their middle third; the median antenna may extend to the end of the palpi; the lateral antennæ are about one-half as long as the head.

Buccal segment about one-half as long as the second segment; tentacular cirri shaped like the lateral antennæ, but a little shorter.

Dorsal cirri fusiform, a little longer and stouter than the lateral antennæ. Ventral cirri (fig. 47) similar to the dorsal, but more delicate. Anal cirri as long as the median antenna; one specimen has three of equal length; others, two only; others, three, with the middle cirrus quite short.

The setæ on the anterior segment are numerous, and of two kinds, both compound. In the upper part of each bundle usually three with long delicate appendix (fig. 48); in the lower part, five to seven, short, with short appendix (fig. 49); at about the middle third a new and very peculiar form of seta appears (fig. 50); one in each bundle, above the others. This seta seems to terminate in two teeth; one stout, curved, bluntly rounded at apex; the other a delicate spine, as long as the first, or even projecting beyond it.

The pharynx occupies five segments; the stomach, about two; it has twelve series of "glands."

Body convex above and below (fig. 47); white or yellowish white.

On the only male taken the sexual setæ begin on the thirteenth setigerous segment; on the only female, on the eighth; but these indications cannot be relied on.

No entire specimens were found, but the dimensions are about the same as for the last species.

Rare. Low water; sand, to 20 fathoms, sand, gravel, shells.

AUTOLYTUS (*Grube*) *Marentzeller.*

AUTOLYTUS CORNUTUS *A. Ag.*

A. AGASSIZ. Journal Boston Society Natural History, vol. vii, p. 392, pl. 9, 11. 1863.

Rare. Low water; sand.

AUTOLYTUS SOLITARIUS *n. sp.*

(PL. II, FIGS. 51: PL. IV, FIGS. 52, 54.)

A single male specimen was taken, which does not seem to agree with any described form.

Head short, concave in front and behind; dorsal and ventral eyes with lenses; anterior antennæ bifurcated, roughened, and covered with numerous hairs; the antennæ back of these short, increasing in diameter from origin to apex; median antenna and superior tentacular cirri very long, regularly tapering.

The feet of the first three segments are conical, a trifle flattened; their dorsal cirri (fig. 54) arise near their base from stout rounded basal articles; on the fourth segment the feet become irregularly cylindrical; the dorsal cirri originate near the apex (figs. 52, 53) and are enlarged at base; capillary (sexual) setæ appear on this segment and persist on all save the last two segments. The feet elongate gradually to about the eighth segment, where they equal the width of the body; they shorten again along the posterior third.

The compound setæ are of the usual form, but quite long; a little longer on the first three segments than afterwards.

Color, brownish-red.

Length, 5^{mm}.

Width in the middle, without feet, 0.25^{mm}; with feet, 0.7^{mm}.

PROCERÆA *Ehlers.*

PROCERÆA GRACILIS *Verrill.*

VERRILL. American Journal of Science, vol. vii, p. 132, pl. v, fig. 1. 1874.

Our specimens, in all probability, belong to this species. The epaulets, however, are much wider than figured by Verrill; in fact, they nearly cover the buccal segment, leaving a narrow triangular space in the middle; they are yellowish-brown, with a yellowish-white margin. The body is white, or yellowish-white; there is a broad, median, brown band, which runs the whole length of the body; similar lateral brown bands extending to the middle of the body, or, if prolonged beyond the middle, becoming fainter. Antennæ and all cirri covered with stiff hairs and filled with gleaming granules. The pharynx is much convoluted; it occupies seven segments; the stomach, three segments. The palpi project beyond the head as a thin rounded rim, with a shallow, median, impressed line above and below.

No adult females were found. In two specimens, not yet separated from the stem form, the head originated just back of the fourteenth segment; sexual setæ on the eighth segment behind the head; and on those specimens were found only on 14 segments, followed by many segments with the ordinary setæ only. The length of the median antenna was about twice the width of the body; lateral antennæ two-thirds as long as the median; tentacular cirri formed, but still very short. The eggs were numerous, pink.

Only one adult male was taken. This is very much like Œrsted's *Polybostrichus longosetosus*; indeed, it seems to us to be identical with it. We understand Professor Verrill not to concur in this view, and shall leave it to him to determine, as he has probably better material for doing so than we have.

Common. Low water, sand; to 30 fathoms, sand, shells, hydroids, &c.

PROCERÆA (STEPHANOSYLLIS) ORNATA (*Verrill*).

Stephanosyllis ornata VERRILL. American Journal of Science, vol. vii, p. 132, 1874. Proceedings American Association for the Advancement of Science, p. 378, pl. 4, fig. 1, 1874.

Our specimens were not so highly colored as those found by Professor Verrill. For the most part they were some shade of orange along the anterior dorsal region, fading, and often becoming white, behind; sides and ventral surface yellowish-white.

Pharynx occupying from fourteen to eighteen segments; much convoluted along the last part of its course, sometimes passing by the stomach and returning; stomach, two segments. A minute anterior pair of eyes.

Common. Found with the last species.

Family NEREIDÆ.

NEREIS (L.) *Cuvier*.

NEREIS PELAGICA *Linn*.

Very common at low water under-stones, and at all depths on rocky and shelly bottoms.

NEREIS VIRENS *Sars*.

Very common. Low water; mud and sandy mud.

Family EUNICIDÆ.

NOTHRIA (*Johnston*) *Malmgren*.

NOTHRIA CONCHYLEGA *Malmgren*.

Onuphis conchylega SARS. Beskriwelsir og Iagttogelser, p. 61, pl. 10, fig. 28 (*teste* Malmgren). 1835.
Northia conchylega JOHNSTON. Catalogue of British Worms, p. 138, 1865.
Nothria conchylega MALMGREN. Annulata Polychæta, p. 66, 1867.
Nothria conchylega VERRILL. Trans. Conn. Acad., p. 41, 1874.

We obtained but two specimens.

Rocks; 20 fathoms.

NINOË *Kimberg*.

NINOË NIGRIPES *Verrill*.

VERRILL. Invert. Animals of Vin. Sound, p. 595, 1874. Proceedings American Association for the Advancement of Science, p. 382, pl. 3, fig. 5. 1874.

Not uncommon. Stations not noted.

LUMBRINEREIS (*Blv.*) *Ehlers.*

LUMBRINEREIS FRAGILIS *Aud. & M. Ed.*

AUDOUIN AND M. EDWARDS. Annélides. Littoral de la France, p. 170. 1834.
MALMGREN. Annulata Polychæta, p. 177, pl. xv, fig. 83. 1867.

Common. Stations not noted.

LUMBRINEREIS HEBES *Verrill.*

Lumbrinereis obtusa VERRILL. Proceedings A. A. A. S., p. 383. 1874.
Lumbrinereis hebes VERRILL. Proceedings U. S. National Museum, p. 174. 1879.

Only two specimens were taken.

Sand, low water.

LUMBRINEREIS ACICULARUM *n. sp.*

(PL. IV, FIGS. 55–59.)

Head and body of the usual form.

Anterior feet (fig. 57) stout, short; posterior lip a trifle longer than the anterior; further back the feet are longer, and the posterior lip elongated more than the anterior (fig. 58), the disparity in length becoming still better marked on the posterior third; on the extreme posterior segments the feet are obsolete; in each foot from two to five stout aciculæ.

The setæ form two bundles, dorsal and ventral; to about the fortieth segment the setæ are all capillary, those of the dorsal bundle longest.

After the fortieth segment uncinate setæ appear, gradually displacing the others; at the seventieth segment only two or three capillary setæ remain in the dorsal bundle, none in the ventral; on the posterior third or fourth there are only uncinate setæ.

Anal cirri (fig. 59) stout, rather long.

Length, 250^{mm}.

Diameter, 6^{mm}.

Sand, low water. Eastport, Provincetown, Mass., and Block Island, R. I.

This species has much the appearance of *Arabella opalina* VERRILL.

DRILONEREIS *Claparède.*

DRILONEREIS MAGNA *n. sp.*

(PL. IV, FIGS. 60–63.)

The feet throughout are short and stout, somewhat longer behind than in front, the increase in length being due mainly to the elongation of the posterior lip.

The setæ are simple, bilimbate, margins minutely denticulate; a few appear to be without margin. In each foot a stout acicula (fig. 60) projecting far beyond the foot. The upper-jaw pieces (fig. 62) resemble those of *Drilonereis longa* Webster, but the posterior pieces (*träger*) are slightly enlarged at their anterior end. The second pair of jaw pieces have ten teeth along their inner margin. Of these the first (anterior) and third are quite large, the second and all behind the third small and of nearly uniform size. The lower jaws were present in all specimens examined; they are minute and have the form shown in fig. 63.

This species may be readily distinguished from *Drilonereis longa* Webster by the shortness of the posterior feet and by its greater diameter.

Length, 175mm.

Diameter, 2mm.

Sand, low water. Rare.

Family GLYCERIDÆ.

EUGLYCERA *Verrill.*

EUGLYCERA DIBRANCHIATA *Verrill.*

Glycera dibranchiata EHLERS. Die Borstenwürmer, p. 670, pl. xxiv, figs. 1, 10–28. 1868.
Rhynchobolus dibranchiatus VERRILL. Invert. An. Vin. Sound, &c., p. 596, pl. x, figs. 43, 44. 1874.
Euglycera dibranchiata VERRILL. Trans. Conn. Acad., p. 296, foot-note. 1881.

We found but one specimen; this one, however, was very large.

Sand, low water.

RHYNCHOBOLUS *Claparède.*

RHYNCHOBOLUS CAPITATUS *Verrill.*

Glycera capitata ŒRSTED. Grønl. Ann. Dorsibr., p. 44, pl. vii, figs. 87, 88, 90–94, 96, 99. 1843.
Rhynchobolus capitatus VERRILL. Trans. Conn. Acad., p. 43. 1874.

Not common. Low water; sand; to 30 fathoms, rocks and sand.

GONIADA *Aud. and M. Ed.*

GONIADA MACULATA *Œrsted.*

ŒRSTED. Ann. Dan. Consp., p. 33, figs. 16, 23, 91, 95, 97, 98. 1843.

Not common. Low water to 30 fathoms, rocks and sand.

Family OPHELIIDÆ.

OPHELINA *Œrsted.*

OPHELINA AULOGASTRA *Grube.*

Ammotrypane aulogaster RATHKE. Beiträge zur Fauna Norwegens, p. 188, pl. x, figs. 1–3. 1840.
Ophelina acuminata ŒRSTED. Ann. Dan. Consp., p. 45. 1843.
Ammotrypane aulogastra MALMGREN. Annulata Polych., p. 73. 1867.
Ophelina aulogastra GRUBE. Annulata Sempriana, p. 193. 1877.

The descriptions of this species differ from each other in some points. Œrsted assigns branchiæ to all the segments; Rathke and Grube say that they begin on the 4th setigerous segment; on our specimens they appear sometimes on the 4th, but usually on the 2d, setigerous segment. Grube gives 44 pairs of branchiæ; Rathke says 43, with one ante-anal segment without branchiæ; ours have 42 pairs, with 3 ante-anal setigerous segments without branchiæ. Grube finds 6 pairs of lateral papillæ, or cirri, on the anal segment; Rathke none; ours have, in adults, 8 pairs, and a terminal cirrus. The head is not correctly figured by Rathke; near the apex is a well-defined constriction, followed by a fusiform, sharp-pointed article.

Common. Low water to 10 fathoms; sand, gravel, and shells.

Family SCALIBREGMIDÆ.

SCALIBREGMA *Rathke.*

SCALIBREGMA MINUTUM, *n. sp.*

Differs from *Scalibregma inflatum* Rathke in that the branchiæ begin on the second setigerous segment, and in having five anal cirri—two dorsal, two ventral, one medio-ventral. It is also much smaller than Rathke's species.

The notes made on the living specimens were not full, and the present condition of the alcoholic specimens does not admit of accurate description.

Length, 5–7^{mm}.

Diameter, 1.5–2^{mm}.

Common. Sand and mud, shallow dredgings.

Family THELETHUSIDÆ.

ARENICOLA *Lamarck.*

ARENICOLA MARINA *L.*

Not generally distributed, but abundant at Welch Pool, in the sand, at low water.

Family SPHÆRODORIDÆ.

EPHESIA *Rathke.*

EPHESIA GRACILIS *Rathke.*

Ephesia gracilis RATHKE. Beiträge zur Fauna Norwegens, p. 176, pl. vii, figs. 5–8. 1840.

Sphærodorum peripatus CLAPARÈDE. Beobachtungen, &c., p. 50, pl. xi, figs. 8–18. 1863.

Only two specimens of this species were taken. One had the body filled with rather large eggs, dark red, with a purple tinge, and with a darker nucleus. Our specimens agree perfectly with Claparède's description of *Sphærodorum peripatus.* The body is covered by a very delicate membrane, which is external to and completely covers all the appendages—rami, cirri, papillæ, &c.

Just within each dorsal cirrus is a second spherule, smaller than the cirrus, but larger than the other papillæ, and definite in position. On each segment there are three series of papillæ attached to the body by a slender cylindrical stalk. The papillæ have various forms—spherical, cylindrical, or even cup-shaped, in which case the margin of the cup is fringed (digitate).

Twenty-five to thirty fathoms, rocks, shells, hydroids, &c.

EPHESIA MINUTA, *n. sp.*

(PL. IV, FIGS. 64–66.)

In this species the head is rounded at the sides and above, truncated in front, nearly straight behind, its length a little less than its width. One pair of black circular eyes, lateral, median. From the outer angles, above and below, of the truncated front of the head arise antennæ. These are longer than the head, somewhat swollen along their inner third, then conical; their inner two-thirds bearing numerous long cylindrical papillæ, so long that the antennæ seem to be branched.

The head can be retracted so far as to conceal both itself and the antennæ. The head is also furnished with cylindrical papillæ, shorter than those on the antennæ. One of the papillæ, however, arising between the eyes is much elongated and seems almost like an unpaired antenna.

The first segment bears setæ, but has a pair of tentacular cirri, of about the same length as the median papilla of the head, and in all respects similar to it.

The dorsal cirri are globular (fig. 64), attached to the body by a narrow neck. There is a transverse series of these globular papillæ, 10–12 in number on each segment, with numerous smaller globular and cylindrical papillæ scattered over the general surface. The terminal papillæ at the summit of the large spheres, described by Claparède for *Sphærodrum peripatus*, do not exist in this species, but all the papillæ show the vermiform contents described by him. All the papillæ are attached to the body in the same way as the dorsal cirri.

The anal segment is without rami or setæ, and is smooth above. It has, however, two large dorsal cirri, and a median, elongated, cylindrical ventral cirrus.

The feet are unramous, carry numerous papillæ, and often appear to be bifurcate at extremity, owing to one of these papillæ arising near the apex and pointing outward, reaching to the apex of the foot.

The setæ (fig. 66) are all compound, delicate; those on the anterior segments relatively short (figs. 64, 65).

The pharynx occupies four segments. The stomach is barrel-shaped, transversely striated, occupies four segments. The intestine in the first segment back of the stomach is very narrow; just back of this the intestine becomes quite large.

Some specimens had the body cavity filled with a granular fluid without corpuscles of any kind. In others there were numerous corpuscles, in form similar to those found in Cirratulus, reddish purple, with clear center, their diameter about one-fifth that of the body. They floated about freely, rolling over each other. They were all back of the stomach. In one large specimen there were 70 of these corpuscles. In other specimens the place of these corpuscles was taken by cells, which seemed to be simply membranous sacks with fluid contents. Some of these were quite large, others small. They were spherical, or somewhat elongated. In number and position they agreed with the purple disks mentioned above. When the purple disks existed the cirri and papillæ were filled with dark-brown, almost black, pigment. This was also sometimes the case, but always in a less degree, when the purple disks were absent.

The diameter was greatest at the middle of the body.

Dorsum, yellowish-white; sides and feet, white.

Length, 3–4^{mm}.

Diameter, 0.6–0.8^{mm}.

This form occurred in nearly all dredging, appearing to be very generally distributed.

Family CHLORÆMIDÆ.

TROPHONIA *M. Edwards.*

TROPHONIA PLUMOSA *Johnston.*

Amphitrite plumosa MÜLLER. Prodr. Z. D. n. 2621, p. 216 (*teste* Malmgren).
Trophonia plumosa JOHNSTON. Cat. Brit. Mus., p. 224, pl. 19, figs. 1–10. 1865.

We found but one specimen of this species. One other was brought to us by Dr. Nolan from Grand Manan.

Sand and shells, 8–12 fathoms.

TROPHONIA ASPERA (*Stimpson*) *Verrill.*

We refer two specimens—one entire, the other a fragment—to Stimpson's species, with, however, some doubt. Professor Verrill has referred some form to *Trophonia aspera*, but without description, and Stimpson's description is so defective as to make identification doubtful, if not impossible. On our specimens the dorsal setæ are more strongly curved, and the papillæ of the body longer and stouter than on *T. plumosa*. There are four or five dorsal setæ in each bundle. They decrease in length and increase in curvature from above downward.

Sandy mud, 6–10 fathoms.

ZORUS, *n. g.*

Tentacles and branchiæ arise from a protrusible cylindrical stalk. Setæ of anterior segments prolonged to form a cephalic cage. Setæ all capillary. Body covered with papillæ.

ZORUS SARSI, *n. sp.*

(PL. V, FIG. 67.)

The branchiæ of this species are dark green, flattened, of uniform width, reaching in full extension nearly to the end of the cephalic cage; four pairs.

The tentacles are white, shorter and stouter than the branchiæ, smooth above and at the sides, canaliculate below, with the sides of the canal scolloped.

The upper setæ of the first segment are about one-third longer than the width of the fifth segment; those of the second segment not quite so long; the lower setæ of these two segments are a little shorter than the last. These four bundles of setæ form the cephalic cage; for while the dorsal setæ of the next three segments are directed forwards, they do not reach beyond the head.

After the first two segments the length of the dorsal setæ is about equal to the width of the body, or even a little longer (fig. 67); they do not increase in length on the posterior segments, but seem to do so, owing to the decrease in the diameter of the body. On a few of the anterior segments the ventral setæ are a little shorter than the dorsal setæ, but soon become of the same length.

The setæ are all of one kind, delicate, transversely striate, capillary.

The diameter of the body is greatest from the fifth to about the tenth segment; before the fifth there is a rapid falling off in width; behind the tenth a gradual diminution, giving for the posterior segments about one-third the greatest diameter.

The middle third of the body is concave dorsally (fig. 67); rounded at the sides and below; anterior and posterior thirds regularly rounded.

The body is densely covered with elongated papillæ. There is one very long papilla at the base of each dorsal fan of setæ. These papillæ may be conical or cylindrical, and, like the setæ, retain their number and length on the posterior segments.

Body green, covered with dirt; setæ golden-yellow, gleaming.

Length, 10–15^{mm}.

Diameter, 2–3^{mm}.

Number of segments, 28–32.

Not common; 6–10 fathoms; sand and sandy mud.

SIPHONOSTOMUM *Otto.*

SIPHONOSTOMUM GRUBEI, *n. sp.*

(PL. V, FIGS. 68–71.)

In this species there are thirty rather stout branchiæ, a little shorter than the setæ of the cephalic cage; the tentacles are two-thirds as long as the branchiæ.

The body is covered with papillæ of two kinds (fig. 68), some long, slender, cylindrical to near the end, then fusiform, terminating in a little swelling; these occur for the most part on the feet, and are especially innumerous on the segments bearing the setæ which form the cephalic cage, but they are also found on the body both above and below; the others are much shorter, may be either conical or cylindrical, and exist both on the body and feet.

The superior ramus is flattened, bilabiate (fig. 68), sides concave; its setæ pass out between the two lips, 4–6 in each bundle, about as long as the width of the body, remotely and faintly striate (loculate). The lower ramus is as long as the upper, slightly tapering, apex bluntly rounded, constricted near the outer fourth. In each lower ramus are two stout setæ, compound, appendix a strong, variously-curved hook (Figs. 70, 71). One of these setæ is as long as the dorsal setæ, the other much shorter.

The body is colorless and transparent, but the color of the internal organs is for the anterior third white; middle third, red; posterior third, greenish white.

Length, 8–12^{mm}.

Sandy bottom, 6–10 fathoms.

FLABELLIGERA *Sars.*

FLABELLIGERA AFFINIS *Sars.*

SARS. Bidrag till Söedyrenes Naturalh., i, p. 31, pl. 3, fig. 16—. Beskr. og Iaktt., p. 47 (*teste* MALMGREN).

Common. Low water to 20 fathoms, under stones, &c.

BRADA *Stimpson.*

BRADA SUBLEVIS *Stimpson.*

STIMPSON. Marine Invertebrata of Grand Manan, p. 32. 1854.

It seems very probable that this species will be found to be the same as *Brada granulata* MALMGREN, in which case it would be better to retain Malmgren's name, as Stimpson's notice of the species can hardly be called a description.

Common. Low water to 30 fathoms, sand and sandy mud.

BRADA GRANOSA *Stimpson.*

(PL. V, FIGS. 72–76.)

STIMPSON. Grand Manan, p. 32. 1854.

We found at Eastport two species of Brada, which, by comparison with each other, were referred to Stimpson's species. The form referred to *granosa* has the dorsum and sides densely covered with long, conical, or cylindrical papillæ (fig. 72), which, for their inner two-thirds, are covered with sand, closely adherent. In each dorsal ramus there are two setæ, delicate, distinctly, but distantly striate (fig. 73). In the ventral rami, 4–6 much stouter setæ (figs. 74, 75), which may be more or less curved at apex.

Common. Low water to 30 fathoms, sand and sandy mud.

Young forms of this species, taken in the first part of July, had a length of 2^{mm}, diameter, 0.5^{mm}. They had a distinct head (fig. 76), near the anterior margin of which was a pair of minute red eyes; from the under surface of the head, just beneath the eyes, arose a pair of flattened, oval plates, densely ciliated; these, as became evident afterwards, were the tentacles. From a membranous ring, back of the head, arose one or two pairs of similar plates, slightly swollen; their origin was usually concealed by the projection of the anterior margin of the first segment, so that they seemed to arise from the posterior lateral surface of the head. These are the first branchiæ; afterwards the ring, from which they originate, grows forward, completely covering the head and carrying the branchiæ, increasing in number, forward with it. The tentacles at first are simple, fleshy plates, not canaliculate.

Family STERNASPIDÆ.

STERNASPIS *Otto.*

STERNASPIS FOSSOR *Stimpson.*

STIMPSON. Grand Manan, p. 29, fig. 19. 1854.

Common in mud at all depths.

Family CHÆTOPTERIDÆ.

ETHOCLES, *n. g.*

Head without appendages. Buccal segment without setæ, with two canaliculate tentacles. Dorsal rami (branchiæ) situated dorsally, each with concealed seta. Ventral rami of first seven setigerous segments, with superior lingula (cirrus) situated dorsally, and with several rows of simple setæ, which arise in front of a lateral plate, which varies in form from segment to segment.

Middle region composed of few segments. The ventral rami of this region are elongate, cylindrical, furnished with an external, lateral membrane. The posterior region is composed of numerous segments, and differs from the middle region only in the absence of the lateral membrane from the ventral rami. Anal cirri, two.

It is with much hesitation that this genus is referred to the Chætopteridæ, from all previously described genera of which it differs in many respects: the branchiæ begin on the first setigerous segment; there is no peculiar seta developed in any of the anterior segments; the ventral rami are not bifurcate. On the other hand, the structure of the tentacles would refer it either to this family or to the Spionidæ; the branchiæ both by their position, structure, and from the fact that they have concealed setæ, recall Spiochætopterus; and the division of the body into three regions, though not very well defined, would seem to bring this form nearer to Chætopterus than to Spio. The absence of the peculiar seta from the anterior segments has a parallel among the Spionidæ.

ETHOCLES TYPICUS, *n. sp.*

(PL. VI, FIGS. 77–85.)

The head is convex above and at the sides; apex bluntly rounded; length is little more than the width; no appendages; no eyes.

The buccal segment is a little shorter than the second segment; it carries a pair of long, canaliculated, spio-like tentacles; these are probably very long, but on all four specimens were broken. This segment is plainly set off from the head below by a deeply impressed line. The mouth is longitudinal, sides rounded, fleshy, united behind, free in front. When the mouth is closed it appears simply as a longitudinal white line, running to meet a similar transverse white line. This last is the line of division between the head and the buccal segment.

The second and all following segments have elongated, densely ciliated, dorsal branchiæ, or dorsal rami (figs. 77–83), each containing a delicate seta, which falls short of the apex. On the first seven setigerous segments, between the branchiæ and the ventral setigerous lobe, is a cirrus, or lingula, about one-half as long as the branchiæ. On the first three segments this cirrus is close to the ventral ramus (fig. 77), but recedes gradually till on the segments 4–7 it is about half-way between this ramus and the branchia (fig. 80).

The ventral ramus on segments 1–3 is a fleshy, lateral plate, somewhat quadrangular, and with a small conical lobe projecting from its lower margin (fig. 77). On the fourth segment (fig. 78), in place of this single lobe, there is a second plate not so thick as the setigerous plate, but not membranous, with its outer margin divided into 4–6 stout conical processes. Segments 5 and 6 have the setigerous lobe much smaller (fig. 79), while a membranous, elevated plate, starting from about the middle of this lobe, runs downward, encroaching on the ventral surface. This membrane has its outer margin convex and minutely digitate, or beset with numerous minute cylindrical papillæ. On the seventh segment this membrane is longer, entirely replaces the setigerous lobe, and its margin (fig. 80) is divided into conical lobes similar to those on the fourth segment, but larger and irregular. On these seven segments the setæ are practically all of one kind (fig. 84), wide at base, regularly and rapidly tapering, flattened. They are very numerous and in several series on segments 1–4; less numerous on segments 5–7.

Segments 8–12, forming the middle region of the body, have their ventral rami elongated, conical (figs. 81, 82), carrying a few very long, delicate setæ (fig. 85). On the eighth segment a membrane starting from the middle of the ramus runs down the side of the body (fig. 81); the outer margin of this membrane is finely denticulated. A similar membrane exists on segments 9–12, but it is longer, arising nearer the apex of the ramus, and encroaching on the ventral surface (fig. 82). On the eleventh segment the denticulations are larger than on the others, approaching in form and size those found on the fourth and seventh segments.

The segments of the posterior third of the body are numerous. The ventral rami on these segments are rather cylindrical than conical (fig. 83), and they lack the lateral membrane, but are furnished with a variable number of conical papillæ. The setæ are like those of the middle region.

Back of the seventh segment the branchiæ become somewhat elongated and delicate; they are found on all except a few of the posterior segments, where, however, all the appendages become much smaller, or even disappear.

Only two of our specimens had the extreme posterior segments; only one the anal cirri. Anal segment obliquely truncated, at a small angle; anal opening situated dorsally, on the truncated surface. Anal cirri two, delicate, filiform, latero-ventral, as long as the last six segments.

Our specimens were for the most part badly broken, and have not kept well in alcohol. It seems probable that they live in tubes, but we always found them free.

The body is flattened both above and below in front, slightly convex farther back, tapering slightly along the posterior half. General color white or yellowish-white; tenacles white; setæ yellow, or yellowish-brown.

Length probably about 8–12^{mm}.

Width, 1.5–2^{mm}.

Common, 8–10 fathoms, mud.

Family SPIONIDÆ.

SCOLECOLEPIS *Blainville*.

SCOLECOLEPIS CIRRATA *Malmgren*.

Nerine cirrata SARS. Bidrag til Kundskaben om Norges Annelider, p. 15. 1861.
Scolecolepis cirrata MALMGREN. Annulata Polychæta, p. 91, pl. 9, fig. 54. 1867.

Only one specimen was obtained, an anterior, badly mutilated part.

SPIONIDES, *n. g.*

Much like Scolecolepis, but distinguished from it by the possession of lateral pouches between the ventral rami, beginning near the anterior end, and continued to the posterior third.

This form is very closely related to *Scolecolepis cirrata* MALMGREN. We have no good specimens of that species for comparison. It seems certain, however, that the peculiarity mentioned above could not have escaped observation.

The material for description is not very good, as we only found three specimens, all more or less injured.

SPIONIDES CIRRATUS, *n. sp.*

(PL. VI, FIGS. 86–89.)

Head wide in front, narrow behind, continued backward as a carina on three segments. Two pairs of eyes, minute, lateral, pink; one pair on the middle line of the head; the second pair, posterior. A minute antenna or occipital tentacle, posterior. Buccal segment visible from above only at the sides of the head; tentacles white, not very long, deeply canaliculated, margins of the canal scolloped.

The branchiæ begin on the third setigerous segment, 13 pairs.

The anterior feet have the form shown in fig. 86, behind the branchiæ, as in fig. 87.

After the first few segments the membranous pouches appear between the ventral rami. They are formed by a delicate membrane with free upper margin, which curves outward between the ventral rami, and is prolonged down the sides of the body below the rami, forming a series of deep pouches with crescentic opening above. The membrane is continuous, but is attached to the body above each ventral ramus, and seems to be prolonged inward, as a low ridge, to the outer base of the dorsal rami.

There are four pairs of anal cirri, of which three pairs are lateral, delicate, as long as five or six of the last segments; one pair latero-ventral, stout, one-half as long as the lateral cirri.

Body widest in front, tapering gradually but uniformly.

Body white or colorless, lateral membrane white, branchiæ with red center.

Length of largest specimen, 25mm; width of largest specimen, 0.8mm. Rare; sandy bottom, 6–8 fathoms.

SPIO (*Fabricius*) *Œrsted.*

SPIO FILICORNIS *Fabricius.*

Nereis filicornis FABRICIUS. Fauna Grönl., p. 307. 1780.

Spio filicornis FABRICIUS. Schr. Naturf. Freunde Berlin, vi, p. 264, pl. v, figs. 8–12 (*teste* MALMGREN).

Spio filicornis MALMGREN. Annulata Polych., p. 91, pl. i, fig. 1. 1867.

A form common at Eastport seems certainly to agree with the species regarded by Malmgren as identical with the *S. filicornis* of Fabricius. The specimens show considerable diversity of coloring. Young forms have the body colorless, with two brown spots on each segment, and numerous flake-white markings, also two brown spots, anterior and posterior, at the base of each dorsal ramus; tentacular cirri colorless, with a few brown rings, and numerous specks and irregular lines of flake-white. Other young forms had these cirri very dark brown, almost black throughout; or, again, the cirri may be brown above, colorless below, without transverse bands.

Some larger specimens, not full-grown, were entirely without markings. Adult forms were light green; tentacular cirri green, with bands of white and chestnut; or, tentacular cirri colorless above, green below, with brown bands. Others had umber-brown tentacular cirri, and on each segment two brown spots, one in front of, the other above (within) each dorsal ramus.

Branchiæ green or brown with red center; sometimes with flake-white spots. Common; sand and gravel; low water to 10 fathoms.

SPIO RATHBUNI *Webster & Benedict.*

Annelida Chætopoda of Provincetown.

Common in sand and sandy mud, at low water.

STREBLOSPIO *Webster.*

STREBLOSPIO BENEDICTI *Webster.*

Annelida Chætopoda of New Jersey, p. 20, pl. v, figs. 48–50. Also, Annelida Chætopoda of Provincetown. (Webster and Benedict.)

One specimen was found with eggs. They are dorsal, lateral, two to each segment. They are covered by a membrane, which is continued across the dorsum, forming a low ridge between the eggs on opposite sides of the same segment. On this specimen they appeared first at about the middle of the body.

Half-tide, soft mud. Found only at "Clam Cove," in Saint Andrew's Bay.

PRIONOSPIO *Malmgren.*

PRIONOSPIO STEENSTRUPI *Malmgren.*

MALMGREN. Annulat. Polych., p. 93, pl. ix, fig. 55. 1867.

The tentacles are long, delicate, similar to those described for *Prionospio plumosa* by Sars.

The head rests on the buccal segment; the sides of this segment, back of its rami, curve inward, so as almost to cut it off from the second segment. The buccal segment has both dorsal and ventral rami. Eyes, four, black, circular; anterior pair farther apart than the posterior. The branchiæ do not arise from the first segment, but are found on segments 2–5.

General color, greenish; branchiæ, red. Not common; sand and shells, 10–15 fathoms.

POLYDORA *Bosc.*

POLYDORA CILIATA *A. Agassiz.*

Annals Lyc. Nat. Hist., vol. viii, p. 323, figs. 26–38. 1866.

It does not seem probable that the species described by Agassiz is identical with *Leucodore ciliatus* JOHNSTON, which species again is not the same as *Leucodora ciliata* KEFERSTEIN. We understand Professor Verrill to concur in this view, and as our material is not in good condition, prefer to leave the whole subject with him.

POLYDORA GRACILIS *Verrill.*

Proceedings U. S. National Museum, p. 174. 1879.

Our specimens were found under the same conditions as those indicated by Professor Verrill, and, for the most part, agree with his description. He states, however, that on the sixth and following segments there are, with the capillary setæ, three or four uncini in the dorsal fascicles. This is not the case with our specimens. Sometimes the head is slightly bilobed in front, but this is not always the case. An elevated carina extends back to the fourth segment. The number of eyes is variable; there may be none, or one, two, three, or four.

On shells of *Pecten tenuicostatus*, 10–35 fathoms.

DIPOLYDORA *Verrill.*

DIPOLYDORA CONCHARUM *Verrill.*

Polydora concharum VERRILL. Proc. U. S. National Museum, p. 174. 1879.
Dipolydora concharum VERRILL. Trans. Conn. Acad., p. 320, foot-note. 1881.

Not common; 20–30 fathoms, on shells.

Family ARICIIDÆ.

SCOLOPLOS (*Blnv.*) *Œrsted.*

SCOLOPLOS ARMIGER (*Blnv.*) *Œrsted.*

Scoloplos armiger BLAINVILLE. Dict. Sc. Nat., Tom. 57 (*teste* Malmgren).
Aricia Mülleri RATHKE. Beiträge zur Fauna Norwegens, p. 176, pl. viii, figs. 9–15. 1840.
Scoloplos armiger ŒRSTED. Ann. Dan. Comp., p. 37, figs. 8, 106, 107, 109. 1843.
Scoloplos armiger MALMGREN. Ann. Polych., p. 72. 1867.
Anthostoma acutum VERRILL. Invert. An. of Vin. Sound, p. 599. 1874.

There seems to be no doubt as to the identity of the forms referred to above. No one except Professor Verrill has seen the divided or lobed proboscis, which led him to refer this species to Anthostoma. But this is not strange, as the proboscis is rarely extended, and one may examine many individuals without once seeing one in that condition. Œrsted makes the branchiæ begin on the fifteenth segment, but the anterior branchiæ are very small, and readily escape observation. Malmgren identifies this species with *Aricia Mülleri* RATHKE. The figures of Rathke show the small anterior branchiæ. Œrsted also says there are no anal cirri; these, however, fall off readily.

Common in sand at low water.

NAIDONEREIS *Blainville* (*teste Malmgren*).

NAIDONEREIS QUADRICUSPIDA *Malmgren.*

(PL. VI, FIGS. 90–92.)

Nais quadricuspida FABRICIUS. Fauna Grönl., p. 315. 1780.
Nainereis quadricuspida BLAINVILLE. Dict. Sc. Nat., Tom. 57, p. 440 (*teste* Malmgren).
Scoloplos quadricuspida ŒRSTED. Grönl. Ann. Dors., p. 48, figs. 106–111. 1843.
Aricia quadricuspida LEUCKART. Arch. Naturg., vol. x, p. 198, pl. 3, fig. 11 (*teste* Malmgren).
Naidoneris quadricuspida MALMGREN. Annulata Polych., p. 73. 1867.

This species has a pair of minute black eyes, hard to find even on fresh specimens, and not to be found on alcoholic forms. The first two segments are without appendages of any kind. The branchiæ appear on the fifth setigerous segment, nearly full size from the first; on a few of the posterior segments they fall off a little in size.

The dorsal setæ are long, delicate, transversely striated; at the lower part of each dorsal bundle are one or two shorter and stouter setæ, with bifurcate extremity (fig. 90). The ventral setæ on the anterior segments are in three or four series, and of two kinds. The anterior are short, stout spines (fig. 91); those of the posterior series similar to the dorsal setæ. From about the eighth setigerous segment the spines decrease in number, and disappear at the fifteenth. Each ventral ramus has three aciculæ (fig. 92).

Back of each ventral bundle of setæ, on the first twelve segments, is a stout fleshy plate, from the middle of the concave outer margin of which arises a stout conical cirrus. The dorsal and ventral rami are distinct and remote from each other on the first twelve segments, but behind this segment they both arise from a low, rounded, fleshy lip, having a shallow depression between the rami. This plate is continued to the base of the branchiæ, and crosses the dorsum as a low, rounded ridge. Below the ventral ramus it widens, and forms low, rounded lobes, so wide near the ramus that they are separated from each other only by the lines of segmentation; passing downward they become narrower.

Each segment is distinctly trianulate. The anal segment ends in four flattened lobes, bluntly rounded behind—one dorsal, one ventral, two lateral; from each of these lobes arises an anal cirrus, rather stout, slightly tapering, as long as the last five segments.

Common at half-tide, under stones; gregarious.

ARICIDEA *Webster.*

ARICIDEA QUADRILOBATA *n. sp.*

(PL. VII, FIGS. 93–96.)

In this species the head (fig. 93) is constricted a little behind the middle, broadly rounded in front; posterior part convex; anterior part sloping, so as to be much thinner in front than behind.

The antenna is delicate, almost filiform, reaching back to the sixth setigerous segment. A pair of minute red eyes, about half way between the origin of the antenna and the sides of the head.

The buccal segment is short, without rami; it carries four oval elevations, arranged in a series, about equally distant from each other.

The next three segments carry both dorsal and ventral cirri, conical and slightly fusiform, the ventral somewhat larger than the dorsal.

The branchiæ begin on the fourth setigerous segment; there are nine pairs. They are broad at base (fig. 94), do not taper much along their inner two-thirds, then suddenly become pointed. They are usually applied closely to the body, and would overlap, but the pointed ends turn suddenly backward.

The dorsal cirri, on the branchiated segments, are more delicate than on the anterior segments, and slightly swollen externally, near their origin; back of the branchiated segments these cirri become very delicate, filiform (figs. 95, 96), and, on the posterior segments, their length surpasses the width of the body.

The dorsal setæ are all simple, capillary; they increase in length with the dorsal cirri, so that even on the posterior segments some of these setæ project beyond the cirri. The ventral setæ are shorter than the dorsal; arranged in a close-set fan; on the posterior segments a few of these setæ have a sigmoid flexure near the end.

Along the branchiated segments the body is slightly convex dorsally and laterally; flat below; farther back somewhat convex both above and below, but never round.

The anal segment is obliquely truncated from above downward, and carries three delicate anal cirri—one medio-ventral, two latero-ventral.

The width of the anterior half of the body is nearly uniform; along the posterior half it tapers slightly, so that the posterior segments are about one-half as wide as the anterior.

Behind the branchiæ in many specimens the body was filled with large irregularly polygonal eggs, clear white, with distinct nucleus. General color some shade of green, usually light green; branchiæ green, with red center; setæ gleaming white.

Length, $5\text{–}6^{mm}$.

Width, $0.4\text{–}0.5^{mm}$.

Common in mud and sandy mud; 31–2 fathoms.

ARICIDEA NOLANI,* *n. sp.*

(PL. VIII, FIGS. 97, 98.)

With the last form we also found another species of this genus. The head (fig. 97) is a little longer than its greatest width, bluntly rounded in front, but with the apex not so wide as in the preceding species; antenna short, stout, conical or fusiform; eyes situated as in the last species, but larger.

Branchiæ begin on the fourth setigerous segment, 13–20 pairs, overlapping along the middle line (fig. 98). Dorsal cirri, on segments anterior to the branchiæ, short, conical; on branchiated segments, much longer, swollen near the base; behind the branchiæ, delicate, conical, increasing in length, and becoming filiform on the posterior segments.

There are no ventral cirri. The setæ are much as in the preceding species, but on a number of the posterior ventral rami the upper setæ are much elongated.

The body in front is somewhat quadrangular, being flat, or even slightly concave above, a trifle convex below; behind the branchiæ, pretty evenly rounded.

Anal segment and cirri as in last species. The head and body contained numerous oval, gleaming, green granules.

The only sexual form taken was a female, having four eggs in each segment back of the branchiæ, two on each side. These were large, spherical, completely occupying the lateral field, not in contact, white.

General color green, usually dark, with scattered spots of reddish-brown on the head and anterior segments.

Length, 7^{mm}.

Width, 3^{mm}.

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*After Mr. Nolan, of New York City, a gentleman who was of great service to us in collecting.

Specimen of the length just given had but thirteen pairs of branchiæ; a single larger specimen had twenty pairs; its color was reddish-brown in front, passing into brown farther back, ventral surface white.

Common in mud and sandy mud; 6–12 fathoms.

Family CIRRATULIDÆ.

CIRRATULUS *Lamarck.*

CIRRATULUS CIRRATUS *Malmgren.*

MALMGREN. Annulata Polych., p. 95. 1867.

Rare; low water; sand.

DODECACERIA *Œrsted.*

DODECACERIA CONCHARUM *Œrsted.*

ŒRSTED. Ann. Dan. Consp., p. 44, fig. 99. 1843.
VERRILL. Proc. U. S. National Museum, p. 178. 1879.

The arrangement of setæ was not exactly the same, on our specimens, as that given by Professor Verrill.

Rare; 25–30 fathoms.

CHÆTOZONE *Malmgren.*

We found many specimens of a form which seems certainly to be *Chætozone setosa* MALMGREN, but which differ from his specimens in having a pair of tentacular cirri, and also in having, normally, dorsal cirri on all segments, or at least scattered along the entire length of the body.

CHÆTOZONE SETOSA *Malmgren.*

The head is acute, conical; first three segments without appendages; fourth segment with a pair of long, stout, canaliculated, tentacular cirri.

The dorsal cirri are not limited to the anterior segments, but may exist on any segment, though they readily fall off, especially along the posterior two-thirds. The cirri of the fifth and sixth segments are often longer and larger than the others, but have the same structure. The anal segment terminates in a thin, horizontal, semicircular plate.

Anterior fourth of the body yellowish-white; posterior three-fourths dark purple; or the entire body may be colorless.

Common on sandy and shelly bottoms; 6–12 fathoms.

THARYX, *n. g.*

Head and first two segments without appendages. One pair of tentacular cirri; next segment with dorsal cirri, but without setæ; all other segments (normally) with dorsal cirri; setæ capillary.

This genus with the preceding one, to which it is closely related, seem to form a group by themselves in the family, distinguished by having a single pair of tentacular cirri, and by the existence of dorsal cirri along the entire body.

THARYX ACUTUS, *n. sp.*

(PL. VII, FIGS. 99–103.)

Head long, conical; no eyes; no appendages of any kind (fig. 99). First two (three?) segments without appendages. Tentacular cirri very large, very long, deeply and widely canaliculated, margins of the canal deeply scalloped. Next segment very short, with dorsal cirri, but without setæ.

On the anterior segments (fig. 100) the dorsal setæ are about one-half as long as the width of the body; on the middle third they are very much elongated (fig. 101), growing shorter again along the posterior third (figs. 102, 103). The ventral setæ have throughout about the length of the anterior dorsal setæ.

The anterior (20–30) segments are very short; farther back they gain gradually until the length of each segment is about equal to one-half its width.

The form of the body is shown in figs. 100–103.

Body brown, yellow, or yellowish white; numerous umber-brown specks on the body and cirri; tentacular cirri white, specked with umber-brown.

Length, 12–15^{mm}.

Diameter, 0.5–0.7^{mm}.

Common; sand and sandy mud; 6–12 fathoms.

THARYX SIMILIS, *n. sp.*

(PL. VII, FIG. 104.)

We found a few specimens of a second species of this genus similar to the first, but differing from it in some particulars. Head and first four segments as in the last species, except that the head is a little shorter and larger at base; tentacular cirri also shorter and stouter. Dorsal setæ longest and most numerous on the anterior segments. Ventral setæ on anterior segments (6–8) similar to the dorsal; then from 2–4 setæ shorter, stouter, slightly curved at the end, are introduced, alternating with the straight capillary setæ.

These setæ are arranged, not very close to each other, so as to form a single series running down the side of the body. Anterior segments short; posterior segment longer, and with the lines of segmentation so deep and well defined as to give to the posterior two-thirds of the body a moniliform appearance.

Body and tentacular cirri green, with numerous dark-brown spots; dorsal cirri, colorless.

Length, 7–10^{mm}.
Diameter in front, 0.6–0.7^{mm}.
Diameter posterior end, 0.2–0.24^{mm}.
Not common; 20 fathoms; rocks and shells.

COSSURA, *n. g.*

Head and first two segments without appendages (fig. 105). Fourth segment with single median cirrus; no lateral cirri (branchiæ). Capillary setæ, dorsal and ventral from the third segment. Anal segment, with three anal cirri.

Cossura longocirrata, *n. sp.*

(Pl. VIII, Figs. 105–107.)

Head conical (fig. 105); first segment a little shorter than the second; second as long as the third. The median cirrus of the fourth segment is very long, reaching back to the twenty-fifth segment. It increases regularly in diameter along the first fourth of its length, then tapers very gradually to the end. Along the anterior part of this cirrus well-defined and regular constrictions exist; these also occur along the entire cirrus, but irregularly.

The bundles of dorsal and ventral setæ are close to each other, forming a nearly continuous series; the setæ are short in front (fig. 105), on the middle segments nearly as long as the width of the body, while on the posterior segments they again shorten somewhat.

In living specimens the lines of segmentation are very faint along the anterior third; farther back very deep, giving to the body a moniliform appearance; on the extreme posterior segments not so well defined.

Only one specimen with anal segment and cirri was taken, and in this the anal segment was somewhat injured. It appeared to be truncated from above downward; it bears three delicate anal cirri, as long as the last 8–10 segments.

Length, 6^{mm}.
Diameter, 0.6–0.8^{mm}.
Number of segments, 50–70.
Mud and sandy mud; 6–12 fathoms.

LEDON, *n. g.*

We found two specimens, both somewhat injured, which seemed to represent a new genus, allied to *Acrocirrus* and *Macrochæta*, but not agreeing perfectly with either. It differs from *Macrochæta* Grube, as described and figured by Langerhans, in having cirri (? branchiæ) on the buccal segment; and from Acrocirrus in having (apparently) but one pair of appendages on the buccal segment, instead of two; and (certainly) in having two pairs of appendages on the second segment. For the present the generic diagnosis will stand as follows:

Head with antennæ projecting from the anterior margin; branchiæ beginning on the buccal segment, limited to the anterior segments; second segment with a pair of short cirri in addition to the branchiæ; ventral setæ compound, found first on the third segment; dorsal setæ capillary, appearing first on the fourth segment.

LEDON SEXOCULATA, *n. sp.*

(PL. VIII, FIGS. 108, 109.)

Head pentagonal, posterior margin straight, width slightly greater than the length; attennæ flattened, fusiform, wide, as long as the head, distant from each other at origin by about their own width.

Eyes six, circular, lateral, situated at the angles of a hexagon, middle pair largest.

Segments 1 to 5 or 6 each, with a pair of branchiæ three to four times as long as the width of the body, club-shaped, stout.

Second segment with a pair of cylindrical cirri, about one-eighth as long as the branchiæ and placed beneath them.

The ventral setæ appear on the third segment. They are compound (fig. 108), hooked near the end, and with a straight delicate spine originating a little below the terminal hook and projecting beyond it. On a few of the anterior segments there are two of these setæ in each ventral ramus; farther back, only one.

Beginning with the fourth segment, there is a single, long, capillary seta in each dorsal ramus (fig. 109).

The anterior part of the body is densely covered with minute cylindrical papillæ. Body cylindrical; anterior segments short, gaining in length until their length and width are about equal.

Anal segment truncated, margin thickened; on the ventral surface two small rounded projections.

Body covered with dirt; general color light green.

Length, 6–8^{mm}.

Width, 0.4–0.5^{mm}.

Rare; sand and shells; 8–12 fathoms.

Family CAPITELLIDÆ

CAPITELLA *Blainville.*

CAPITELLA CAPITATA *van Beneden.*

Lumbricus capitatus FABRICIUS. Fauna Grönl., p. 279. 1780.

Capitella capitata VAN BENEDEN. Bull. Acad. de Belg., 2d series, vol. 3, p. 137, with 2 plates (*teste* Quatrefga.).

While the specimens taken at Eastport seem certainly to belong to this species, both the young and the adults have two minute black eyes.

As observed by Claparède the uncini exist on young forms in advance of their position on the adult. On one specimen the capillary setæ changed to uncini on the fourth setigerous segment.

Not common. Mud, any depth to 40 fathoms.

We obtained sufficient material to indicate the existence of another species of Capitella at Eastport, but not sufficient to admit of description

NOTOMASTUS *Sars.*

NOTOMASTUS CAPILLARIS *Verrill.*

Ancistria capillaris VERRILL. Proc. American Association for the Advancement of Science, p. 385. 1874.

Notomastus capillaris VERRILL. Proc. U. S. National Museum, p. 181. 1879.

Single specimen. Station not noted.

Family MALDANIDÆ.

RHODINE *Malmgren.*

RHODINE LOVENI *Malmgren.*

MALMGREN. Nord. Hafs-Ann., p. 189. 1865. Ann. Polych., p. 99., pl. x, fig. 61. 1867.

We found no entire specimen. One specimen had twenty-four segments; from the seventeenth each had the peculiar membranous margin described by Malmgren; it is irregularly denticulated.

Body colorless to brownish red.

Sand and sandy mud; 8 to 12 fathoms.

NICOMACHE *Malmgren.*

NICOMACHE LUMBRICALIS *Mgrn.*

Sabella lumbricalis O. FABRICIUS. Fauna Grönl, p. 374. 1780.
Nicomache lumbricalis MALMGREN. Nordiska Hafs-Ann., p. 190. 1865. Ann. Polych., p. 99, pl. x, fig. 60. 1867.

Only one specimen taken. Rocks; 20 fathoms.

PRAXILLELLA *Verrill.*

PRAXILLELLA ZONALIS *Verrill.*

Praxilla zonalis VERRILL. American Journal of Science, vol. vii, p. 505, pl. vi, fig. 2. 1874. Proc. A. A. A. S., p. 384, pl. 5, fig. 4. 1874.
Praxillella zonalis VERRILL. Trans. Connecticut Acad., vol. iv, part 2, p. 298. 1881.

Our specimens agree well with Professor Verrill's description. Add, that the anterior margin of the fourth sitigerous segment is thickened, rounded, forming a collar which receives the preceding segment; also, that the diameter falls off rapidly to the fourth setigerous segment, so that the posterior end of the third setigerous segment is not more than half as wide as the fourth.

Not common. Station not noted.

PRAXILLELLA PRÆTERMISSA *Verrill.*

Praxilla prætermissa MALMGREN. Nord. Hafs.-Ann., p. 191. 1865. Ann. Polych., p. 100, pl. xi, fig. 62. 1867.

Praxillella prætermissa VERRILL. Loc. cit., p. 298. 1881.

Many of our specimens are young and do not have as many uncini on the anterior segments as indicated by Malmgren for this species. The adults are banded very much as in *Praxillella zonalis* VERRILL, and the anal segment has the same structure as in that species.

Common. Mud; 8 to 40 fathoms.

CLYMENELLA *Verrill.*

CLYMENELLA TORQUATA *Verrill.*

VERRILL. Invert. Animals of Vin. Sound, p. 608, pl. xiv, figs. 71–73. 1874.

Very common at low water; sand and sandy mud.

Family AMMOCHARIDÆ.

OWENIA *Delle Chiaje.*

OWENIA ASSIMILIS (*Sars*).

Ammochares assimilis SARS. Nyt. Mag. vi, p. 201 (*teste* Malmgren).

Ammochares assimilis MALMGREN. Ann. Polych., p. 101, pl. xi, fig. 65. 1867.

Not common; 25–30 fathoms; sandy mud.

Specimens indicating a second species of this genus were obtained; but their condition does not admit of description.

MYRIOCHELE *Malmgren.*

In the same year (1867) Malmgren described a new genus of this family under the name *Myriochele* and Grube (*Novara-Expedition, Anneleden*), the same genus, and probably the same species, giving to it the name *Psammocollus* (*australis*). We do not know which name is entitled to priority.

MYRIOCHELE HEERI *Malmgren.*

MALMGREN. Ann. Polych., p. 211, pl. viii, fig. 37. 1867.

Near the posterior lateral margin on either side of the head a circular collection of reddish-brown pigment specks, which seem to be eye-spots. Head and body with numerous minute reddish-brown specks; otherwise colorless. Intestine showing through; brown or yellowish brown.

Not uncommon; 6–12 fathoms; sand and sandy mud.

Family AMPHICTENIDÆ.

CISTENIDES *Malmgren.*

CISTENIDES GRANULATA *Malmgren.*

Sabella granulata LINN. Syst. Nat., xii, p. 1268 (*teste* Malmgren).
Pectinaria Grönlandica GRUBE. Familien der Anneleden, pp. 82, 138. 1851.
Pectinaria Grönlandica STIMPSON. Grand Manan, p. 30. 1854.
Cistenides granulata MALMGREN. Nord. Hafs-Ann., p. 359. 1865.

Not uncommon; 15–30 fathoms; rocks and shells.

Family AMPHARETIDÆ.

AMPHARETE *Malmgren.*

AMPHARETE CIRRATA, *n. sp.*

(PL. VIII, FIGS. 110–112.)

Very similar to *Ampharete Grubei* Malmgren.

Branchiæ as long as the width of the body, or a little longer.

From the 9th setigerous segment each uncigerous lobe bears a conical cirrus. This cirrus, small at first, and arising from the superior margin of the lobe, rapidly elongates, and recedes to the base of the lobe (figs. 110–112).

Uncigerous lobes quite large on the posterior half of the body.

Anal segment about as long as the two preceding segments taken together. Number of anal cirri, fourteen; conical, as long as the anal segment.

General color, light green. Branchiæ light green, lower surface banded with white, center dark green.

Length of largest specimen, 24^{mm}.

Width in front, with feet, 4^{mm}.

Length of branchiæ, 4^{mm}.

Sand; 6–12 fathoms.

AMPHARETE TRILOBATA, *n. sp.*

Anterior margin of head divided into three lobes, of which the median projects slightly beyond the lateral. Two minute black eyes, lateral, on the middle line.

Branchiæ delicate, wrinkled, tapering very gradually, pointed, in length two or three times the width of the body.

Cirri short, stout, flat, not tapering.

Uncigerous lobes large, quadrangular, projecting.

Posterior part of body composed of twelve uncigerous segments and the anal segment.

The anal segment very short; the last uncigerous lobe, when flattened down, projecting beyond it.

Anal cirri 10; of these 8 are conical, as long as the last two segments; 2 lateral, cylindrical, half as long as the others, much stouter, arising from stout swollen bases.

The posterior half of the body tapers rapidly.

Body colorless; internal organs showing through, giving a green tinge, especially along the anterior half. Branchiæ colorless, with green center.

Length of largest specimen, 10mm.

Width in front, with feet, 2mm.

Sand and shells; 6–12 fathoms.

SABELLIDES (*M. Edw.*) *Malmgren.*

SABELLIDES OCTOCIRRATA *Sars.*

SARS. Fauna Littoralis Norvegiæ, vol. ii, pp. 21, 23. 1856.
MALMGREN. Nord. Hafs-Ann., p. 369, pl. xxv, fig. 74. 1865.

Not uncommon; sand and sandy mud; 6–35 fathoms.

MELINNA *Malmgren.*

MELINNA CRISTATA *Malmgren.*

Sabellides cristata SARS. Fauna Littor. Norvg., vol. ii, pp. 19, 24, pl. 2, fig. 1–7. 1856.
Melinna cristata MALMGREN. Nord. Hafs-Ann., p. 371, pl. xx, fig. 50. 1865.

Rare; sandy mud; 5–12 fathoms.

Family TEREBELLIDÆ.

AMPHITRITE *Müller.*

AMPHITRITE BRUNNEA *Verrill.*

Terebella brunnea STIMPSON. Grand Manan, p. 31, 1854.
Amphitrite Johnstoni MALMGREN. Nord. Hafs-Ann., p. 377, pl. xxi, fig. 51. 1865.
Amphitrite brunnea VERRILL. Check List. 1879.

There may be 24 or 25 segments, with capillary setæ. The color is usually dark brownish-red, but a few were dark brown, without any tinge of red.

Common on mud-flats, at low water.

AMPHITRITE CIRRATA *Müller.*

Amphitrite cirrata MÜLLER. Prodr. Zool. Dan. n, 2617 (*teste* Malmgren).
Amphitrite cirrata MALMGREN. Nord. Hafs-Ann., p. 375, pl. xxi, fig. 53. 1865.

The tube of this species is made of fine dirt, curved, open at both ends, which project from the surface.

Not common; sandy mud; low water.

NICOLEA *Malmgren.*

NICOLEA ZOSTERICOLA *Malmgren.*

MALMGREN. Nord. Hofs-Ann., p. 381, pl. xxvi, fig. 76. 1865.

Only two specimens were taken. Sandy bottom.

SCIONE *Malmgren.*

SCIONE LOBATA *Malmgren.*

MALMGREM. Nord. Hafs-Ann., p. 383, pl. xxiii, fig. 62. 1865.

Body dark red. Branchiæ greenish-yellow. Buccal segment dirty white, with narrow dorsal dark green band. Tentacles white, margins of canal of tentacles light brown.

Two specimens; 20 fathoms; rocks and shells.

THELEPUS (*Leuckart*) *Malmgren.*

THELEPUS CINCINNATUS *Malmgren.*

Lumora flava STIMPSON. Grand Manan, p. 30. 1854.
Thelepus cincinnatus MALMGREN. Nord. Hafs-Ann., p. 387, pl. xxii, fig. 58. 1865.
Thelepus cincinnatus VERRILL. Check List. 1879.

Very common from half tide to any depth; wherever there are stones, shells, &c., to which its tubes can be attached.

EREUTHO *Malmgren.*

EREUTHO SMITTI *Malmgren.*

MALMGREN. Nord. Hafs-Ann., p. 391, pl. xxiii, fig. 63. 1865.

Rare; sand and mud; 6 to 12 fathoms.

POLYCIRRUS *Grube.*

POLYCIRRUS ? PHOSPHOREUS *Verrill.*

VERRILL. Proc. U. S. National Museum, p. 181. 1879.

We found only one species of Polycirrus. It seems probable that it ought to be included in Verrill's species. However, it was not especially phosphorescent, and the number of segments bearing capillary setæ varied from 21–34.

Very common from low water to 30 fathoms; mud and sandy mud.

ARTACAMA *Malmgren.*

ARTACAMA PROBOSCIDEA *Malmgren.*

MALMGREN. Nord. Hafs-Ann., p. 394, pl. xxiii, fig. 60. 1865.

In looking over a collection of Annelids made at Eastport in 1869, we found a single specimen of this species. None were taken in 1880.

TRICHOBRANCHUS *Malmgren.*

TRICHOBRANCHUS GLACIALIS *Malmgren.*

Our specimens probably belong to Malmgren's species; still they did not have the ocular spots described by him.

Branchiæ, in length, three times the width of the body. Anterior segments dark red; the rest of the body yellowish-white.

Rare; sandy mud, 6–12 fathoms.

TEREBELLIDES *Sars.*

TEREBELLIDES STROEMI *Sars.*

SARS. Beskriv. og Jakttag., p. 48, pl. 13, f. 31 a-d. (*teste* Malmgren).
MALMGREN. Nord. Hafs-Ann., p. 396, pl. xx, fig. 48. 1865.

Very common; sand and mud, 10–30 fathoms.

Family SABELLIDÆ

SABELLA (*L.*) *Malmgren.*

SABELLA SPITZBERGENSIS *Malmgren.*

MALMGREN. Nord. Hafs-Ann., p. 399, pl. xxix, fig. 93. 1865.

Not common; low water to 30 fathoms.

POTAMILLA *Malmgren.*

POTAMILLA RENIFORMIS *Malmgren.*

Potamilla reniformis MALMGREN. Ann. Polych., p. 114, pl. xiii, fig. 77. 1867.

Common on rocky and shelly bottoms.

OTHONIA *Johnston.*

OTHONIA FABRICII *Johnston.*

Fabricia stellaris BLAINVILLE. Dict. Sc. Natur., t, 57, p. 439 (*teste* Malmgren).
Othonia Fabricii JOHNSTON. Catal. British Museum, p. 274. 1865.
Amphicora Fabrica MALMGREN. Ann. Polych., p. 117. 1867.

Common; low water to 30 fathoms, mud.

MYXICOLA (*Koch*) *Malmgren.*

MYXICOLA STEENSTRUPI *Kröyer.*

KRÖYER. Om Sabellerne, p. 35. 1856.
MALMGREN. Nords. Hafs-Ann, p. 409, pl. xxix, f. 90. 1865.

Rocks, low water to 30 fathoms.

Family SERPULIDÆ.

FILIGRANA *Oken.*

FILIGRANA IMPLEXA *Berkley.*

BERKLEY. Zool. Journ., v, p. 427. 1832–1834 (*teste* Mörch).

Common; rocks and shells, 18–30 fathoms.

Several species of *Spirorbis* were collected and partially studied, but in some way they have all disappeared from the collection. The same is the case with *Vermilia serrula* Stimpson.

EXPLANATION OF PLATES.

PLATE I.

EULALIA BILINEATA *n. sp.*

FIG. 1.—Head and anterior segments, × 35.
2.—Transverse section; anterior view, × 35.
3.—Middle foot, × 35.

ETEONE TRILINEATA *n. sp.*

FIG. 5.—Head and anterior segments, × 60.
6.—Posterior segments, × 60.
7.—Anterior feet, × 60.
8.—Posterior foot, × 60.

MYSTIDES VIRIDIS *n. sp.*

FIG. 10.—Head and anterior segments (without setæ), × 115.
11.—Transverse section, × 60.
13.—Posterior segments, × 115.

PODARKE ABERRANS *n. sp.*

FIG. 14.—Foot of adult from below, × 125.
15.—Posterior segments; adult, × 65.
16.—Head and anterior segments; young, × 65.
17.—Posterior segments; young, × 65.
18.—Transverse section middle; young, × 65.

GYPTIS VITTATA *n. sp.*

FIG. 21.—Head and anterior segments, × 65.
22.—Transverse section from behind, × 65.

PLATE II.

EULALIA BILINEATA *n. sp.*

FIG. 4.—Seta, × 500.

ETEONE TRILINEATA *n. sp.*

FIG. 9.—Seta, × 850.

MYSTIDES VIRIDIS *n. sp.*

FIG. 12.—Seta, × 850.

PODARKE ABERRANS *n. sp.*

FIG. 19.—Dorsal seta; young, × 850.
20.—Ventral seta; young, × 850.

GYPTIS VITTATA *n. sp.*

FIG. 23.—Ventral seta, × 850.

STREPTOSYLLIS VARIANS *n. sp.*

FIG. 24.—Head and anterior segments, × 65.
25.—Anterior foot, × 115.
26.—Middle foot; female, × 115.
27.—Middle foot; male, × 115.
28.—Seta of anterior segments, × 850.
29.—Seta showing the four terminal points of stem, × 850.
30.—Seta showing ordinary length of appendix, × 850.
31.—Simple seta, × 850.

PÆDOPHYLAX BREVICORNIS *n. sp.*

FIG. 40.—Head and anterior segments, × 65.
41.—Transverse section; middle segment, × 65.

AUTOLYTUS SOLITARIUS *n. sp.*

FIG. 51.—Head and tentacular cirri ♂, × 20.

PLATE III.

STREPTOSYLLIS VARIANS *n. sp.*

FIG. 32.—Acicula, × 500.
33.—Palpus, from below, × 130.
34 *a–h*.—Moniliform dorsal cirri, × 130.

SPHÆROSYLLIS LONGICAUDA *n. sp.*

FIG. 35.—Head and first two segments, × 130.
36.—Posterior segments, × 130.
37.—Middle segment, transverse section, × 130.
38.—Upper compound seta, × 850.
39.—Lower compound seta, × 850.

PÆDOPHYLAX BREVICORNIS *n. sp.*

FIG. 42.—Lower compound seta, × 850.
43.—Upper compound seta, × 850.
44 and 45.—Simple setæ, × 850.

PÆDOPHYLAX LONGICIRRIS *n. sp.*

EIG. 46.—Head and anterior segments, × 75.
47.—Transverse section, middle of body, × 75.
48.—Long compound seta, × 850.
49.—Short compound seta, × 850.
50.—Simple seta with terminal hook and spine, × 850.

PLATE IV.

AUTOLYTUS SOLITARIUS *n. sp.*

FIG. 52.—Eighth foot dorsal view ♂, × 75.
53.—Eighth foot ventral view, ♂, × 75.
54.—Third foot dorsal view, ♂, × 75.

LUMBRINEREIS ACICULARUM *n. sp.*

FIG. 55.—Upper jaw pieces, magnified.
56—Lower jaw pieces, magnified.
57.—Twelfth foot, × 20.
58.—Middle foot, × 20.
59.—Posterior segments, × 20.

DRILONEREIS MAGNA *n. sp.*

FIG. 60.—Foot, magnified.
61.—Seta, magnified.
62.—Upper jaw pieces, magnified.
63.—Lower jaw pieces, magnified.

EPHESIA MINUTA *n. sp.*

FIG. 64.—Anterior foot; dorsal view, × 150.
65.—Middle foot; ventral view, × 150.
66.—Anterior setæ, × 500.

PLATE V.

ZORUS SARSI *n. g.*, *n. sp.*

FIG. 67.—Middle segment; transverse section, × 30.

SIPHONOSTOMUM GRUBEI *n. sp.*

FIG. 68.—Segment; transverse section, × 30.
69.—Short capillary seta, × 500.
70 and 71.—Compound uncinate setæ, × 500.

BRADA GRANOSA *Stimpson.*

FIG. 72.—Portion of transverse section showing rami and dorsal papillæ, × 30.
73.—Dorsal seta; outer half, × 150.
74 and 75.—Ventral setæ; outer half, × 150.
76.—Head of young specimen, enlarged.

PLATE VI.

ETHOCLES TYPICUS, *n. g.*, *n. sp.*

FIG. 77.—Transverse section one-half, second setigerous segment, × 40.
78.—Transverse section one-half, fourth setigerous segment, × 40.
79.—Transverse section one-half, fifth setigerous segment, × 40.
80.—Transverse section one-half, seventh setigerous segment, × 40.
81.—Transverse section one-half, eighth setigerous segment, × 40.
82.—Transverse section one-half, ninth setigerous segment, × 40.
83.—Foot and branchia, middle segment, × 40.
84.—Setæ, anterior, × 250.
85.—Setæ, after seventh segment, × 250.

SPIONIDES CIRRATUS *n. g.*, *n. sp.*

FIG. 86.—Branchiated segment, × 30.
87.—Segment just back of the branchiated segment from above, × 30.
88.—Posterior segment (smaller specimen), × 120.
89.—Uncini, × 850.

NAIDONEREIS QUADRICUSPIDA *Blainv*

FIG. 90.—Forked seta from lower part of dorsal ramus, × 400
91.—Seta from anterior segment, lower ramus, × 400.
92.—Aciculæ, ventral ramus, × 400.

PLATE VII.

ARICIDEA QUADRILOBATA *n. sp.*

FIG. 93.—Head and anterior segments, × 40.
94.—Branchiated segments, × 40.
95.—Segment just back of branchiated segment, × 40.
96.—Segment from posterior third, × 40.

ARICIDEA NOLANI *n. sp.*

FIG. 97.—Head and anterior segments, × 70.
98.—Branchiated segment, × 70.

THARYX ACUTUS *n.g., n. sp.*

FIG. 99.—Head and anterior segments, × 70.
100.—Anterior segment, transverse section, × 40.
101.—Middle segment, transverse section, × 40.
102.—Segment from posterior third, × 40
103.—Segment near posterior end, × 40.

THARYX SIMILIS *n. sp.*

FIG. 104.—Anterior segment, transverse section, × 40.

PLATE VIII.

COSSURA LONGOCIRRATA *n. g., n. sp.*

FIG. 105.—Head and anterior segments, with cirrus, × 70.
106.—Segment from anterior third, transverse section, × 70.
107.—Segment from posterior half, × 70.

LEDON SEXOCULATA *n. g., n. sp.*

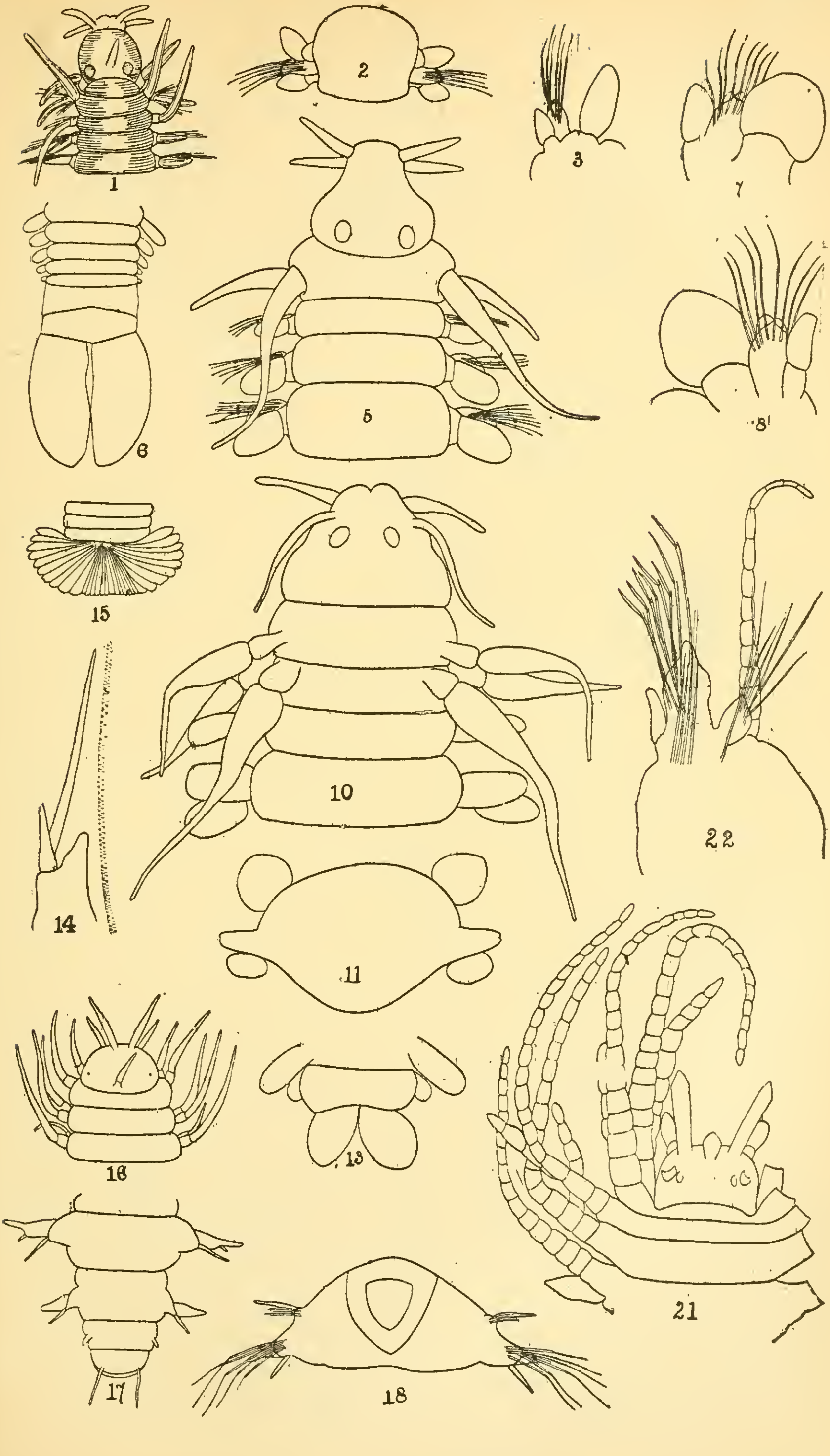
FIG. 108.—Ventral setæ, × 150.
109.—Dorsal seta, × 150.

AMPHARETE CIRRATA *n. sp.*

FIG. 110.—Torus from 10th setigerous segment, seen obliquely from above, × 30.
111.—Torus from 16th setigerous segment, × 30.
112.—Torus from 20th setigerous segment, × 30.

TAPHUS HEBES *n. g., n. sp.*

FIG. 113.—Head and anterior segments, × 120.
114.—Head, lower surface showing palpi and peculiar lobes on anterior margin of first segment, × 120.
115.—Œsophagus and stomach with jaws, × 130.
116.—Ventral ramus, × 75.
117.—Dorsal seta, × 500.
118.—Ventral seta outer end, × 500.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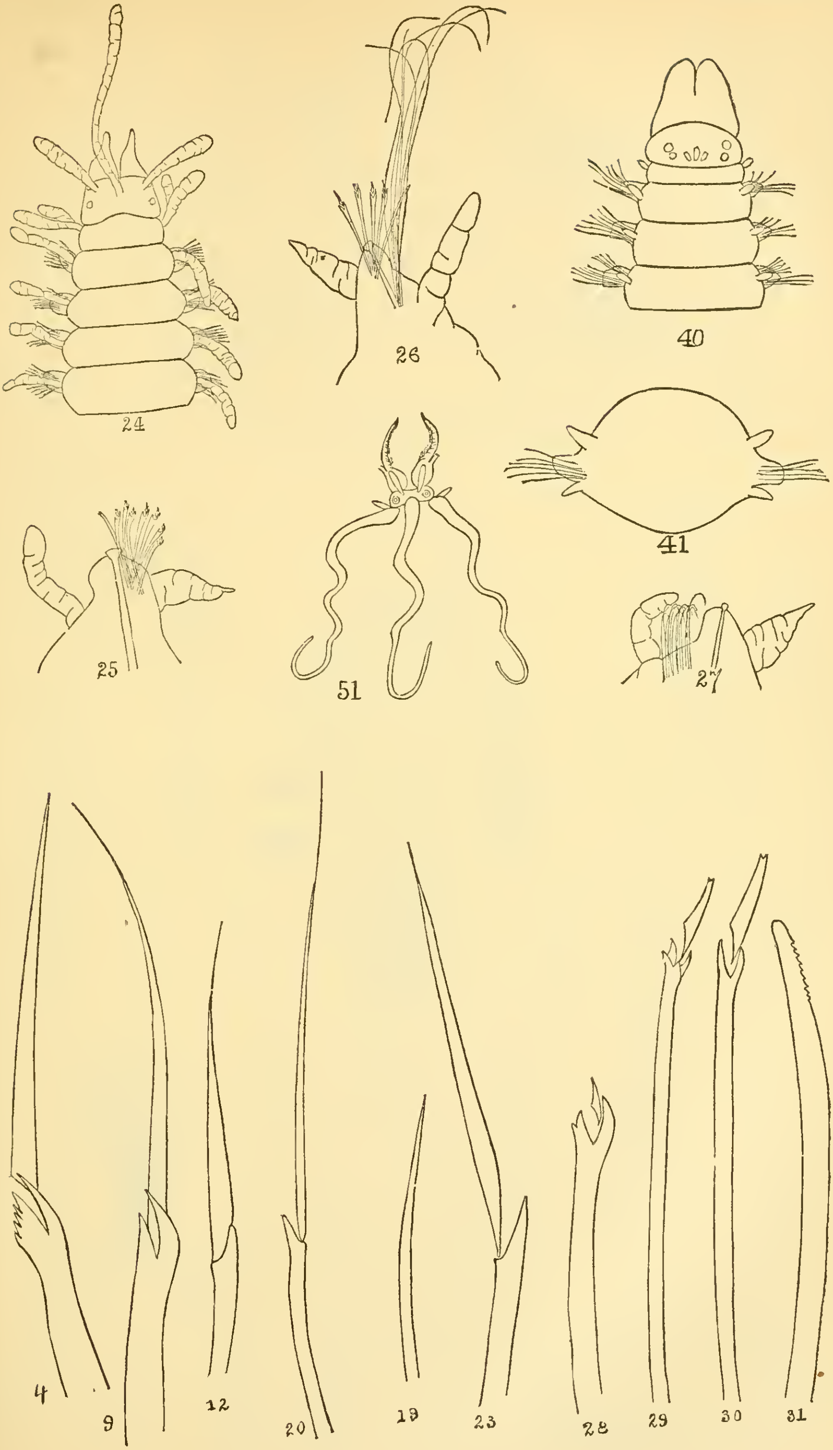
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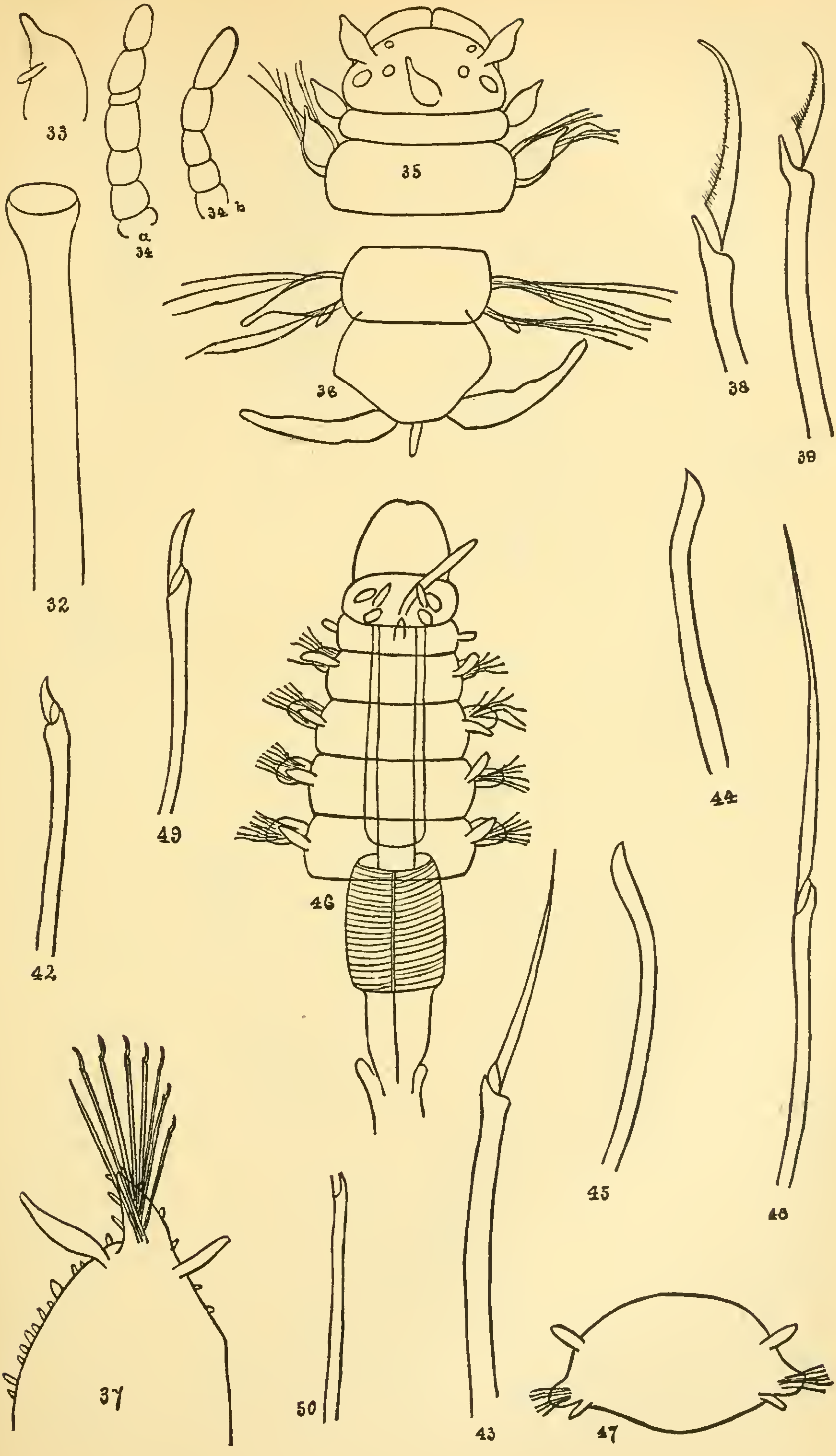
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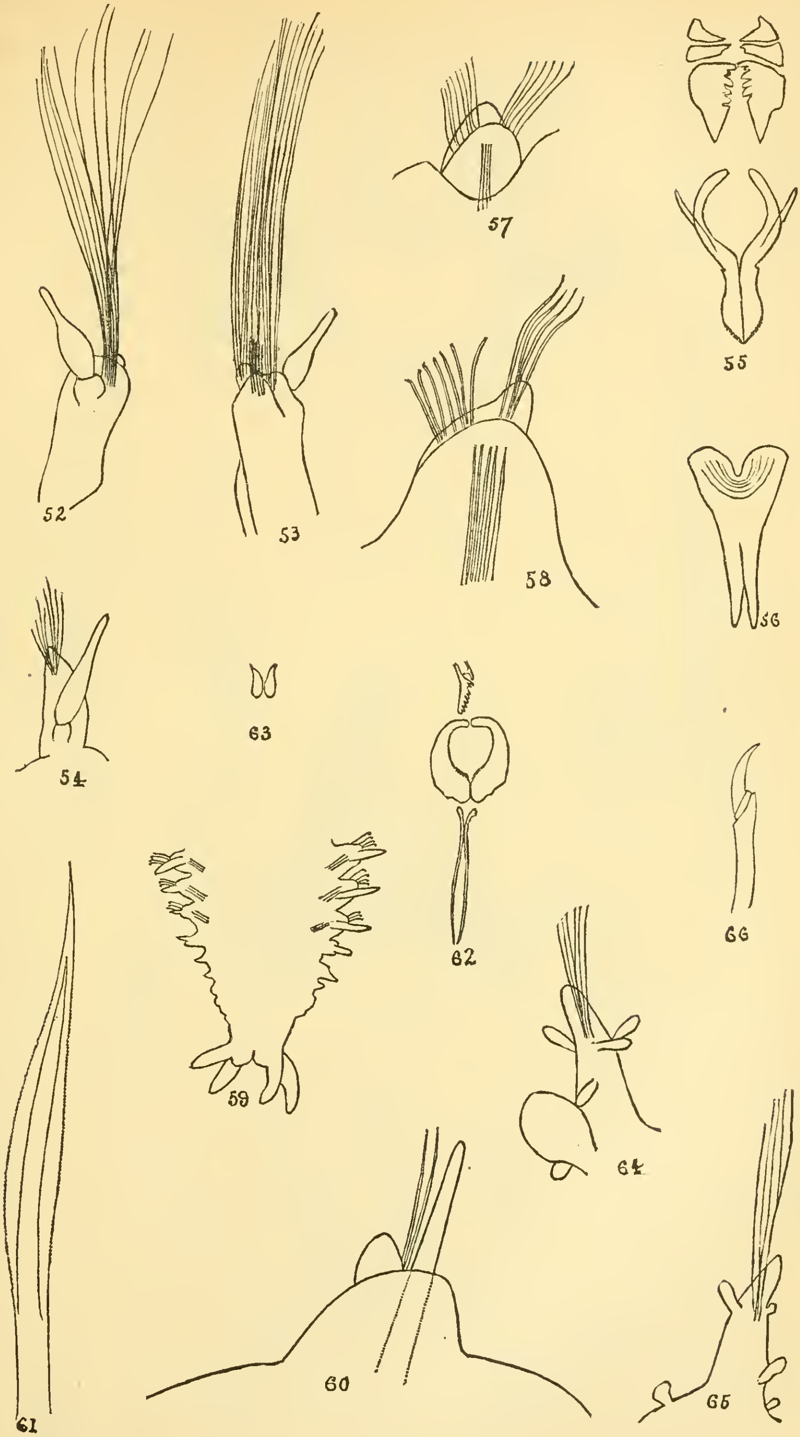
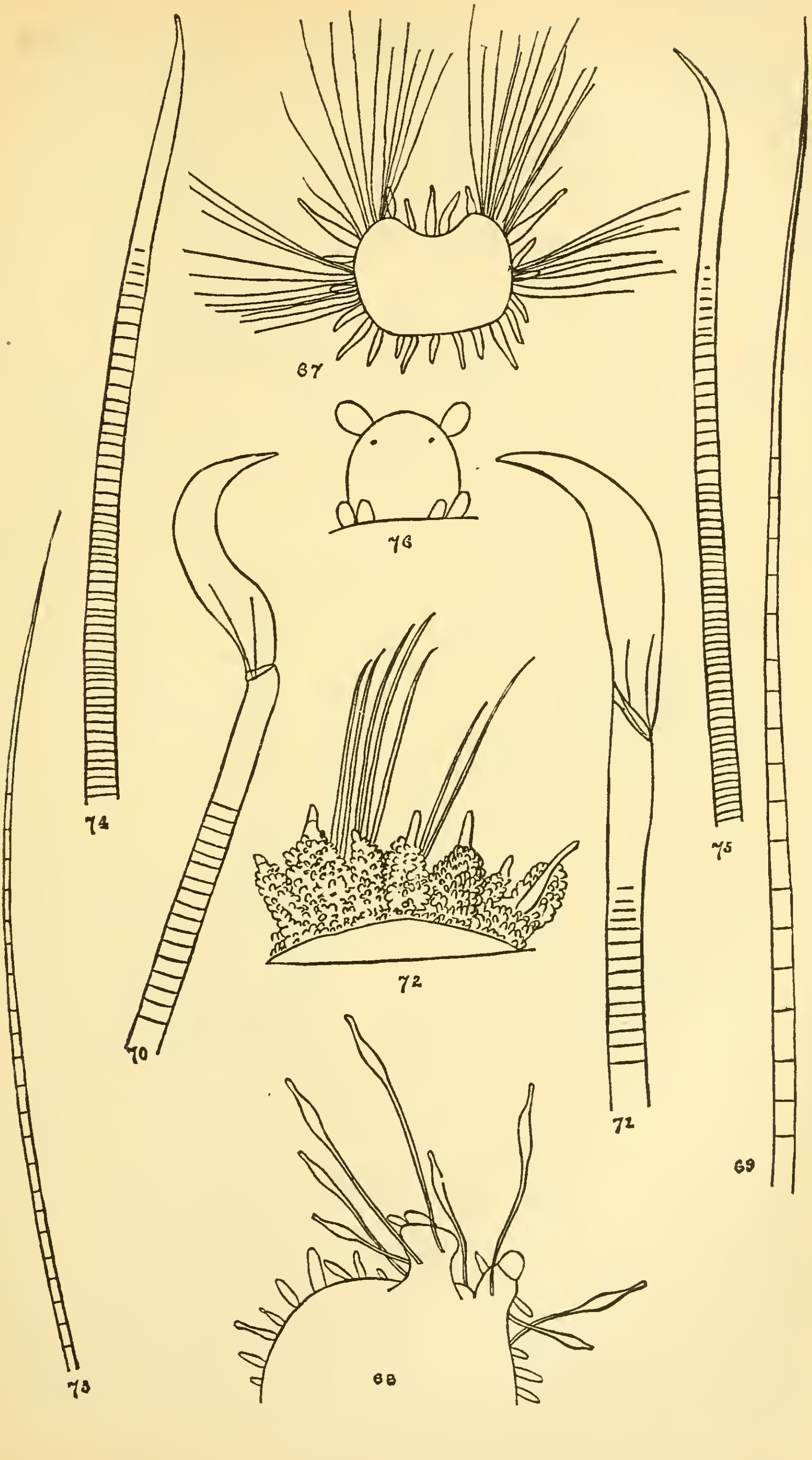
PLATE IV.

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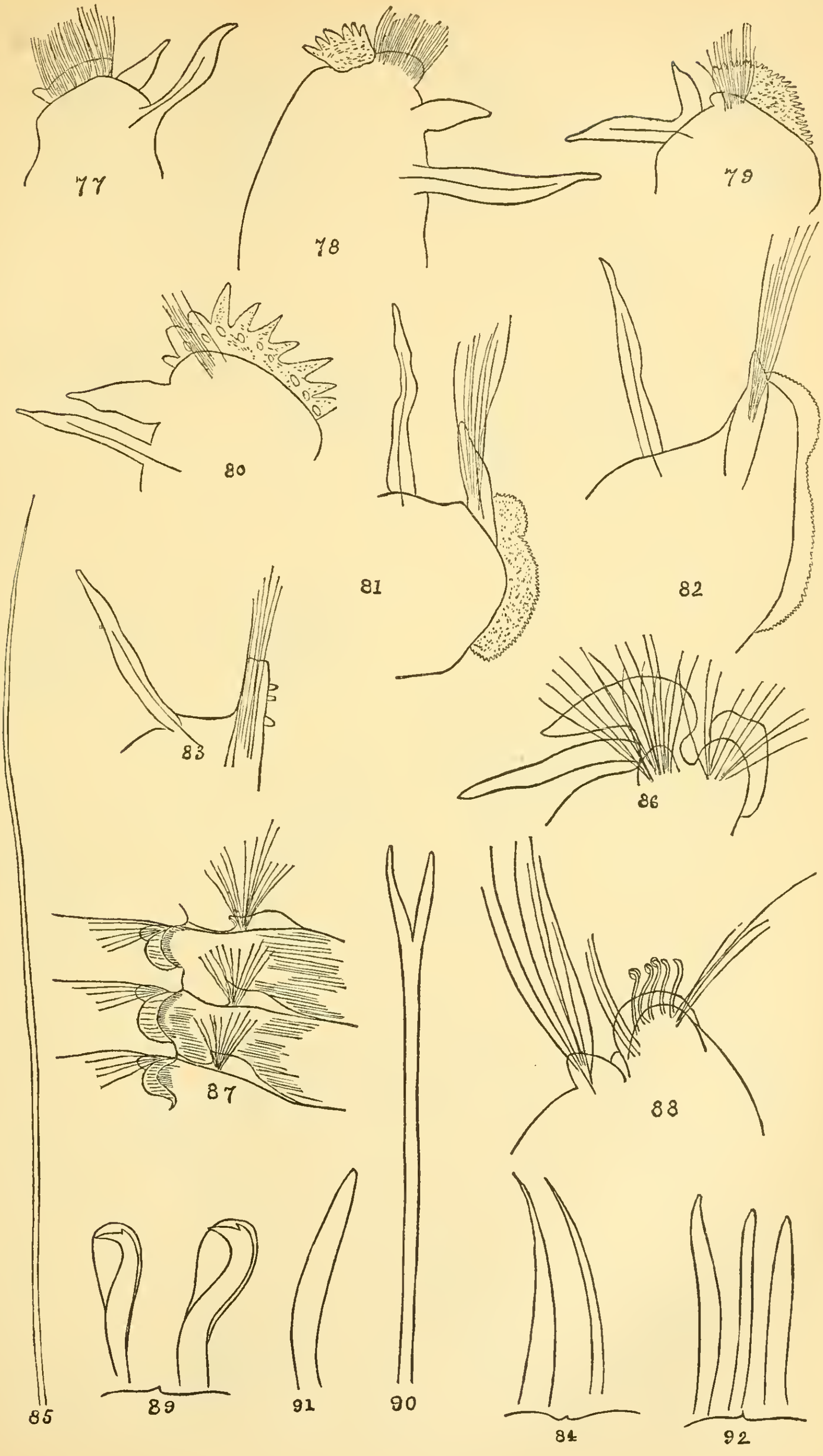
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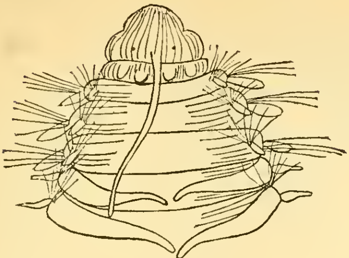

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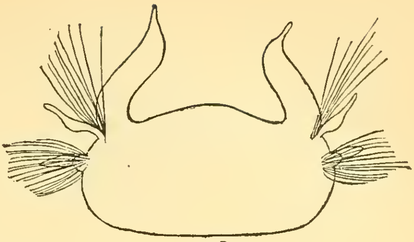

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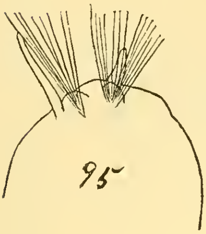

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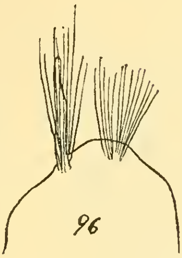

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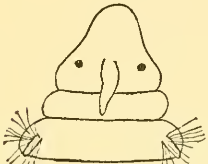

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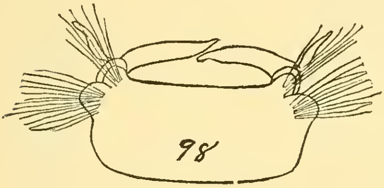

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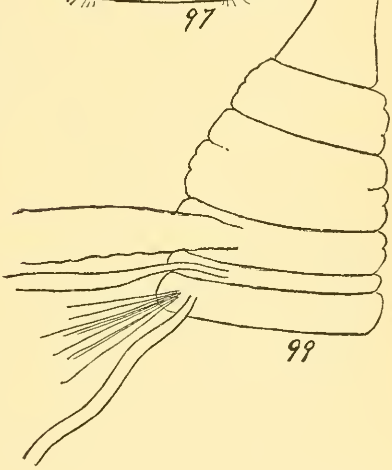

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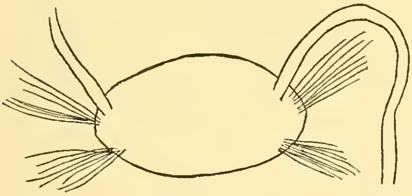

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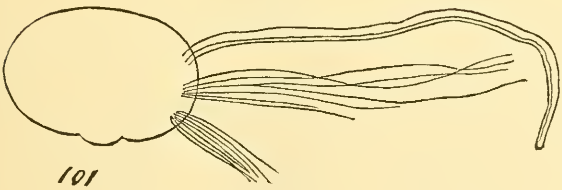

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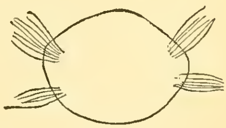

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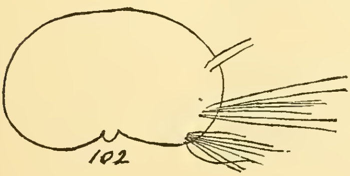

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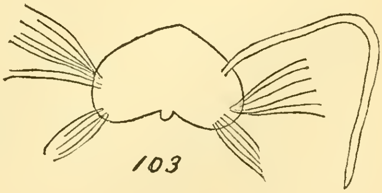

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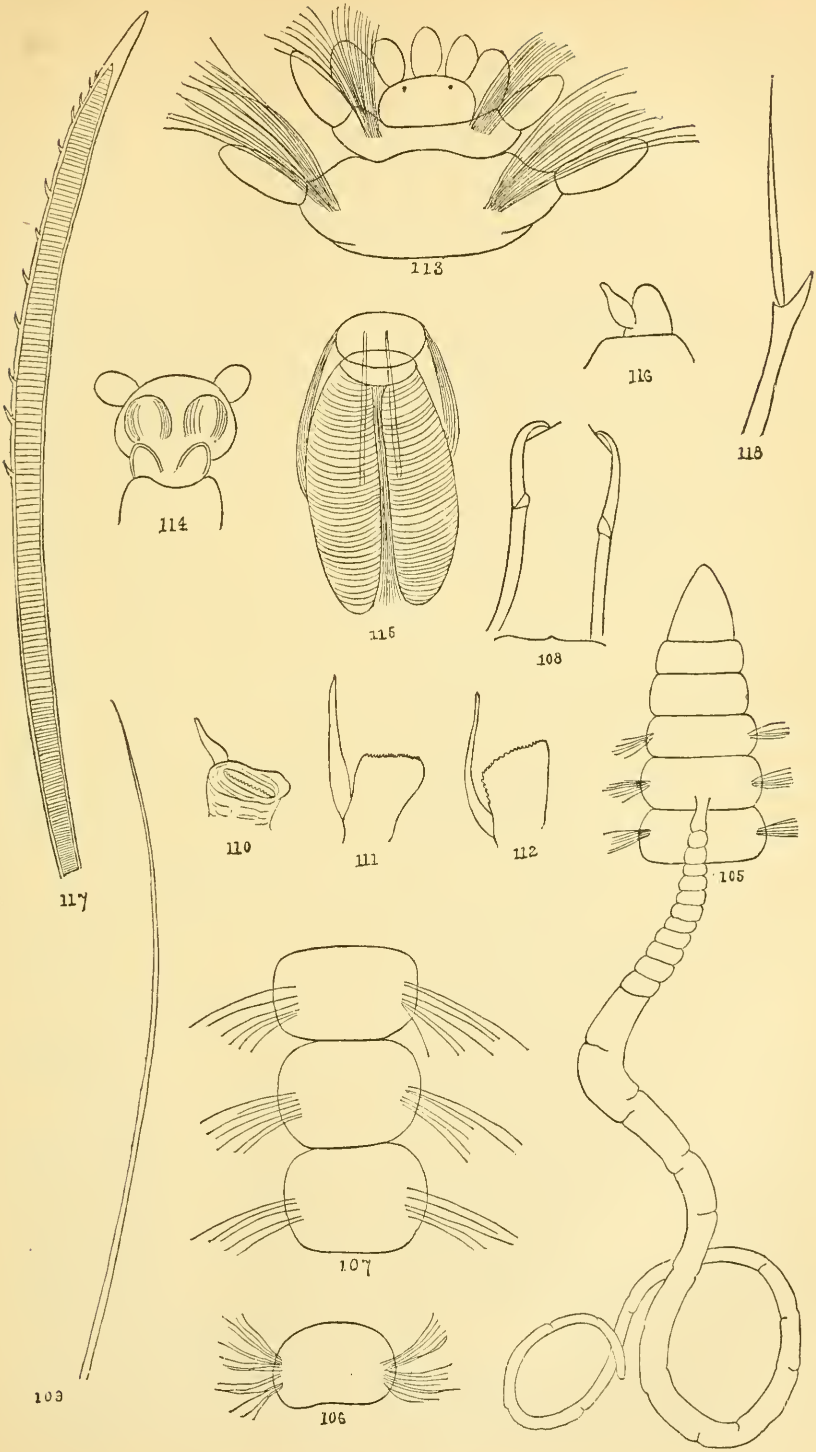
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XXIII.—ON THE NOMENCLATURE, ORIGIN, AND DISTRIBUTION OF DEEP-SEA DEPOSITS.

By John Murray and A. Renard.

[A paper read before the Royal Society of Edinburgh.]

The sea is unquestionably the most powerful dynamic agent on the surface of the globe, and its effects are deeply imprinted on the external crust of our planet; but among the sedimentary deposits which are attributed to its action, and among the effects which it has wrought on the surface features of the earth, the attention of geologists has, till within quite recent times, been principally directed to the phenomena which take place in the immediate vicinity of the land. It is incontestable that the action of the sea along coast and in shallow water has played the largest part in the formation and accumulation of those marine sediments which, so far as we can observe, form the principal strata of the solid crust of the globe; and it has been from an attentive study of the phenomena which take place along the shores of modern seas that we have been able to reconstruct in some degree the conditions under which the marine deposits of ancient times were laid down.

Attention has been paid only in a very limited degree to deposits of the same order, and, for the greater part, of the same origin, which differ from the sands and gravels of the shores and shallow waters only by a lesser size of the grains, and by the fact that they are laid down at a greater distance from the land and in deeper water. And still less attention has been paid to those true deep-sea deposits which are only known through systematic submarine investigations. One might well ask what deposits are now taking place, or have in past ages taken place, at the bottom of the great oceans at points far removed from land, and in regions where the erosive and transporting action of water has little or no influence. Without denying that the action of the tidal waves can, under certain special conditions, exert an erosive and transporting power at great depths in the ocean, especially on submerged peaks and barriers, it is none the less certain that these are exceptional cases, and that the action of waves is almost exclusively confined to the coasts of emerged land. There are in the Pacific immense stretches of thousands of miles where we do not encounter any land, and in the Atlantic we have similar conditions. What takes place in these vast regions where the waves exercise no mechanical action on any solid object? We are about to answer this question by reference to the facts which an examination of deep-sea sediments has furnished.

A study of the sediments recently collected in the deep sea shows that their nature and mode of formation, as well as their geographical and bathymetrical distribution, permit deductions to be made which have a great and increasing importance from a geological point of view. In making known the composition of these deposits and their distribution, the first outlines of a geological map of the bottom of the ocean will be sketched.

This is not the place to give a detailed history of the various contributions to our knowledge of the terrigenous deposits in deep water near land, or of those true deep-sea deposits far removed from land, which may be said to form the special subject of this communication. From the time of the first expeditions undertaken with a view of ascertaining the depth of the ocean, small quantities of mud have been collected by the sounding lead and briefly described. We may recall in this connection the experiments of Ross and the observations of Hooker and Maury.

These investigations, made with more or less imperfect appliances, immediately fixed the attention, without, however, giving sufficient information on which to establish any general conclusions as to the nature of the deposits or their distribution in the depths of the sea.

When systematic soundings were undertaken with a view of establishing telegraphic communication between Europe and America, the attention of many distinguished men was directed to the importance, in a biological and geological sense, of the specimens of mud brought up from great depths. The observations of Wallich, Huxley, Agassiz, Baily, Pourtalès, Carpenter, Thomson, and many others, while not neglecting mineralogical and chemical composition, deal with this only in a subordinate manner. The small quantities of each specimen at their command, and the limited areas from which they were collected, did not permit the establishment of any general laws as to their composition or geographical and bathymetrical distribution. These early researches, however, directed attention to the geological importance of deep-sea deposits, and prepared the way for the expeditions organized with the special object of a scientific exploration of the great ocean basins.

The expedition of the Challenger takes the first rank in these investigations. During that expedition a large amount of material was collected and brought to England for fuller study under the charge of Mr. Murray, who has in several preliminary papers pointed out the composition and varieties of deposits which are now forming over the floor of the great oceans. In order to arrive at results as general as possible, it was resolved to investigate the subject from the biological, mineralogical, and chemical points of view, and M. Renard was associated with Mr. Murray in the work. In addition to the valuable collections and observations made by the Challenger, we have had for examination material collected by other British ships, such as the Porcupine, Bulldog, Valorous, Nassau, Swallow, Dove; and, through Professor Mohn, by the Norwegian North Atlantic expedition. Again, through the liberality of the United States Coast Survey and Mr. Agassiz, the material amassed in the splendid series of soundings taken by the American ships Tuscarora, Blake, and Gettysburg, were placed in our hands. The results at which we have arrived may therefore be said to have been derived from a study of all the important available material.

The work connected with the examination and description of these large collections is not yet completed, but it is sufficiently advanced to permit some general conclusions to be drawn which appear to be of considerable importance. In addition to descriptions and results, we shall briefly state the methods we have adopted in the study. All the details of our research will be given in the report on the deep-sea deposits in the Challenger series, which will be accompanied by charts indicating the distribution, plates showing the principal types of deposits as seen by the microscope, and numerous analyses giving the chemical composition and its relation to the mineralogical composition. The description of each sediment will be accompanied by an enumeration of the organisms dredged with the sample, so as to furnish all the biological and mineralogical information which we possess on deep-sea deposits, and finally, we shall endeavor to establish general conclusions which can only be indicated at present.

Before entering on the subject, we believe it right to point out the difficulties which necessarily accompany such a research as the one now under consideration, difficulties which arise often in part from the small quantity of the substance at our disposal, but also from the very nature of the deposit. Since we have endeavored to determine, with great exactitude, the composition of the deposit at any given point, we have, whenever possible, taken the sample collected in the sounding-tube. That procured by the trawl or dredge, although usually much larger, is not considered so satisfactory on account of the washing and sorting to which the deposit has been subjected while being hauled through a great depth of water. We have, however, always examined carefully the contents of these instruments, although we do not think the material gives such a just idea of the deposit as the sample collected by the sounding-tube. The material collected by the last-named instrument has been taken as the basis of our investigations, although the small quantity often gives to it an inherent difficulty. It was the small quantity of substance collected by the sounding-tube in early expeditions which prevented the first observers from arriving at any definite results, but when such small samples are supplemented by occasional large hauls from the dredge or trawl, they become much more valuable and indicative of the nature of the deposit as a whole. Not only the scantiness of the material, but the small size of the grains, which in most instances make up deep-sea deposits, render the determinations difficult. In spite of the improvements recently effected in the microscopical examination of minerals, it is impossible to apply all the optical resources of the instrument to the determination of the species of extremely fine, loose, and fractured particles. Again, the examination of these deposits is rendered difficult by the presence of a large quantity of amorphous mineral matter, and of shells, skeletons, and minute particles of organic origin. It is also to be observed that we have not to deal with pure and unaltered mineral fragments, but with particles upon which the chemical action of the sea has wrought great changes, and more or less destroyed their distinctive characters.

What still further complicates these researches is the endeavor to discover the origin of the heterogeneous materials which make up the deposits. These have been subjected to the influence of a great number of agents, of some of which our knowledge is to a great extent still in its infancy. We must take into account a large number of agents and processes, such as ocean currents; the distribution of temperature in the water at the surface and at the bottom; the distribution of organisms as dependent on temperature and specific gravity of the water; the influence of aerial currents; the carrying power of rivers; the limit of transport by waves; the eruptions of aerial and submarine volcanoes; the effect of glaciers in transporting mineral particles, and, when melting, influencing the specific gravity of the water, which in turn affects the animal and plant life of the surface. It is necessary to study the chemical reactions which take place in great depths; in short, to call to our aid all the assistance which the physical and biological sciences can furnish. It will thus be understood that the task, like all first attempts in a new field, is one of exceptional difficulty, and demands continued effort to carry it to a successful issue.

In presenting a short résumé of our methods, of the nomenclature we have adopted, and of the investigation into the origin of the deposit in the deep sea and deeper parts of the littoral zones, we offer it as a sketch of our research, prepared to modify the arrangements in any way which an intelligent criticism may suggest.

Before proceeding to a description of methods and of the varieties of deposits, with their distribution in modern ocean, we will briefly enumerate the materials which our examination has shown to take part in the formation of these deposits, state the origin of the material, and the agent concerned in their deposition, distribution, and modification.

MATERIALS.—The materials which unite to form the deposits which we have to describe may be divided into two groups, viewed in relation to their origin, viz, mineral and organic.

The mineral particles carried into the ocean have a different form and size, according to the agents which have been concerned in their transport. Generally speaking, their size diminishes with distance from the coast, but here we limit our remarks to the mineralogical character of the particles. We find isolated fragments of rocks and minerals coming from crystalline and schisto-crystalline series, and from the clastic and sedimentary formations; according to the nature of the nearest coasts they belong to granite, diorite, diabase, porphyry, &c.; crystalline schists, ancient limestones, and sedimentary rocks of all geological ages, with the minerals which come from their disintegration, such as quartz, monoclinic and triclinic feldspars, hornblende, augite, rhombic pyroxene, olivine, muscovite, biotite, titanic and magnetic iron, tourmaline, garnet, epidote, and other secondary minerals. The trituration and decomposition of these rocks and minerals give rise to materials more or less amorphous and without distinctive characters, but the origin of which is indicated by association with the rocks and minerals just mentioned.

Although the *débris* of continental land to which we have just referred plays the most important *rôle* in the immediate vicinity of shores, yet our researches show beyond doubt that when we pass out towards the central parts of the great ocean basins, the *débris* of continental rocks gradually disappears from the deposits, and its place is taken by materials derived from modern volcanic rocks, such as basalts, trachytes, augite-andesites, and vitreous varieties of these lithological families, for instance, pumice, and loose, incoherent, volcanic particles of recent eruptions, with their characteristic minerals. All these mineral substances being usually extremely fine or areolar in structure, are easily attacked by the sea water at the place where they are deposited. This chemical action brings about an alteration of the minerals and vitreous fragments, which soon passes into complete decomposition, and in special circumstances gives rise to the formation of secondary products. In some places the bottom of the sea is covered with deposits due to this chemical action, principal among which is clayey matter, associated with which there are often concretions composed of manganese and iron. In other regions the reactions which result in the formation of argillaceous matter from volcanic products give rise also to the formation of zeolites.

Among other products arising from chemical action, probably combined with the activity of organic matter, may be mentioned the formation of glauconite and phosphatic nodules, with, in some rare and doubtful examples, the deposition of silica. The decomposition of the tissues, shells, and skeletons of organisms adds small quantities of iron, fluorine, and phosphoric acid to the inorganic constituents of the deep-sea deposits.

Finally, we must mention extra-terrestrial substances in the form of cosmic dust.

We now pass to the consideration of the *rôle* played by organisms in the formation of marine deposits. Organisms living at the surface of the ocean, along the coasts, and at the bottom of the sea are continually extracting the lime, magnesia, and silica held in solution in sea water. The shells and skeletons of these, after the death of the animals and plants, accumulate at the bottom and give rise to calcareous and siliceous deposits. The calcareous deposits are made up of the remains of coccospheres, rhabdospheres, pelagic and deep-sea Foraminifera, pelagic and deep-sea Mollusks, Corals, Alcyonarians, Polyzoa, Echinoderms, Annelids, Fish, and other organisms. The siliceous deposits are formed principally of frustules of Diatoms, skeletons of Radiolarians, and spicules of Sponges.

While the minute pelagic and deep-sea organisms above mentioned play by far the most important part in the formation of deep-sea deposits, the influence of vertebrates is recognizable only in a very slight degree in some special regions by the presence of large numbers of sharks' teeth and the ear bones and a few other bones of whales. The otoliths of fish are usually present in the deposits, but, with the exception of two vertebræ and a scapula, no other bones of fish have been detected in the large amount of material we have examined.

Agents.—Having passed in review the various materials which go to the formation of deposits in the deep water immediately surrounding the land and in the truly oceanic areas, attention must now be directed to the agents which are concerned in the transport and distribution of these, and to the sphere of their action. The relations existing between the organic and inorganic elements of deposits to which we have just referred, and the laws which determine their distribution, will be pointed out at the same time.

The fluids which envelop the solid crust of the globe are incessantly at work disintegrating the materials of the land, which, becoming loose and transportable, are carried away, sometimes by the atmosphere, sometimes by water, to lower regions, and are eventually borne to the ocean in the form of solid particles or as matter in solution. The atmosphere, when agitated, after having broken up the solid rock, transports the particles from the continents, and in some regions carries them far out to sea, where they form an appreciable portion of the deposit, as, for instance, off the west coast of North Africa and the southwest coast of Australia. Again, in time of volcanic eruptions, the dust and scoria which are shot into the air are carried immense distances by winds and atmospheric currents, and no small portion eventually falls into the sea.

Water is, however, the most powerful agent concerned in the formation and distribution of marine sediments. Running water corrodes the surface of the land and carries the triturated fragments down into the ocean. The waters of the ocean, in form of waves and tides, attack the coast and distribute the débris at a lower level. Independently of the action of the waves, there exists along most coasts currents, more or less constant, which have an effect in removing sand, gravel, and pebbles farther from their origin. Generally, terrestrial matters appear to be distributed by these means to a distance of one or two hundred miles from the coast. Waves and currents probably have no erosive or transporting power at depths greater than 200 or 300 fathoms, and even at such depths it is necessary that there should be some local and special conditions in order that the agitated water may produce any mechanical effect. However, it is not improbable that, by a peculiar configuration of the bottom and ridges among oceanic islands, the deposit on a ridge may be disturbed by the tidal wave even at 1,000 fathoms; and this may be the cause of the hard ground sometimes met with in such positions. By observations off the coast of France it has been shown that fine mud is at times disturbed at a depth of 150 fathoms; but while admitting that this is the case on exposed coasts, the majority of observations indicate that beyond 100 fathoms it is an oscillation of the water, rather than a movement capable of exerting any geological action, which concerns us in this connection.

Although the great oceanic currents have no direct influence upon the bottom, yet they have a very important indirect effect upon deposits, because the organisms which live in the warm equatorial currents form a very large part of the sediment being deposited there, and this in consequence differs greatly from the deposits forming in regions where the surface water is colder. In the same way a high or low specific gravity of the surface water has an important bearing on the animal and vegetable life of the ocean, and this in its turn affects the character of the deposits.

The thermometric observations of the Challenger show that a slow movement of cold water must take place in all the greater depths of the ocean from the poles, but particularly from the southern pole, towards the equator. It could be shown from many lines of argument that this extremely slow massive movement of the water can have no direct influence on the distribution of marine sediments.

Glaciers, which eventually became icebergs that are carried far out to sea by currents, transport detrital matter from the land to the ocean, and thus modify in the Arctic and Antarctic regions the deposits taking place in the regions affected by them. The detritus from icebergs in the Atlantic can be traced as far south as latitude 36° off the American coast, and in the southern hemisphere as far north as latitude 40°.

The fact that sea water retains fine matter in suspension for a much shorter time than fresh water should be referred to here as having an important influence in limiting the distribution of fine argillaceous and other materials borne down to the sea by rivers, thus giving a distinctive character to deposits forming near land.

We have pointed out the influence of the temperature and salinity upon the distribution of the surface organisms whose skeletons form a large part of some oceanic deposits, and may state also that the bathymetrical distribution of calcareous organisms is influenced by the chemical action of sea water. We will return to these influences presently when describing the distribution of the various kinds of deposits and their reciprocal relations, especially in those regions of the deep sea far removed from the mechanical action of rivers, waves, and superficial currents. The action of life as a geological agent has been indicated under the heading Materials.

METHODS.—We give here an example showing the order followed in describing the deposits examined:

Station 338; latitude 21° 15′ S., longitude 14° 2′ W.; March 21, 1876; surface temperature, 76°.5; bottom temperature, 36°.5; depth, 1,990 fathoms.

Globigerina ooze, white, with slightly rosy tinge when wet; granular, homogeneous, and very slightly coherent when dry; resembles chalk.

I. Carbonate of calcium, 90.38 per cent., consists of pelagic Foraminifera (80 per cent.); coccoliths and rhabdoliths (9 per cent.); Miliolas, Discorbinas, and other Foraminifera, Ostracode valves, fragments of Echini spines, and one or two small fragments of Pteropods (1.38 per cent.).

II. Residue, 9.62 per cent., reddish brown, consists of—

1. Minerals [1.62] m. di. 0.45^{mm}, fragments of feldspar, hornblende, magnetite, magnetic spherules, a few small grains of manganese, and pumice.

2. Siliceous organisms [1.00], Radiolarians, spicules of Sponges, and imperfect casts of Foraminifera.

3. Fine washings [7.00], argillaceous matter with small mineral particles and fragments of pumice and siliceous organisms.

The description of the deposits has been made upon this plan, which was adopted after many trials and much consideration. This is not the place to give the reasons which have guided us in adopting this mode of description, or to give in detail the methods that we have systematically employed for all the sediments which we are engaged in describing. These will be fully given in the introduction to our Challenger report. We limit ourselves here to explaining the meanings and arrangement of terms and abbreviations, so that the method may be understood and made available for others.

The description commences by indicating the kind of deposit (red clay, blue mud, Globigerina ooze, &c.), with the microscopic characters of the deposit, when wet or dry.

We have always endeavored to give a complete chemical analysis of the deposit, but when it was impossible to do this we have always determined the amount of carbonate of calcium. This determination was generally made by estimating the carbonic acid. We usually took a gram of a mean sample of the substance for this purpose, using weak and cold hydrochloric acid. However, as the deposits often contain carbonates of magnesia and iron as well, the results calculated by associating the carbonic acid with the lime are not perfectly exact, but these carbonates of magnesia and iron are almost always in a very small proportion, and the process is, we think, sufficiently accurate, for, owing to the sorting of the elements which goes on during collection and carriage, no two samples from the same station give exactly the same percentage. The number which follows the words "carbonate of calcium" indicates the percentage of $CaCO_3$; we then give the general designations of the principal calcareous organisms in the deposit.

The part insoluble in the hydrochloric acid, after the determination of the carbonic acid, is designated in our descriptions "residue." The number placed after this word indicates its percentage in the deposit; then follow the color and principal physical properties. This residue is washed and submitted to decantations, which separate the several constituents according to their density; these form three groups, (1) minerals, (2) siliceous organisms, (3) fine washings.

1. MINERALS.—The number within brackets indicates the percentage of particular minerals and fragments of rocks. This number is the result of an approximate evaluation, of which we will give the basis in our report. As it is important to determine the dimensions of the grains of minerals which constitute the deposit, we give, after the contraction *m. di.*, their mean diameter in millimeters. We give next the form of the grains, if they are rounded or angular, &c.; then the enumeration of the species of minerals and rocks. In this enumeration we have placed the minerals in the order of the importance of the *rôle* which they play in the deposit. The specific determinations have been made with the mineralogical microscope in parallel or convergent polarized light.

2. SILICEOUS ORGANISMS.—The number between brackets indicates the percentage of siliceous organic remains; we obtain it in the same manner as that placed after the word "minerals." The siliceous organisms and their fragments are examined with the microscope and determined. We have also placed under this heading the Glauconitic casts of the Foraminifera and other calcareous organisms.

3. FINE WASHINGS.—We designate by this name the particles which, resting in suspension, pass with the first decantation. They are about 0.04^{mm} or less in diameter. We have been unable to arrange this microscopic matter under the category of minerals, for, owing to its minute and fragmentary nature, it is impossible to determine the species. We have always found that the fine washings increase in quantity as the deposit passes to a clay, and it is from this point of view that the subdivision has its *raison d'être*. We often designate the lightest particles by the name argillaceous matter, but usually there are associated with this very small particles of indeterminable minerals and fragments of siliceous organisms. The number within brackets which follows the words "fine washings" is obtained in the same manner as those placed after "minerals" and "siliceous organisms."

These few words will suffice to render the descriptions intelligible. Greater details will be given, as already stated in the Challenger report.

It may be added that in the majority of cases we have solidified the sediments and formed them into thin slides for microscopic examination, and that at all times the examination by transmitted light has been carried on at the same time as the examination by reflected light. Each description is followed by notes upon the dredging or sounding, upon the animals collected, and a discussion of the analysis whenever a complete analysis has been made, which is always the case with typical samples of the deposits.

KINDS OF DEPOSITS.—We now proceed to the description of the various types of deposits into which it is proposed to divide the marine formations that are now taking place in the deeper water of the various oceans and seas. We will speak first of those which are met with in the deeper water of inland seas, and around the coasts of continents and islands, and afterwards of those which are found in the abysmal regions of the great oceans. Those coast formations which are being laid down on the shores, or in very shallow water, and which have been somewhat carefully described previous to the recent deep-sea explorations, are here neglected.

A study of the collections made by the Challenger and other expeditions shows—

(1.) That in the deeper water around continents and islands which are neither of volcanic nor coral origin, the sediments are essentially composed of a mixture of sandy and amorphous matter, with a few remains of surface organisms, to which we give the name of muds, and which may be distinguished microscopically by their color. We distinguish them by the names blue, red, and green muds.

(2.) Around volcanic islands the deposits are chiefly composed of mineral fragments derived from the decomposition of volcanic rocks. These, according to the size of the grains, are called volcanic muds or sands.

(3.) Near coral islands and along shores fringed by coral reefs the deposits are calcareous, derived chiefly from the disintegration of the neighboring reefs, but they receive large additions from shells and skeletons of pelagic organism, as well as from animals living at the bottom. These are named, according to circumstances, coral or coralline muds and sands.

Let us now see what are the chief characteristics of each of these deposits.

Blue mud is the most extensive deposit now forming around the great continents and continental islands and in all inclosed or partially inclosed seas. It is characterized by the slaty color which passes in most cases into a thin layer of a reddish color at the upper surface. These deposits are colored blue by organic matter in a state of decomposition and frequently give off an odor of sulphureted hydrogen. When dried a blue mud is grayish in color and rarely or never has the plasticity and compactness of a true clay. It is finely granular and occasionally contains fragments of rocks 2^{cm} in diameter; generally, however, the minerals, which are derived from the continents and are found mixed up with the muddy matter in these deposits, have a diameter of 0.5^{mm} and less. Quartz particles, often rounded, play the principal part; next come mica, feldspar, augite, hornblende, and all the mineral species which come from the disintegration of the neighboring lands, or the lands traversed by rivers which enter the sea near the place where the specimens have been collected. These minerals make up the principal and characteristic portion of blue muds, sometimes forming 80 per cent. of the whole deposit. Glauconite, though generally present, is never abundant in blue muds. The remains of calcareous organisms are at times quite absent, but occasionally they form over 50 per cent. The latter is the case when the specimen is taken at a considerable distance from the coast and at a moderate depth. These calcareous fragments consist of bottom-living and pelagic Foraminifera, Mollusks, Polyzoa, Serpulæ, Echinoderms, Alcyonarian-spicules, Corals, &c. The remains of Diatoms and Radiolarians are usually present. Generally speaking, as we approach the shore the pelagic organisms disappear, and, on the contrary, as we proceed seawards, the size of the mineral grains diminishes, and the remains of shore and coast organisms give place to pelagic ones, till finally a blue mud passes into a true deep-sea deposit. In those regions of the ocean affected with floating ice the color of these deposits becomes gray rather than blue at great distances from land, and is further modified by the presence of a greater or less abundance of glaciated blocks and fragments of quartz.

Green muds and sands.—As regards their origin, composition, and distribution near the shores of continental land, these muds and sands resemble the blue muds. They are largely composed of argillaceous matter and mineral particles of the same size and nature as in the blue muds. Their chief characteristic is the presence of a considerable quantity of glauconitic grains, either isolated or united into concretions. In the latter case the grains are cemented together by a brown argillaceous matter, and include, besides quartz, feldspar, phosphate of lime, and other minerals, more or less altered. The Foraminifera and fragments of Echinoderms and other organisms in these muds are frequently filled with glauconitic substance, and beautiful casts of these organisms remain after treatment with weak acid. At times there are few calcareous organisms in these deposits, and at other times the remains of diatoms and radiolarians are abundant. When these muds are dried they become earthy and of a gray-green color. They frequently give out a sulphureted hydrogen odor. The green color appears sometimes to be due to the presence of organic matter, probably of vegetable origin, and to the reduction of peroxide of iron to protoxide under its influence. The green sands differ from the muds only in the comparative absence of the argillaceous and other amorphous matter, and by the more important part played by the grains of glauconite, which chiefly give the green color to these sands.

Red muds.—In some localities, as for instance off the Brazilian coast of America, the deposits differ from blue muds by the large quantity of ochreous matter brought down by the rivers and deposited along the coast. The ferruginous particles when mixed up with the argillaceous matter give the whole deposit a reddish color. These deposits, rich in iron in the state of limonite, do not appear to contain any traces of glauconite, and have relatively few remains of siliceous organisms.

Volcanic muds and sands.—The muds and sands around volcanic islands are black or gray; when dried they are rarely coherent. The mineral particles are generally fragmentary, and consist of lapilli of the basic and acid series of modern volcanic rocks, which are scoriaceous or compact vitreous or crystalline, and usually present traces of alteration. The minerals are sometimes isolated, sometimes surrounded by their matrix, and consist principally of plagioclases, sanadin, amphibole, pyroxene, biotite, olivine, and magnetic iron; the size of the particles diminishes with distance from the shore, but the mean diameter is generally 0.5^{mm}. Glauconite does not appear to be present in these deposits, and quartz is also very rare or absent. The fragments of shells and rocks are frequently covered with a coating of peroxide of manganese. Shells of calcareous organisms are often present in great abundance, and render the deposit of a lighter color. The remains of Diatoms and Radiolarians are usually present.

Coral muds.—These muds frequently contain as much as 95 per cent. of carbonate of lime, which consist of fragments of Corals, calcareous Algæ, Foraminifera, Serpulæ, Mollusks, and remains of other lime-secreting organisms. There is a large amount of amorphous calcareous matter, which gives the deposit a sticky and chalky character. The particles may be of all sizes, according to the distance from the reefs, the mean diameter being 1 to 2^{mm}, but occasionally there are large blocks of coral and large calcareous concretions; the particles are white and red. Remains of siliceous organisms seldom make up over 2 or 3 per cent. of a typical coral mud. The residue consists usually of a small amount of argillaceous matter, with a few fragments of feldspar and other volcanic minerals; but off barrier and fringing reefs facing continents we may have a great variety of rocks and minerals. Beyond a depth of 1,000 fathoms off coral islands the *débris* of the reefs begins to diminish and the remains of pelagic organisms to increase; the deposit becomes more argillaceous, of a reddish or rose color, and gradually passes into a Globigerina ooze or red clay. Coral sands contain much less amorphous matter than coral muds, but in other respects they are similar, the sands being usually found nearer the reefs and in shallower water than the muds, except inside lagoons. In some regions the remains of calcareous algæ predominate, and in those cases the name coralline mud or sand is employed to point out the distinction.

Such is a rapid view of the deposits found in the deeper waters of the littoral zones, where the débris from the neighboring land plays the most important part in the formation of muds and sands.

When, however, we pass beyond a distance of about 200 miles from land, we find that the deposits are characterized by the great abundance of fragmentary volcanic materials which have usually undergone great alteration, and by the enormous abundance of the shells and skeletons of minute pelagic organisms which have fallen to the bottom from the surface waters. These true deep-sea deposits may be divided into those in which the organic elements predominate, and those in which the mineral constituents play the chief part. We shall commence with the former.

GLOBIGERINA OOZE.—We designate by this name all those truly pelagic deposits containing over 40 per cent. of carbonate of lime, which consists principally of the dead shells of pelagic *Foraminifera*, *Globigerina*, *Orbulina*, *Pulvinulina*, *Pullenia*, *Sphæroidina*, &c. In some localities this deposit contains 95 per cent. of carbonate of lime. The color is milky white, yellow, brown, or rose, the varieties of color depending principally on the relative abundance in the deposit of the oxides of iron and manganese. This ooze is fine grained ; in the tropics some of the Foraminifera shells are microscopic. When dried it is pulverulent. Analyses show that the sediment contains, in addition to carbonate of lime, phosphate and sulphate of lime, carbonate or magnesia, oxides of iron and manganese, and argillaceous matters. The residue is of a reddish brown tinge. Lapilli, pumice, and glassy fragments often altered into palagonite, seem always to be present, and are frequently very abundant. The mineral particles are generally angular, and rarely exceed 0.08^{mm} in diameter; monoclinic and triclinic feldspars, augite, olivine, hornblende, and magnetite are the most frequent. When quartz is present it is in the form of minute, rounded, probably wind-borne grains, often partially covered with oxide of iron. More rarely we have white and black mica, bronzite, actinolite, chromite, glauconite, and cosmic dust. Siliceous organisms are probably never absent, sometimes forming 20 per cent. of the deposit, at other times only recognizable after careful microscopic examination. In some regions the frustules of Diatoms predominate, in others the skeletons of Radiolarians.

The fine washings, viewed with the microscope, are not homogeneous. The greater part consists of argillaceous matter colored by the oxides of manganese. Mixed with this, we distinguish fragments of minerals with a diameter less than 0.05^{mm}, and minute particles of pumice can nearly always be detected. Fragments of Radiolarians, Diatoms, and siliceous spicules can always be recognized, and are sometimes very abundant.

PTEROPOD OOZE.—This deposit differs in no way from a Globigerina ooze except in the presence of a greater number and variety of pelagic organisms, and especially in the presence of Pteropod and Heteropod shells, such as *Diacria, Atlanta, Styliola, Carinaria*, &c. The shells of the more delicate species of pelagic Foraminifera and young shells are also more abundant in these deposits than in a Globigerina ooze. It must be remembered that the name "Pteropod ooze" is not intended to indicate that the deposit is chiefly composed of the shells of these mollusks, but as their presence in a deposit is characteristic and has an important bearing on geographical and bathymetrical distribution, we think it desirable to emphasize the presence of these shells in any great abundance. It may here be pointed out that there is a very considerable difference between a Globigerina ooze or a Pteropod ooze situated near continental shores and deposits bearing the same names situated towards the centers of oceanic areas, both with respect to mineral particles and remains of organisms.

DIATOM OOZE.—This ooze is of a pale straw color, and is composed principally of the frustules of Diatoms. When dry it is a dirty white siliceous flour, soft to the touch, taking the impression of the fingers, and contains gritty particles which can be recognized by the touch. It contains on an average about 25 per cent. of carbonate of lime, which exists in the deposit in the form of small Globigerina shells, fragments of Echinoderms and other organisms. The residue is pale white and slightly plastic; minerals and fragments of rocks are in some cases abundant; these are volcanic, or, more frequently, fragments and minerals coming from continental rocks and transported by glaciers. The fine washings consist essentially of praticles of Diatoms along with argillaceous and other amorphous matter. We estimate that the frustules of Diatoms and skeletons of siliceous organisms make up more than 50 per cent. of this deposit.

RADIOLARIAN OOZE.—It was stated when describing a Globigerina ooze that Radiolarians were seldom, if ever, completely absent from marine deposits. In some regions they make up a considerable portion of a Globigerina ooze, and are also found in Diatom ooze and in the terrigenous deposits of the deeper water surrounding the land. In some regions of the Pacific, however, the skeletons of these organisms make up the principal part of the deposits, and to these we have given the name "Radiolarian ooze." The color is reddish or deep brown, due to the presence of the oxides of iron and manganese. The mineral particles consist of fragments of pumice, lapilli, and volcanic minerals, rarely exceeding 0.07^{mm} in diameter. There is not a trace of carbonate of lime in the form of shells in some samples of Radiolarian ooze, but other specimens contain 20 per cent. of carbonate of lime, derived from the shells of pelagic Foraminifera. The clayey matter and mineral particles in this ooze are the same as those found in the red clays, which we will now proceed to describe.

RED CLAY.—Of all the deep-sea deposits this is one which is distributed over the largest areas of the modern oceans. It might be said that it exists everywhere in the abysmal regions of the ocean basins, for the residue in the organic deposits, which has been described under the name Globigerina, Pteropod, and Radiolarian ooze, is nothing else than the red clay. However, this deposit only appears in its characteristic form in those areas where the terrigenous minerals and calcareous and siliceous organisms disappear to a greater or less extent from the bottom. It is in the central regions of the Pacific that we meet with the typical examples. Like other marine deposits this one passes literally, according to position and depth, into the adjacent kind of deep-sea ooze or mud.

The argillaceous matters are of a more or less deep brown tint from the presence of the oxides of iron and manganese. In the typical examples no mineralogical species can be distinguished by the naked eye, for the grains are exceedingly fine and of nearly uniform dimensions, rarely exceeding 0.05^{mm} in diameter. It is plastic and greasy to the touch; when dried it coagulates into lumps so coherent that considerable force must be employed to break them. It gives the brilliant streak of clay, and breaks down in water. The pyrognostic properties show that we are not dealing with a pure clay, for it fuses easily before the blow-pipe into a magnetic bead.

Under the term "red clay" are comprised three deposits in which the characters of clay are not well pronounced, but which are mainly composed of minute particles of pumice and other volcanic material which, owing to their relatively recent deposition, have not undergone great alterations. If we calculate the analyses of red clay, it will be seen, moreover, that the silicate of alumina present as clay ($2\ SiO_2, Al_2\ O_3 + 2\ H_2O$) comprises only a relatively small portion of the sediment; the calculation shows always an excess of free silica, which is attributed chiefly to the presence of siliceous organisms.

Microscopic examination shows that a red clay consists of argillaceous matter, minute mineral particles, and fragments of siliceous organisms; in a word, it is in all respects identical with the residue of the organic oozes. The mineral particles are, for the greater part, of volcanic origin, except in those cases where continental matters are transported by floating ice, or where the sand of deserts has been carried to great distances by winds. These volcanic minerals are the same constituent minerals of modern eruptive rocks enumerated in the description of volcanic muds and sands. In the great majority of cases they are accompanied by fragments of lapilla, and of pumice more or less altered. Vitreous volcanic matters belonging to the acid and basic series of rocks predominate in the regions where the red clay has its greatest development, and it will be seen presently that the most characteristic decompositions which there take place are associated with pyroxenic lavas.

Associated with the red clay are almost always found concretions and microscopic particles of the oxides of iron and manganese, to which the deposit owes its color. Again, in the typical examples of the deposit zeolites in the form of crystals and crystalline spherules are present, along with metallic globules and silicates, which are regarded as of cosmic origin. Calcareous organisms are so generally absent in the red clay that they cannot be regarded as characteristic. When present they are chiefly the shells of pelagic Foraminifera, and are usually met with in great numbers in the surface layers of the deposit, to which they give a lighter color. On the other hand, the remains of Diatoms, Radiolarians, and Sponge-spicules are generally present, and are sometimes very abundant. The ear-bones of various cetaceans, as well as the remains of other cetacean bones, and the teeth of sharks, are, in some of the typical samples far removed from the continents, exceedingly abundant, and are often deeply impregnated with or imbedded in thick coatings of oxides of iron and manganese. The remains of these vertebrates have seldom been dredged in the organic oozes, and still more rarely in the terrigenous deposits.

The fine washings, as examined with a power of 450 diameters, are composed of an amorphous matter, fragments of minerals, the remains of siliceous organisms, and coloring substances. What we call amorphous matter may be considered as properly the argillaceous matter, and presents characters essentially vague. It appears as a gelatinous substance, without definite contours, generally colorless, perfectly isotropic, and forms the base which agglutinates the other particles of the washings. As these physical properties are very indefinite, it is difficult to estimate even approximately the quantity present in a deposit. However, it augments in proportion as the deposit becomes more clayey, but we think that only a small quantity of this substance is necessary to give a clayey character to a deposit. Irregular fragments of minerals, small pieces of vitreous rocks, and remains of siliceous organisms predominate in this fundamental base. These particles probably make up about 50 per cent. of the whole mass of the fine washings, and this large percentage of foreign substances must necessarily mask the character of the clayey matter in which they are imbedded. The mineral particles are seldom larger than 0.01^{mm} in diameter, but descend from this size to the merest points. It is impossible, on account of their minuteness, to say to what mineral species they belong; their optical reactions are insensible, their outlines too irregular, and all special coloration has disappeared. All that can be reasonably said is that these minute mineral particles probably belong to the same species as the larger particles in the same deposit, such as feldspar, hornblende, magnetite, &c. In the case of pumice and siliceous organisms the fragments can, owing to their structure, be recognized when of a much less size than in the case of the above minerals.

It can be made out by means of the microscope that the coloring substances are hydrated oxides of iron and manganese. The former is scattered through the mass in a state of very fine division; in some points, however, it is more localized, the argillaceous matter here appearing with a browner tinge, but these spots are noticed gradually to disappear in the surrounding mass. The coloration given by the manganese is much more distinct. There are small, rounded brownish spots with a diameter of less than 0.01^{mm}, which disappear under the action of hydrochloric acid with disengagement of chlorine. These small round concretions, which are probably a mixture of the oxides of iron and manganese, will be described with more detail in the Challenger report.

The following table shows the nomenclature we have adopted:

TERRIGENOUS DEPOSITS.	Shore formations, Blue mud, Green mud and sand, Red mud,	Found in inland seas and along the shores of continents.
	Coral mud and sand, Coralline mud and sand, Volcanic mud and sand,	Found about oceanic islands and along the shores of continents.
PELAGIC DEPOSITS.	Red clay, Globigerina ooze, Pteropod ooze, Diatom ooze, Radiolarian ooze,	Found in the abysmal regions of the ocean basins.

GEOGRAPHICAL AND BATHYMETRICAL DISTRIBUTION.—In the preceding pages we have confined our remarks essentially to the lithological nature of the deep-sea deposits, including in this term the dead shells and skeletons of organisms. From this point of view it has been possible to define the sediments and to give them distinctive names. We now proceed to consider their geographical and bathymetrical distribution, and the relations which exist between the mineralogical and organic composition and the different areas of the ocean in which they are formed.

A cursory glance at the geographical distribution shows that the deposits which we have designated muds and sands are situated, at various depths, at no great distance from the land, while the organic oozes and red clays occupy the abysmal regions of the ocean basins far from land. Leaving out of view the coral and volcanic muds and sands which are found principally around oceanic islands, we notice that our blue muds, green muds and sands, red muds, together with all the coast and shore formations, are situated along the margins of the continents and in inclosed and partially inclosed seas. The chief characteristic of these deposits is the presence in them of continental *débris*. The blue muds are found in all the deeper parts of the regions just indicated, and especially near the embouchures of rivers. Red muds do not differ much from blue muds except in color, due to the presence of ferruginous matter in great abundance, and we find them under the same conditions as the blue muds. The green muds and sands occupy, as a rule, portions of the coast where detrital matter from rivers is not, apparently, accumulating at a rapid rate, viz, on such places as the Angulhas Bank, off the east coast of Australia, off the coast of Spain, and at various points along the coast of America.

Let us cast a glance at the region occupied by terrigenous deposits, in which we include all truly littoral formations. This region extends from high-water mark down, it may be, to a depth of over 4 miles, and in a horizontal direction from 60 to perhaps 300 miles seawards, and includes, in the view we take, all inland seas, such as the North Sea, Norwegian Sea, Mediterranean Sea, Red Sea, China Sea, Japan Sea, Caribbean Sea, and many others. It is the region of change and of variety with respect to light, temperature, motion, and biological conditions. In the surface waters the temperature ranges from 80° F. in the tropics to 28° F. in the polar regions. Below the surface down to the nearly ice-cold water found at the lower limits of the region in the deep sea there is in the tropics an equally great range of temperature. Plants and animals are abundant near the shore, and animals extend in relatively great abundance down to the lower limits of this region, which is now covered with these terrigenous deposits. The specific gravity of the water varies much, owing to mixture with river water or great local evaporation, and this variation in its turn affects the fauna and flora. In the terrigenous region tides and currents produce their maximum effect, and these influences can in some instances be traced to a depth of 300 fathoms, or nearly 2,000 feet. The upper or continental margin of the region is clearly defined by the high-water mark of the coast-line, which is constantly changing through breaker action, elevation, and subsidence. The lower or abysmal margin is less clearly marked out. It passes in most cases insensibly into the abysmal region, but may be regarded as ending when the mineral particles from the neighboring continents begin to disappear from the deposits, which then pass into an organic ooze or a red clay.

Contrast with these those conditions which prevail in the abysmal region in which occur the organic oozes and red clay, the distribution of which will presently be considered. This area comprises vast undulating plains from 2 to 5 miles beneath the surface of the sea, the average being about 3 miles, here and there interrupted by huge volcanic cones (the oceanic islands). No sunlight ever reaches these deep, cold tracts. The range of temperature over them is not more than 7°, viz, from 31° to 38° F., and is apparently constant throughout the whole year in each locality. Plant life is absent, and, although animals belonging to all the great types are present, there is no great variety of form or abundance of individuals. Change of any kind is exceedingly slow.

What is the distribution of deposits in this abysmal region of the earth's surface? In the tropical and temperate zones of the great oceans, which occupy about 110° of latitude between the two polar zones, at depths where the action of the waves is not felt, and at points to which the terrigenous materials do not extend, there are now forming vast accumulations of Globigerina and other Pelagic Foraminifera, coccoliths, rhabdoliths, shells of pelagic Mollusks, and remains of other organisms. These deposits may perhaps be called the sediments of median depths and of warmer zones, because they diminish in great depths and tend to disappear towards the poles. This fact is evidently in relation with the surface temperature of the ocean, and shows that pelagic Foraminifera and Mollusks live in the superficial waters of the sea, whence their dead shells fall into the bottom. Globigerina ooze is not found in inclosed seas nor in polar latitudes. In the southern hemisphere it has not been met with beyond the fiftieth parallel. In the Atlantic it is deposited upon the bottom at a very high latitude below the warm waters of the Gulf Stream, and is not observed under the cold descending polar current which runs south in the same latitude. These facts are readily explained if we admit that this ooze is formed chiefly by the shells of surface organisms which require an elevated temperature and a wide expanse of sea. But as long as the conditions of the surface are the same we would expect the deposits at the bottom also to remain the same. In showing that such is not the case we are led to take into account an agent which is in direct correlation with the depth. We may regard it as established that the majority of the calcareous organisms which make up the Globigerina and Pteropod oozes live in the surface waters, and we may also take for granted that there is always a specific identity between the calcareous organisms which live at the surface and the shells of these pelagic creatures found at the bottom. This observation will permit us to place in relation the organic deposits and those which are directly or indirectly the result of the chemical activity of the ocean. Globigerina ooze is found in the tropical zone at depths which do not exceed 2,400 fathoms, but when depths of 3,000 fathoms are explored in this zone of the Atlantic and Pacific there is found an argillaceous deposit without, in many instances, any trace of calcareous organisms. When we descend from the "submarine plateaus" to depths which exceed 2,250 fathoms the Globigerina ooze gradually disappears, passing into a grayish marl, and finally is wholly replaced by an argillaceous material, which covers the bottom at all depths greater than 2,900 fathoms.

The transition between the calcareous formations and the argillaceous ones takes place by almost insensible degrees. The thinner and more delicate shells disappear first. The thicker and larger shells lose little by little the sharpness of their contour and appear to undergo a profound alteration. They assume a brownish color, and break up in proportion as the calcareous constituent disappears. The red clay predominates more and more as the calcareous element diminishes in the deposit.

If we now recollect that the most important elements of the organic deposits have descended from the superficial waters, and that the variations in contour of the bottom of the sea cannot of themselves prevent the *débris* of animals and plants from accumulating upon the bottom, their absence in the red clay areas can only be explained by a decomposition under the action of a cause which we must seek to discover.

Pteropod ooze, it will be remembered, is a calcareous organic deposit, in which the remains of Pteropods and other pelagic Mollusca are present, though they do not always form a preponderating constituent, and it has been found that their presence is in correlation with the bathymetrical distribution.

In studying the nature of the calcareous elements which are deposited in the pelagic areas it has been noticed that, like the shells of the Foraminifera, those of the Thecosomatous Pteropoda, which live everywhere in the superficial waters, especially in the tropics, become fewer in number as the depth from which the sediments are derived increases. We have just observed that the shells of Foraminifera disappear gradually as we descend along a series of soundings from a point where the Globigerina ooze has abundance of carbonate of lime towards deeper regions; but we notice also that when the sounding-rod brings up a graduated series of sediments from a declivity descending into deep water, among the calcareous shells, those of the Pteropods and Heteropods disappear first in proportion as the depth increases. At depths less than 1,400 fathoms in the tropics a Pteropod ooze is found with abundant remains of Heteropods and Pteropods; deeper soundings then give a Globigerina ooze without these molluscan remains; and in the still greater depths, as before mentioned, there is a red clay in which calcareous organisms are nearly if not quite absent.

In this manner, then, it is shown that the remains of calcareous organisms are completely eliminated in the greatest depths of the ocean. For if such be not the case why do we find all these shells at the bottom of the shallower depths and not at all in the greater depths, although they are equally abundant on the surface at both places? There is reason to think that this solution of calcareous shells is due to the presence of carbonic acid throughout all depths of ocean water. It is well known that this substance dissolved in water is an energetic solvent of calcareous matter. The investigations of Buchanan and Dittmar have shown that carbonic acid exists in a free state in sea water, and, in the second place, Dittmar's analyses show that deep-sea water contains more lime than surface water. This is a confirmation of the theory which regards carbonic acid as the agent concerned in the total or partial solution of the surface shells before or immediately after they reach the bottom of the ocean, and is likewise in relation with the fact that in high latitudes, where fewer calcareous organisms are found at the surface, their remains are removed at lesser depths than where these organisms are in greater abundance. It is not improbable that sea water itself may have some effect in the solution of carbonate of lime, and, further, that the immense pressure to which water is subjected in great depths may have an influence on its chemical activity. We await the result of further researches on this point, which have been undertaken in connection with the Challenger reports.

We are aware that objections have been raised to the explanation here advanced on account of the alkalinity of sea water, but we may remark that alkalinity presents no difficulty which need be here considered (Dittmar, "Phys. Chem. Chall. Exp.," part 1, 1884).

This interpretation permits us to explain how the remains of Diatoms and Radiolarians (surface organisms like the Foraminifera) are found in greater abundance in the red clay than in a Globigerina ooze. The action which suffices to dissolve the calcareous matter has little or no effect upon the silica, and so the siliceous shells accumulate. Nor is this view of the case opposed to the distribution of the Pteropod ooze. At first we should expect that the Foraminifera shells, being smaller, would disappear from a deposit before the Pteropod shells; but if we remember that the latter are very thin and delicate, and, for the quantity of carbonate of lime present, offer a larger surface to the action of the solvent than the thicker, though smaller, Globigerina shells, we shall see the explanation of this apparent anomaly.

It remains now to point out the area occupied by the red clay. We have seen how it passes at its margins into organic calcareous oozes, found in the lesser depths of the abysmal regions, or into the siliceous organic oozes or terrigenous deposits. In its typical form the red clay occupies a larger area than any of the other true deep-sea deposits, covering the bottom in vast regions of the North and South Pacific, Atlantic, and Indian Oceans. As above remarked, this clay may be said to be universally distributed over the floor of the oceanic basins, but it only appears as a true deposit at points where the siliceous and calcareous organisms do not conceal its proper characters.

Having now indicated its distribution, we must consider the mode of its formation, and give, in addition, a concise description of the minerals and of the organic remains which are commonly associated with it. The origin of these vast deposits of clay is a problem of the highest interest. It was at first supposed that these sediments were composed of microscopic particles arising from the disintegration of the rocks by the rivers and by the waves on the coasts. It was believed that the matters held in suspension were carried far and wide by currents, and gradually fell to the bottom of the sea. But the uniformity of composition presented by these deposits was a great objection to this view. It could be shown, as we have mentioned above, that mineral particles, even of the smallest dimensions, continually set adrift upon disturbed waters, must, owing to a property of sea water, eventually be precipitated at no great distance from land. It has also been supposed that these argillaceous deposits owe their origin to the inorganic residue of the calcareous shells which are dissolved away in deep water, but this view has no foundation in fact. Everything seems to show that the formation of the clay is due to the decomposition of fragmentary volcanic products, whose presence can be detected over the whole floor of the ocean.

These volcanic materials are derived from floating pumice and volcanic ashes, ejected to great distances by terrestrial volcanoes and carried far by the winds. It is also known that beds of lava and of tufa are laid down upon the bottom of the sea. This assemblage of pyrogenic rocks, rich in aluminous silicates, decomposes under the chemical action of the water, and gives rise in the same way as do terrestrial volcanic rocks to argillaceous matters, according to reactions we can always observe on the surface of the globe, and which are too well known to need special mention here.

The detailed microscopic examination of hundreds of soundings has shown that we can always demonstrate in the argillaceous matter the presence of pumice, of lapilli, of silicates, and other volcanic minerals in various stages of decomposition.

As we have shown in another paper,* the deposit most widely distributed over the bed of modern seas is due to the decomposition of the products of the internal activity of the globe; and the final result of the chemical action of sea water is seen in the formation of this argillaceous matter, which is found everywhere in deep-sea deposits, sometimes concealed by the abundance of siliceous or calcareous organisms, sometimes appearing with its own proper characteristics associated with mineral substances, some of which allow us to appreciate the extreme slowness of its formation, or whose presence corroborates the theory advanced to explain its origin.

In the places where this red clay attains its most typical development we may follow, step by step, the transformation of the volcanic fragments into argillaceous matter. It may be said to be the direct product of the decomposition of the basic rocks, represented by volcanic glasses, such as hyalomelan and tachylite. This decomposition, in spite of the temperature approximating to zero (32° F.), gives rise, as an ultimate product, to clearly crystallized minerals, which may be considered the most remarkable products of the chemical action of the sea upon the volcanic matters undergoing decomposition. These microscopic crystals are zeolites lying free in the deposit, and are met with in greatest abundance in the typical red-clay areas of the Central Pacific. They are simple, twinned, or spheroidal groups, which scarcely exceed half a millimeter in diameter. The crystallographic and chemical study of them shows that they must be referred to christianite. It is known how easily the zeolites crystallize in the pores of eruptive rocks in process of decomposition; and the crystals of christianite, which we ob-

* "On Cosmic and Volcanic Dust," Proc. Roy. Soc. Edin., 1883–'84.

serve in considerable quantities in the clay of the center of the Pacific, have been formed at the expense of the decomposing volcanic matters spread out upon the bed of that ocean.

In connection with this formation of zeolites reference may be made to a chemical process whose principal seat is the red-clay areas, and which gives rise to nodules of manganiferous iron. This substance is almost universally distributed in oceanic sediments; yet it is not so much of the areas of its abundance that we intend to speak as to the fact of its occurrence in the red clay, because this association tends to show a common relation of origin. It is exactly in those regions where there is an accumulation of pyroxenic lavas in decomposition, containing silicates with a base of manganese and iron, such, for example, as augite, hornblende, olivine, magnetite, and basic glasses, that manganese nodules occur in greatest numbers. In the regions where the sedimentary action, mechanical and organic, as it were, suspended, and where, as will appear in the sequel, everything shows an extreme slowness of deposition, in these calm waters, favorable to chemical reactions, ferro-manganiferous substances form concretions around organic and inorganic centers.

These concentrations of ferric and manganic oxides, mixed with argillaceous materials whose form and dimensions are extremely variable, belong generally to the earthy variety or wad, but pass sometimes, though rarely, into varieties of hydrated oxide of manganese, with distinct indications of radially fibrous crystallization. The interpretation to which we are led in order to explain this formation of manganese nodules is the same as that which is admitted in explanation of the formation of coatings of this material on the surface of terrestrial rocks. These salts of manganese and iron, dissolved in water by carbonic acid, then precipitated in the form of carbonate of protoxide of iron and manganese, become oxidized, and give rise in the calm and deep oceanic regions to more or less pure ferro-manganiferous concretions. At the same time it must be admitted that rivers may bring to the ocean a contribution of these same substances.

Among the bodies which, in certain regions where red clay predominates, serve as centers for these manganiferous nodules, are the remains of vertebrates. These remains are the hardest parts of the skeleton—tympanic bones of whales, beaks of Ziphius, teeth of sharks; and just as the calcareous shells are eliminated in the depths, so all the remains of the larger vertebrates are absent except the most resistant portions. These bones often serve as a center for the manganese-iron concretions, being frequently surrounded by layers several centimeters in thickness. In the same dredgings in the red-clay areas some sharks' teeth and cetacean ear-bones, some of which belong to extinct species, are surrounded with thick layers of the manganese, and others with merely a slight coating. We will make use of these facts to establish the conclusions which terminate this paper.

In these red clays there occur, in addition, the greatest number of cosmic metallic spherules, or chondres, the nature and character of which we have pointed out elsewhere. We merely innicate their presence here, as we will support our conclusions by a reference to their distribution.

Reviewing, then, the distribution of oceanic deposits, we may summarize thus:

(1) The terrigenous deposits—the blue muds, green muds and sands, red muds, volcanic muds and sands, coral muds and sands—are met with in those regions of the ocean nearest to land. With the exception of the volcanic muds and sands and coral muds and sands around oceanic islands, these deposits are found only lying along the borders of continents and continental islands and in inclosed and partially inclosed seas.

(2) The organic oozes and red clay are confined to the abysmal regions of the ocean basins. A Pteropod ooze is met with in tropical and subtropical regions in depths less than 1,500 fathoms, a Globigerina ooze in the same regions between the depths of 500 and 2,800 fathoms, a Radiolarian ooze in the central portions of the Pacific at depths greater than 2,500 fathoms, a Diatom ooze in the Southern Ocean south of the latitude of 45° south, a red clay anywhere within the latitudes of 45° north and south at depths greater than 2,200 fathoms.

Conclusions.—All the facts and details enumerated in the foregoing pages point to certain conclusions which are of considerable geological interest, and which appear to be warranted by the present state of our investigations.

We have said that the débris carried away from the land accumulates at the bottom of the sea before reaching the abysmal regions of the ocean. It is only in exceptional cases that the finest terrigenous materials are transported several hundred miles from the shores. In place of layers formed of pebbles and clastic elements with grains of considerable dimensions, which play so large a part in the composition of emerged lands, the great areas of the ocean basins are covered by the microscopic remains of pelagic organisms, or by the deposits coming from the alteration of volcanic products. The distinctive elements that appear in the river and coast sediments are, properly speaking, wanting in the great depths far distant from the coasts. To such a degree is this the case that in a great number of soundings, from the center of the Pacific, for example, we have not been able to distinguish mineral particles on which the mechanical action of water had left its imprint, and quartz is so rare that it may be said to be absent. It is sufficient to indicate these facts in order to make apparent the profound differences which separate the deposits of the abysmal areas of the ocean basins from the series of rocks in the geological formations. As regards the vast deposits of red clay, with its manganese concretions, its zeolites, cosmic dust, and remains of vertebrates, and the organic oozes which are spread out over the bed of the Central Pacific, Atlantic, and Indian Oceans, have they their analogues in the geological series of rocks? If it be proved that in the sedimentary strata the pelagic sediments are not represented, it follows that deep and extended oceans like those of the present day cannot formerly have occupied the areas of the present continents, and, as a corollary, the great lines of the ocean basins and continents must have been marked out from the earliest geological ages. We thus get a new confirmation of the opinion of the permanence of the continental areas.

But, without asserting in a positive manner that the terrestrial areas and the areas covered by the waters of the great ocean basins have had their main lines marked out since the commencement of geological history, it is, nevertheless, a fact, proved by the evidence derived from a study of the pelagic sediments, that these areas have a great antiquity. The accumulation of sharks' teeth, of the ear-bones of cetaceans, of manganese concretions, of zeolites, of volcanic material in an advanced state of decomposition, and of cosmic dust, at points far removed from the continents, tend to prove this. There is no reason for supposing that the parts of the ocean where these vertebrate remains are found are more frequented by sharks or cetaceans than other regions where they are never or only rarely dredged from the deposits at the bottom. When we remember, also, that these ear-bones, teeth of sharks, and volcanic fragments are sometimes incrusted with two centimeters of manganese oxide, while others have a mere coating, and that some of the bones and teeth belong to extinct species, we may conclude with great certainty that the clays of these oceanic basins have accumulated with extreme slowness. It is indeed almost beyond question that the red-clay regions of the Central Pacific contain accumulations belonging to geological ages different from our own. The great antiquity of these formations is likewise confirmed in a striking manner by the presence of cosmic fragments, the nature of which we have described ("On Cosmic and Volcanic Dust," Proc. Roy. Soc. Edin.). In order to account for the accumulation of all the substances in such relatively great abundance in the areas where they were dredged, it is necessary to suppose the oceanic basins to have remained the same for a vast period of time.

The sharks' teeth, ear-bones, manganese nodules, altered volcanic fragments, zeolites, and cosmic dust are met with in greatest abundance in the red clays of the Central Pacific, at that point on the earth's surface farthest removed from continental land. They are less abundant in the Radiolarian ooze, are rare in the Globigerina, Diatom, and Pteropod oozes, and they have been dredged only in a few instances in the terrigenous deposits close to the shore. These substances are present in all the deposits, but, owing to the abundance of other matters in the more rapidly forming deposits, their presence is masked, and the chance of dredging them is reduced. We may then regard the greater or less abundance of these materials, which are so characteristic of a true red clay, as being a measure of the relative rate of accumulation of the marine sediments in which they lie. The terrigenous deposits accumulate most rapidly; then follow in order Pteropod ooze, Globigerina ooze, Diatom ooze, Radiolarian ooze, and, slowest of all, red clay.

From the data now advanced it appears possible to deduce other conclusions important from a geological point of view. In the deposits due essentially to the action of the ocean we are at once struck by the great variety of sediments which may accumulate in regions where the external conditions are almost identical. Again, marine faunas and floras, at least those of the surface, differ greatly, both with respect to species and to relative abundance of individuals, in different regions of the ocean; and as their remains determine the character of the deposit in many instances, it is legitimate to conclude that the occurrence of organisms of a different nature in several beds is not an argument against the synchronism of the layers which contain them.

The small extent occupied by littoral formations, especially those of an arenaceous nature, shown by our investigations, and the relatively slow rate at which such deposits are formed along a stable coast, are matters of importance.

In the present state of things there does not appear to be anything to account for the enormous thickness of the clastic sediments making up certain geological formations, unless we consider the exceptional cases of erosion which are brought into play when a coast is undergoing constant elevation or subsidence.

Great movements of the land are doubtless necessary for the formation of thick beds of transported matter like sandstones and conglomerates.

In this connection may be noted the fact that in certain regions of the deep sea no appreciable formation is now taking place; hence the absence in the sedimentary series of a layer representing a definite horizon must not always be interpreted as proof either of the emergence of the bottom of the sea during the corresponding period or of an ulterior erosion. Arenaceous formations of great thickness require seas of no great extent and coasts subject to frequent oscillations, which permit the shores to advance and retire. Along these, through all periods of the earth's history, the great marine sedimentary phenomena have taken place.

The continental geological formations, when compared with marine deposits of modern seas and oceans, present no analogues to the red clays, Radiolarian, Globigerina, Pteropod, and Diatom oozes. On the other hand, the terrigenous deposits of our lakes, shallow seas, inclosed seas, and the shores of the continents reveal the equivalents of our chalks, green sands, sandstones, conglomerates, shales, marls, and other sedimentary formations. Such formation as certain Tertiary deposits of Italy, Radiolarian earth from Barbadoes, and portions of the chalk where Pelagic conditions are indicated must be regarded as having been laid down rather along the border of a continent than in a true oceanic area. On the other hand, the argillaceous and calcareous rocks recently discovered by Dr. Guppy in the upraised coral islands in the Solomon group are nearly identical with the Pteropod and Globigerina oozes of the Pacific.

Regions situated similarly to inclosed and shallow seas and the borders of the present continents appear to have been, throughout all geological ages, the theater of the greatest and most remarkable changes; in short, all, or nearly all, the sedimentary rocks of the continents would seem to have been built up in areas like those now occupied by the terrigenous deposits, which we may designate *the transitional or critical area of the earth's surface.* This area occupies, we estimate, about two-eighths of the earth's surface, while the continental and abysmal areas occupy each about three-eighths.

During each era of the earth's history the borders of some lands have sunk beneath the sea and been covered by marine sediments, while in other parts the terrigenous deposits have been elevated into dry land, and have carried with them a record of the organisms which flourished in the sea of the time. In this transitional area there has been throughout a continuity of geological and biological phenomena.

From these considerations it will be evident that the character of a deposit is determined much more by distance from the shore of a continent than by actual depth, and the same would appear to be the case with respect to the fauna spread over the floor of the present oceans. Dredgings near the shores of continents, in depths of 1,000, 2,000, or 3,000 fathoms, are more productive both in species and individuals than dredgings at similar depths several hundred miles seawards. Again, among the few species dredged in the abysmal areas furthest removed from land the majority show archaic characters, or belong to groups which have a wide distribution *in time* as well as over the floor of the present oceans. Such are the Hexactinellida, Brachiopoda, Stalked Crinoids, and other Echinoderms, &c.

As already mentioned, the transitional area is that which now shows the greatest variety in respect to biological and physical conditions, and in past time it has been subject to the most frequent and the greatest amount of change. The animals now living in this area may be regarded as the greatly modified descendants of those which have lived in similar regions in past geological ages, and some of whose ancestors have been preserved in the sedimentary rocks as fossils. On the other hand, many of the animals dredged in the abysmal regions are most probably also the descendants of animals which lived in the shallower water of former geological periods, but descended into deep water to escape the severe struggle for existence, which must always have obtained in those depths affected by light, heat, motion, and other conditions. Having found existence possible in the less favorable and deeper water, they may be regarded as having slowly spread themselves over the floor of the ocean, but without undergoing great modifications, owing to the extreme uniformity of the conditions and the absence of competition.. Or we may suppose that in the depressions which have taken place near coasts some species have been gradually carried down to deep water, have accommodated themselves to the new conditions, and have gradually migrated to the regions far from land. A few species may thus have migrated to the deep sea during each geological period. In this way the origin and distribution of the deep-sea fauna in the present oceans may in some measure be explained. In like manner the pelagic fauna and flora of the ocean are most probably derived originally from the shore and shallow water. During each period of the earth's history a few animals and plants have been carried to sea, and have ultimately adopted a pelagic mode of life.

Without insisting strongly on the correctness of some of these deductions and conclusions, we present them for the consideration of naturalists and geologists as the result of a long, careful, but as yet incomplete investigation.

APPENDIX, E.

MISCELLANEOUS.

XXIV.—A CATALOGUE OF THE FISHES KNOWN TO INHABIT THE WATERS OF NORTH AMERICA, NORTH OF THE TROPIC OF CANCER, WITH NOTES ON THE SPECIES DISCOVERED IN 1883 AND 1884.

By David Starr Jordan.

The Synopsis of the Fishes of North America, by David S. Jordan and Charles H. Gilbert (Bulletin United States National Museum No. 16), was finished in September, 1882, and was issued to the public about April 1, 1883.

Since the publication of that work an active study of North American fishes has brought to light many species not included in the Synopsis, and has shown various errors in the nomenclature of species already known. The additions are chiefly in the Bassalian or deep-sea fauna of the Atlantic, in the tropical fauna of the Florida Keys, and in the fresh-water fauna of the lower part of the Mississippi Valley.

It was at first determined to issue these addenda in the form of annual supplements to the Synopsis, but the publication of the supplement for 1883 having been delayed till January, 1885, it has been thought best to unite the lists for 1883 and 1884, and to put the matter in the present form.

I have, therefore, given a list representing the present state of our knowledge of the fishes found north of the Tropic of Cancer, in American waters. In all cases where a species is included which is not in the Synopsis, or in which a name is used in the latter work, different from that here adopted, I have given an explanation, reference or description in the form of a foot-note. Species already fully described elsewhere in publications of the U. S. National Museum are not redescribed here.

In matters of nomenclature and classification I have followed, in this list, the arrangement in the Synopsis, unless important reasons for deviation have appeared. In such cases I have endeavored to avoid premature changes, and the substitution of one doubtful opinion for another.

In this list the families, genera, and species are numbered consecutively from the first. These numbers necessarily differ from those in the Synopsis. The numbers used in that work are here placed in parentheses after the names.

I have also indicated in a general way the geographical distribution of each species by the following signs:

B.—Bassalian or deep-sea fauna of the Atlantic.
BC.—Bassalian fauna of the Pacific.
G.—Arctic (Greenland) fauna.
N.—Shore fauna of North Atlantic States.
S.—Shore fauna of South Atlantic and Gulf States.
W.—West Indian fauna (including Florida Keys).
P.—Tropical fauna of the Pacific coast (Gulf of California to Ecuador).
C.—California shore fauna (Cape Flattery to Cerros Island, &c.).
A.—Alaskan shore fauna.
Y.—Alaskan fresh-water fauna (Yukon).
T.—Fresh-water fauna of region west of Sierra Nevada and Cascade Range (Transmontane).
R.—Fauna of region between Rocky Mountains and Sierra Nevada.
V.—Fresh-water fauna of region east of Rocky Mountains (again subdivided into Vn, the northern part of this range; Vs, the southern; Vsw, the southwestern, &c.)
E.—Europe.
O.—Pelagic species.
Ana.—Anadromous species.
Acc. Accidental visitants.

In this paper I have adopted as the southern boundary of temperate North America the Tropic of Cancer, or a line connecting Key West with Brazos Santiago and Cape San Lucas, instead of the conventional Mexican boundary.

INDIANA UNIVERSITY,
January 1, 1885.

CATALOGUE OF THE FISHES OF NORTH AMERICA.

CLASS I.—LEPTOCARDII. (I)

ORDER A.—CIRROSTOMI. (A)

Family I.—BRANCHIOSTOMIDÆ. (1)

1.—BRANCHIOSTOMA Costa. (1)

1. Branchiostoma lanceolatum Pallas. E. S. C. P. (1)

CLASS II.—MARSIPOBRANCHII. (II)

ORDER B.—HYPEROTRETA. (B)

Family II.—MYXINIDÆ. (2)

2.—MYXINE Linnæus. (2)

2. Myxine glutinosa Linnæus. B. Eu. (2)

Family III.—BDELLOSTOMIDÆ.

3.—POLISTOTREMA Gill. (3)

3. Polistotrema dombeyi Müller. C. (3)

ORDER C.—HYPEROTRETA. (C)

Family IV.—PETROMYZONTIDÆ. (3)

4.—AMMOCŒTES Duméril.[1] (3*b*.) (4,5)

§ *Entosphenus* Gill. (3*b*.) (4, 5, 6)

4. Ammocœtes tridentatus Gairdner. C. Ana. (4)

[1] For discussions of the genera of *Petromyzontidæ* see Gill (Proc. U. S. Nat. Mus., 1882, 552) and Jordan & Gilbert (*ibid.*, 1883, 208). Our species fall most naturally into two groups, which we may call genera. *Ammocœtes* with the discal and peripheral teeth differentiated, and the supraoral lamina (maxillary tooth) crescentiform, and *Petromyzon* having the discal and peripheral teeth in obliquely decurved continuous rows, and the supraoral lamina contracted, with 2 or 3 converging teeth. In both groups are minor modifications, indicative of subgenera, the marine species of each (*marinus*, *tridentatus*) being stronger, with more specialized dentition than the small fluviatile forms.

§ *Lampetra* Gray. (3*pt*.)

5. Ammocœtes cibarius[1] Girard. C. Ana. (7)
6. Ammocœtes aureus Bean. A. Ana. (7*b*)

§ *Ammocœtes.*

7. Ammocœtes æpypterus[2] Abbott. Vn. (8)

5.—**PETROMYZON** (Artedi) Linnæus. (7)

§ *Ichthyomyzon* Girard. (6)

8. Petromyzon bdellium[3] Jordan. Vn. (9)
9. Petromyzon hirudo Girard. Vn. (9*b*.)
10. Petromyzon castaneus Girard. Vw. (10)

§ *Petromyzon.* (7)

11. Petromyzon marinus L. N. Eu. Ana. (11)
11b *Petromyzon marinus dorsatus* Wilder. Ve. (12)

6.—**BATHYMYZON**[4] Gill.

12. Bathymyzon bairdii[5] Gill. B.

Class III.—PISCES.

Subclass Elasmobranchii.

Order D.—OPISTHARTHRI.[6]

Family V.—NOTIDANIDÆ. (15)

7.—**HEPTRANCHIAS** Rafinesque. (32)

§ *Notorhynchus* Ayres.

13. Heptranchias maculatus Ayres. C. (42)

8.—**HEXANCHUS** Rafinesque. (31*b*.)

14. Hexanchus corinus Jordan & Gilbert. C. (42*b*.)

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[1] The name *Petromyzon plumbeus* is preoccupied by Shaw, 1805.

[2] The name *Petromyzon niger* is preoccupied by Lacépède, 1798. This is probably the species poorly described by Abbott as *Amm. æpyptera.*

[3] The name *Petromyzon argenteus* is preoccupied by Bloch, 1790. I propose the new name *P. bdellium* for this species, as I cannot identify it certainly with *Ammocœtes concolor* Kirtland, *A. borealis* Ag., or any other nominal species, based on larval forms.

[4] Bathymyzon Gill, Proc. U. S. Nat. Mus., 1883, 254; type *Petromyzon* (*Bathymyzon*) *bairdii* Gill. (βαθυς—deep; μύζω—to suck.) This genus is said to differ from *Petromyzon* in having "the suproral and infroral plates or laminæ destitute of odontoid tubercles, the armature of the lamprey type being obsolescent."

[5] *Petromyzon* (*Bathymyzon*) *bairdii* Gill., l. c. 254, Gulf Stream, latitude 40°, at a depth of 547 fathoms. The species has not been described, except that it is "closely related to *Petromyzon marinus*."

[6] The groups called *Opistharthri* and *Proarthri*, certainly worthy of ordinal distinction from the other Sharks, are defined by Professor Gill in our Synopsis Fish. N. A., 967.

ORDER E.—PROARTHRI.

Family VI.—CESTRACIIDÆ. (14)

9.—CESTRACION[1] Cuvier. (31)

§ *Gyropleurodus* Gill.

15. Cestracion francisci Girard. C. (41)

ORDER F.—SQUALI.

Family VII.—SCYMNIDÆ. (4)

10.—ECHINORHINUS Blainville. (8)

16. Echinorhinus spinosus Gmelin. Acc. Eu. (13)

11.—SOMNIOSUS Le Sueur. (9)

17. Somniosus microcephalus Bloch. A. G. Eu. (14)

Family VIII.—SPINACIDÆ. (5)

12.—CENTROSCYLLIUM Müller & Henle. (10)

18. Centroscyllium fabricii Reinhardt. G. (15)

13.—SQUALUS (Artedi) Linnæus. (11)

19. Squalus acanthias Linnæus. C. A. G. N. Eu. (16)

14.—CENTROSCYMNUS Bocage & Capello. (12)

20. Centroscymnus cœlolepis Bocage & Capello. B. Eu. (17)

Family IX.—SCYLLIIDÆ. (6)

15.—SCYLLIORHINUS Blainville. (13*b*.)

§ *Catulus* Smith. (13*b*.)

21. Scylliorhinus ventriosus Garman. C. (18*b*.)
22. Scylliorhinus retifer Garman. B. (18*c*.)

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[1] CESTRACION Cuvier (Règne Animal, type *Cestracion philippi* Bloch and Schneider) should perhaps be adopted instead of *Heterodontus* Blainville, preoccupied in Herpetology as *Heterodon*. Both words are from ἕτερος, ὀδών (ὀδούς), and are correctly written *Heterodus* or *Heterodon*, not *Heterodontus*. *Cestracion* is an old name of the Hammerheaded shark, from κέστρα, a pick-axe, or similar instrument.

16.—PSEUDOTRIACIS[1] Capello.

23. **Pseudotriacis microdon**[2] Capello. P. Eu.

17.—GINGLYMOSTOMA Müller & Henle. (13)

24. **Ginglymostoma cirratum** Gmelin. W. P. (18)

Family X.—GALEORHINIDÆ. (7)

18.—GALEUS[3] (Rafinesque) Leach. (14)

§ *Galeus.*

25. **Galeus lunulatus**[4] Jordan & Gilbert. P.

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[1] PSEUDOTRIACIS Capello. (*Pseudotriakis* Capello, Jorn. Sci. Math. Phys. e Nat. Lisboa, 1868, 321; type *Pseudotriakis microdon* Capello.)

Body elongate; mouth wide, with a very short labial fold near the angle; snout depressed; nostrils inferior, not confluent with the mouth; eyes oblong, lateral, without nictitating membrane; spiracles well developed behind the eye; gill openings moderate, in advance of pectoral; jaws with many rows of very small, tricuspid teeth; first dorsal fin long and low, highest posteriorly, inserted opposite the space between pectorals and ventrals; second dorsal rather large, larger than anal; ventrals and pectorals well developed; no pit at root of caudal; caudal fin divided by a notch into a short upper portion and a very low and long lower portion. Skin with minute asperities. One species known (Ψεῦδος, false; τρειακις, triacis).

[2] *Pseudotriacis microdon* Capello, Jorn. Sci. Math. &c., Lisboa, 1868, 321; Gunther, VIII, 395; Bean, Proc. U. S. Nat. Mus., VI, 1883, 147. Two specimens of this species are known, the type from Portugal, the second, 10 feet in length, lately taken at Amagansett, on Long Island. (*Bean.*)

[3] GALEUS Rafinesque. (*Mustelus* Cuvier.)

(Rafinesque, Caratteri di alcuni nuovi Generi, 1810, 13: *vulpeculus, melastomus, catulus* and *mustelus*: *Galeus* Leach, Observ. Genus *Squalus* of Linné: 1812, 62, type *Squalus mustelus* Leach = *Sq. canis* Mitchill.)

The name *Galeus* was first used in binomial nomenclature by Rafinesque, for a genus thus defined:

"VIII. G. GALEUS.—Due spiragli, due ale dorsali, un ala anale, cinque branchie da ogni lato; coda diseguale, obliqua.

"*Osservazione.* La maggior parti delli *Squali* degli autori si annoverano in questo genere, il quale si distingue dal vero genere *Squalus* della prezenza di un ala anale."

Four species are mentioned, *vulpeculus*: *melastomus*: *catulus* and *mustelus*. Although the species which the author had in mind was probably *Squalus galeus* L., it is improper to assume this species as the type, as no mention is made of it by the author in question.

In 1812, Leach proposed a genus *Galeus*, to include sharks with the anal fin present and the caudal fin irregular (*i. e.*, not lunate). But one species, *Galeus mustelus*, is mentioned by Leach. Still later, a subgenus, *Galeorhinus*, was proposed by Blainville for sharks distinguished from *Carcharinus* Blainv. (=*Carcharias* Cuvier), by the presence of spiracles. In this group are included with others, *Squalus mustelus* and *Squalus galeus* of Linnæus. Still later (1817), the genera *Mustelus*, *Carcharias*, and *Galeus* were defined by Cuvier, and with his definition have been accepted by nearly all later authors.

The rules of nomenclature seem to me to require the retention of the genus *Galeus* Rafinesque, for the group for which the same name was used by Leach, *i e.*, instead of *Mustelus* Cuvier.

[4] *Mustelus lunulatus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 108; Mazatlan, Mexico.

In this paper is given an analysis of the distinctive characters of the four North American species of *Galeus*:—*lunulatus, canis, dorsalis*, and *californicus*.

26. **Galeus canis** Mitchill. N. Eu. (19)

§ *Pleuracromylon* Gill.

27. **Galeus californicus** Gill. C.

19.—TRIACIS Müller & Henle. (15)

§ *Triacis.*

28. **Triacis semifasciatus** Girard. C. (21)

§ *Rhinotriacis* Gill.

29. **Triacis henlei** Gill. C. (22)

20.—GALEORHINUS Blainville. (16)

30. **Galeorhinus zyopterus** Jordan & Gilbert. C. (23)

21.—GALEOCERDO Müller & Henle. (17)

31. **Galeocerdo maculatus**[1] Ranzani. W. P. (24)

22.—CARCHARHINUS[2] Blainville. (18, 19, 20, 21)

§ *Carcharinus.*

32. **Carcharhinus glaucus** Linnæus. C. O. Eu. (25)

§ *Eulamia* Gill.

33. **Carcharhinus obscurus** Le Sueur. N. (26)
34. **Carcharhinus æthalorus**[3] Jordan & Gilbert. P.
35. **Carcharhinus fronto**[4] Jordan & Gilbert. P.
36. **Carcharhinus platyodon** Poey. W. S. (26*b*.)

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[1] *Galeus maculatus* Ranzani, De Novis Speciebus Piscium, Dissert. Prima, 1838, 7; *Galeocerdo maculatus*, Poey, Enumeratio Pisc. Cubens., 201, 1875. This name has priority over *G. tigrinus* Müller & Henle.

[2] Although *Carcharias glaucus* was probably the species in mind when Rafinesque proposed his genus *Carcharias*, he makes no reference to this species. The only species actually mentioned by him in connection with the original account of his genus *Carcharias* is *Odontaspis taurus*. The name *Carcharias*, if used at all, should supersede *Odontaspis*. This is the view at first taken by us in the Synopsis Fish. N. A., but afterwards, in the Addendum, p. 872, changed to follow current usage.

The oldest tenable name of this group is that of *Carcharhinus* Blainville. I think it best to regard *Eulamia*, *Aprionodon*, *Hypoprion*, and *Scoliodon* as subgenera under *Carcharhinus*, rather than as distinct genera.

[3] *Carcharias æthalorus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 104; Mazatlan: Panama.

[4] *Carcharias fronto* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 102. Mazatlan.

37. **Carcharhinus caudatus**[1] De Kay. N. (27)
38. **Carcharhinus lamia**[2] Risso. W. Eu.
39. **Carcharhinus lamiella** Jordan & Gilbert. C. (27*b*.)

§ *Hypoprion* Müller & Henle. (19*b*)

40. **Carcharhinus brevirostris**[3] Poey. W. (28*b*.)

§ *Isogomphodon* Gill. (19)

41. **Carcharhinus limbatus** Müller & Henle. W. Acc. (28)

§ *Aprionodon* Gill.

42. **Carcharhinus isodon**[4] Müller & Henle. W. Acc. (29)

§ *Scoliodon* Müller & Henle. (21)

43. **Carcharhinus longurio**[5] Jordan & Gilbert. P.
44. **Carcharhinus terræ-novæ**[6] Richardson. N. S. W. (30)

Family XI.—SPHYRNIDÆ. (8)

23.—SPHYRNA Rafinesque. (22, 23)

§ *Reniceps* Gill. (22)

45. **Sphyrna tiburo** Gill. S. W. (31)

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[1] The name *cœruleus* is preoccupied in this genus by the *Squalus* (*Carcharinus*) *cœruleus* of Blainville, 1816, a synonym of *Carcharhinus glaucus*. The name next in date is that of *Lamna caudata* De Kay, New York Fauna, Fishes, 1842, 354.

[2] *Carcharhinus lamia*. This species is described on page 873, in the Synopsis. It is abundant in the Mediterranean and in the West Indies, ranging northward to the Florida Keys, being common about the wharves at Key West. Base of first dorsal 1⅔ in interspace between dorsals; base of second, 4⅗; length of pectoral, about 5 in length of body.

(*Carcharias lamia* Rafinesque, Indice, 1810, 44; name only; *Squalus carcharias* (in part?) Cuvier (Règne Animal), and of several authors; not of Linnæus; *Carcharias lamia* Risso, Hist. Nat. Europ. Mérid., III, 119, 1826; *Squalus longimanus* Poey, Memorias Cuba, II, 338; *Eulamia longimana* Poey, Syn. Pisc. Cubens., 1868, 448; *Eulamia lamia* Poey, Enum. Pisc. Cubens., 188; *Carcharias lamia* Jordan, Proc. U. S. Nat. Mus., 1884, 104 (Key West).)

[3] *Carcharhinus brevirostris* is described in detail by Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 581, and by Jordan *op. cit.*, 1884, 104, from specimens obtained at Charleston and Key West.

[4] *Carcharhinus isodon*, briefly described in the Synopsis (p. 24) as *Aprionodon punctatus*, is a West Indian species, very lately obtained for the first time on our coast. (Parker.)

[5] *Carcharias longurio* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 106; Mazatlan.

[6] Specimens of *Scoliodon terræ-novæ*, *Malthe radiata* (*cubifrons*), *Scorpæna plumieri* (*bufo*), and other fishes of the warm seas, were given by Audubon to Richardson, and by Richardson described as coming from the waters about Newfoundland. There can be little doubt that these specimens really came from Southern Florida, in which region Audubon made extensive collections. The *Squalus punctatus* of Mitchill has been identified by me with *C. terræ-novæ*, and by Prof. Gill with *C. isodon*. The name *punctatus* is any case preoccupied and cannot be used for either species. *Squalus punctatus* Bloch & Schneider 1801, is a *Ginglymostoma*.

§ *Sphyrna.*

46. Sphyrna tudes[1] Cuvier. W. P. Eu.
47. Sphyrna zygæna Linnæus. N. S. W. C. P. (32)

Family XII.—ALOPIIDÆ. (9)

24.—ALOPIAS Rafinesque. (24)

48. Alopias vulpes Gmelin. C. N. Eu. (33)

Family XIII.—ODONTASPIDIDÆ. (10).

25.—CARCHARIAS[2] Rafinesque. (25)

§ *Eugomphodus* Gill.

49. Carcharias littoralis Mitchill. N. (34)

Family XIV.—LAMNIDÆ. (11)

26.—ISURUS Rafinesque. (26)

§ *Isuropsis* Gill.

50. Isurus dekayi Gill. W. S. (35; 36)

27.—LAMNA Cuvier. (27)

51. Lamna cornubica Gmelin. C. Eu. N. (37)

28.—CARCHARODON Smith. (28)

52. Carcharodon carcharias[3] Linnæus. C. N. Eu. O. (38)

Family XV.—CETORHINIDÆ. (12)

29.—CETORHINUS Blainville. (29)

53. Cetorhinus maximus Gunner. C. N. Eu. O. (39)

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[1] *Sphyrna tudes* Cuvier. Intermediate in all respects between *S. zygæna* and *S. tiburo,* the hammer longer and less produced laterally than in the former. Anterior margin of the head much curved, but not continuous with the lateral edge; length of hinder margin of one side of the hammer less than its width near the eye. Nostril close to the eye, its groove longer than in *S. tiburo,* but very short, continued for but a short distance along the side of the head, and followed by a line of pores.

A large shark, of the warm seas, Gulf of California, West Indies, Mediterranean, and Indian Ocean.

(*Zygæna tudes* Cuvier (Règne Animal); *Sphyrna tudes* Müller & Henle, Plagiost., 53; *Zygæna tudes* Günther, VIII, 382; *Sphyrna tudes* Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 105.)

[2] *Carcharias* Rafinesque was established for those sharks, "the most enormous and most voracious of their order, which differ from the genus *Galeus* Rafinesque, by the lack of spiracles." But one species (*Carcharias taurus* Rafinesque) is mentioned, and this species, although really possessing spiracles, must be regarded as the type of *Carcharias.* This name should therefore supersede *Odontaspis.*

[3] A good account of this species is given by Dr. W. B. Stevenson, Proc. Vassar Brothers Sci. Soc., Poughkeepsie, 1884, and in American Naturalist for the same year.

Family XVI.—RHINODONTIDÆ. (13)

30.—**MICRISTODUS** Gill. (30)

54. **Micristodus punctatus** Gill. P. (40)

Family XVII.—SQUATINIDÆ. (16)

31.—**SQUATINA** Duméril. (33)

55. **Squatina squatina**[1] Linnæus. C. N. Eu. (43)

Order G.—RAIÆ. (E)

Family XVIII.—PRISTIDIDÆ. (17)

32.—**PRISTIS.** Latham. (34)

56. **Pristis pectinatus** Latham. W. S. (44)
57. **Pristis perrottetii**[2] Müller & Henle. P.

Family XIX.—RHINOBATIDÆ. (18)

33.—**RHINOBATUS** Bloch & Schneider. (35)

§ *Rhinobatus.*

58. **Rhinobatus productus** Ayres. C. (45)
59. **Rhinobatus glaucostigma**[3] Jordan & Gilbert. P.
60. **Rhinobatus lengtiginosus** Garman. W. (45*d*)

§ *Zapteryx.* Jordan & Gilbert.

61. **Rhinobatus exasperatus** Jordan & Gilbert. C. P. (45*b*)

§ *Platyrhinoidis.* Garman.

62. **Rhinobatus triseriatus** Jordan & Gilbert. C. (45*c*)

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[1] Our reasons for retaining the original specific name, even when identical with the name of the genus, have been given in full in Proc. U. S. Nat. Mus., 1884, 18. The same view of the case has been adopted by the American Ornithologists' Union.

[2] *Pristis perrotteti* Müller & Henle. Rostral teeth in 18 or 20 pairs, not trenchant behind; distant from one another, the base of each tooth being about one-third the interspaces. Dorsal fin nearly in advance of ventrals. Root of pectoral in advance of first gill-opening, its outer angle a right one. Second dorsal not much smaller than first; a smaller lower caudal lobe. (Günther.) Tropical seas, north to Mazatlan, on the Pacific coast.

(Müller & Henle, 108; Günther, VIII, 436; Jordan & Gilbert, Bull. U. S. Nat. Mus., 1882, 105.)

[3] *Rhinobatus glaucostigma* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1883, 210. Mazatlan; Gulf of California.

Family XX.—RAIIDÆ. (20)

34.—RAIA Linnæus. (37)

63. Raia erinacea Mitchill. N. (48)
64. Raia ocellata Mitchill. N. (49)
65. Raia radiata Donovan. N. Eu. (50)
66. Raia eglanteria Lacépède. N. (51)
67. Raia ackleyi ornata Garman. W. B. (53*c.*)
68. Raia plutonia Garman. W. B. (53*c.*)
69. Raia granulata Gill. B. (53)
70. Raia parmifera Bean. A. (57*b.*)
71. Raia stellulata Jordan & Gilbert. C. (57)
72. Raia inornata Jordan & Gilbert. C. (56)
72 b *Raia inornata inermis* Jordan & Gilbert. C.
73. Raia rhina Jordan & Gilbert. C. A. (55)
74. Raia binoculata Cooper. C. A. (54)
75. Raia lævis Mitchill. N. (52)

Family XXI.—TORPEDINIDÆ. (19)

35.—TORPEDO Duméril. (36)

76. Torpedo occidentalis Storer. E. (46)
77. Torpedo californica Ayres. W. (47)

36.—NARCINE Müller & Henle. (36*b.*)

78. Narcine brasiliensis Olfers. W. (47*b.*)
78 b *Narcine brasiliensis corallina* Garman. W.
79. Narcine umbrosa[1] Jordan. W.

Family XXII.—TRYGONIDÆ. (21)

37.—UROLOPHUS Müller & Henle. (38)

80. Urolophus halleri Cooper. C. P. (58)
81. Urolophus asterias[2] Jordan & Gilbert. P.

38.—PTEROPLATEA Müller & Henle. (39)

82. Pteroplatea crebripunctata[3] Peters. P.
83. Pteroplatea maclura Le Sueur. S. (59)
84. Pteroplatea marmorata Cooper. C. (60)

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[1] *Narcine umbrosa* Jordan, Proc. U. S. Nat. Mus., 1884, 105; Key West.

[2] *Urolophus asterias* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 579; Mazatlan, Panama.

[3] *Pteroplatea crebripunctata* Peters, Monatsber, Berl. Akad, 1869, 703. This species is very common in the Gulf of California. It is thus described by Dr. Peters:

Breadth of disk twice the distance from tip of snout to vent. Snout with a blunt projection; anterior margin of pectorals undulate, convex anteriorly and posteriorly, medially weakly concave; outer angle sharply rounded; posterior margins weakly convex, the posterior angle rounded, covering outer half of base of ventrals; spiracle without tentacle; tail (mutilated) with a low fold on its upper edge. Brown above, with thick-set black points; a row of small, close-set yellow spots on front ofdisk; under side yellowish.

I have compared specimens of this species with *P. maclura* and *P. marmorata*, and regard the three as unquestionably distinct, although closely related.

39.—**TRYGON** Adanson. (40)

85. Trygon centura Mitchill. N. (61)
86. Trygon hastata De Kay. S. (62*b*)
87. Trygon sayi Le Sueur. S. W. (62)
88. Trygon longa[1] Garman. P.
89. Trygon dipterura Jordan & Gilbert. C. (63)
90. Trygon tuberculata Lacépède. W. (64)
91. Trygon sabina Le Sueur. S. (65)

Family XXIII.—MYLIOBATIDÆ. (22.)

40.—**STOASODON** Cantor. (41)

92. Stoasodon narinari Euphrasen. S. W. (66)
93. Stoasodon laticeps[2] Gill. P.

41.—**MYLIOBATIS** Duméril. (42)

94. Myliobatis freminvillei Le Sueur. E. S. (67)
95. Myliobatis californicus Gill. C. (68)

42.—**RHINOPTERA** Kuhl. (43)

96. Rhinoptera quadriloba Le Sueur. N. (69)

Family XXIV.—CEPHALOPTERIDÆ. (23.)

43.—**MANTA** Bancroft. (44)

97. Manta birostris Walbaum. S. P. W. (70)

Subclass HOLOCEPHALI.

ORDER II.—HOLOCEPHALI. (F)

Family XXV.—CHIMÆRIDÆ. (24)

44.—**CHIMÆRA** Linnæus. (45)

§ *Chimæra.*

98. Chimæra affinis Capello.[3] B. Eu. (71)

§ *Hydrolagus* Gill.

99. Chimæra colliei Bennett. C. A. (72)

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[1] *Trygon longa* Garman. This species is described in the Synopsis Fish N. A., p. 66, It is not uncommon along the Pacific coast, from the Gulf of California to Panama.

[2] *Aëtobatis laticeps* Gill, Ann. Lyc. Nat. Hist. N. Y., 1865, 137. This species is abundant from the Gulf of California southward. It has never benn properly compared with *S. narinari*, and may not be different.

[3] *Chimæra plumbea* and *abbreviata* Gill.

To the synonymy in the Synopsis (. 54) add: *Chimæra affinis* Capello, Jorn. Sci. Math. Phys. e. Nat., Lisboa, IV, 1868, 314, pl. III (facing p. 274), ff. 1, 1*a*.; Günther, VIII, 350; *Chimæra abbreviata* Gill, Proc. U. S. Nat. Mus., 1883, VI, 254.)

We are indebted to Dr. Bean for the information that the *Chimæra plumbea* and *Chimæra abbreviata* of Dr. Gill are identical with each other and with *Ch. affinis.*

Subclass ACTINOPTERI.

Order I.—SELACHOSTOMI. (G)

Family XXVI.—POLYODONTIDÆ. (25)

45.—POLYODON Lacépède. (46)

100. **Polyodon spathula** Walbaum. Vw. (73)

Order J.—GLANIOSTOMI. (H)

Family XXVII.—ACIPENSERIDÆ. (26)

46.—ACIPENSER Linnæus. (47)

101. **Acipenser sturio oxyrhynchus** Mitchill. N. Ana. (74).
102. **Acipenser transmontanus** Richardson. C. A. Ana. (75)
103. **Acipenser medirostris** Ayres. C. A. Ana. (76)
104. **Acipenser rubicundus** Le Sueur. Vn. (77)
105. **Acipenser brevirostris** Le Sueur. N. S. (78)

47.—SCAPHIRHYNCHOPS Gill. (48)

106. **Scaphirhynchops platyrhynchus** Rafinesque. Vw. (79)

Order K.—GINGLYMODI.[1] (I)

Family XXVIII.—LEPIDOSTEIDÆ. (27)

48.—LEPIDOSTEUS Lacépède. (50)

107. **Lepidosteus osseus** Linnæus. V. (80)
108. **Lepidosteus platystomus** Rafinesque. V. (81)
109. **Lepidosteus tristœchus**[2] Bloch & Schneider. Vs. W. (82)

Order L.—HALECOMORPHI. (J)

Family XXIX.—AMIIDÆ. (28)

49.—AMIA Linnæus. (51)

110. **Amia calva** Linnæus. V. (83)

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[1] The word *Ginglymodi* is from γιγγλυμὸς, hinge, ειδος, like, in allusion to the ball-and-socket joints of the vertebræ.

[2] The subdivisions of *Lepidosteus* (*Cylindrosteus; Atractosteus*) certainly have no value higher than specific, and the characters used in distinguishing them are variable and of slight importance. It is often difficult to distinguish *L. platystomus*, even specifically, from *L. tristœchus*. Specimens from Cuba (*tristœchus*) are not distinguishable from others from Florida (*spatula*).

ORDER M.—NEMATOGNATHI. (K)

Family XXX.—SILURIDÆ. (29)

50.—NOTURUS Rafinesque. (52)

§ *Schilbeodes* Bleeker.

111. **Noturus gyrinus** Mitchill. Vn. (84)
112. **Noturus leptacanthus** Jordan. Vs. (85)
113. **Noturus nocturnus**[1] Jordan & Gilbert. Vw.
114. **Noturus funebris**[2] Gilbert & Swain. Vs.
115. **Noturus latifrons**[3] Gilbert & Swain. Ve.
116. **Noturus miurus**[4] Jordan. V. (86, 87)
117. **Noturus exilis**[5] Nelson. Vw. (88)
118. **Noturus insignis** Richardson. Ve. (89)

§ *Noturus.*

119. **Noturus flavus** Rafinesque. Vw. (90)

51.—LEPTOPS Rafinesque. (53)

120. **Leptops olivaris** Rafinesque. V. (91)

52.—GRONIAS Cope. (54)

121. **Gronias nigrilabris** Cope. Ve. (92)

53.—AMIURUS Rafinesque. (55)

122. **Amiurus brunneus** Jordan. Vse. (93)
123. **Amiurus platycephalus** Girard. Vse. (94)
124. **Amiurus melas**[6] Rafinesque. Vw. (95, 96)
125. **Amiurus nebulosus**[7] Le Sueur. V. (98)
125 b. *Amiurus nebulosus catulus*[8] Girard. Vsw.

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[1] *Noturus nocturnus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. Arkansas to Texas.

[2] *Noturus funebris* Gilbert & Swain, Proc. U. S. Nat. Mus., 1885. Northern Alabama.

[3] *Noturus latifrons* Gilbert & Swain, Proc. U. S. Nat. Mus., 1885. White River, Indiana.

[4] *Noturus eleutherus* seems to be inseparable from *Noturus miurus.*

[5] *Noturus elassochir* Swain & Kalb (Proc. U. S. Nat. Mus., 1882, 639) seems to me identical with *Noturus exilis.* I regard the latter as distinct from *N. insignis.* For a detailed review of the genus *Noturus*, see Swain & Kalb, *loc cit.*

[6] The species called in the Synopsis *Amiurus xanthocephalus* seems to be not distinct from *A. melas. Amiurus eragini* Gilbert, Bull. Washburn Lab. Nat. Hist., 1884, 1, 10, from Kansas, is identical with *Amiurus obesus* Gill, which I regard as the original *melas* of Rafinesque. *Amiurus brachyacanthus* Cope is probably the same species. The chief characters by which *A. melas* is distinguished from *A. nebulosus* are the much shorter pectoral spines and shorter anal fin of the former.

[7] The original *Silurus catus* L. was certainly not this species, or any other North American siluroid. The oldest tenable specific name for this species is that of *nebulosus* Le Sueur.

[8] The type of *Pimelodus catulus* Girard should be referred to *A. nebulosus* rather than to *A. melas.* It represents a slight variety of *A. melas* occurring in the lower Mississippi Valley and Texas.

125c *Amiurus nebulosus marmoratus*[1] Holbrook. Vs. (97)
126. Amiurus vulgaris Thompson. Vn. (99)
127. Amiurus natalis Le Sueur. V. (100)
127b. *Amiurus natalis lividus* Rafinesque. V.
127c. *Amiurus natalis bolli* Cope. Vsw. (100*b*.)
128. Amiurus erebennus[2] Jordan. Vse. (101)
129. Amiurus albidus[3] Le Sueur. Ve. (102, 103)
130. Amiurus lupus Girard. Vsw. (104)
131. Amiurus niveiventris Cope. Vse. (105)
132. Amiurus nigricans Le Sueur. Vw. (106)
133. Amiurus ponderosus[4] Bean. Vw. (107)

54.—ICTALURUS[5] Rafinesque. (56)

134. Ictalurus punctatus Rafinesque. V. (108)
135. Ictalurus furcatus Cuv. & Val. Vsw. (109)

55.—GALEICHTHYS[6] Cuv. & Val. (57)

§ *Arius* Cuv. & Val.

136. Galeichthys guatemalensis[7] Günther. P.
137. Galeichthys seemanni[8] Günther. P.

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[1] *Amiurus marmoratus* represents apparently a color variety only of *Amiurus nebulosus*. It inhabits grassy waters southward.

[2] Professor Cope describes (Proc. Ac. Nat. Sci., Phila., 1883, 133) a catfish from Batstoe River, New Jersey, as a new species, under the name of *Amiurus prosthistius*. Except that the caudal fin is said to be rounded rather than truncate, this species agrees with *A. erebennus*, with which species we think that it will prove identical. Greatest width of head equal to depth of body; eye small, 5 in interorbital width; dorsal spine inserted much nearer tip of snout than adipose fin; pectoral spines a little larger than dorsal spine; maxillary barbel reaching middle of pectoral spine; humeral process extending a little farther; black, whitish below; fins black; pectoral and ventral pale at base; head, $3\frac{3}{5}$; depth, $4\frac{1}{4}$. D. I. 6. A. 24 to 27. Batstoe River, New Jersey. (*Cope.*)

[3] *Amiurus lophius* Cope seems to be the adult form of *A. albidus*.

[4] *Amiurus ponderosus* is perhaps the adult form of *A. nigricans*. The type of the former species has 35 anal rays. We have counted 25, 27, 28, and 32 anal rays in four individuals of *A. nigricans*.

[5] It is probably better, if the genus *Amiurus* is to be retained as distinct from *Ictalurus*, to refer to it all the transitional species having the tail forked and the bony bridge, from occiput to dorsal not quite continuous. It is true that this latter character is largely one of degree, but still there is a positive difference between *I. punctatus* and *furcatus* and the fork-tailed *Amiuri*.

[6] GALEICHTHYS Cuvier & Valenciennes.

Arius (C. & V.); *Hexanematichthys*, *Guiritinga*, *Hemiarius*, *Cephalocassis*, *Netuma*, and *Pseudarius* Bleeker; *Notarius*, *Ariopsis*, and *Leptarius* Gill; *Sciadarius* and *Bagropsis* Kner; *Cathorops* Jor. & Gilb.).

(Cuvier & Valenciennes, Hist. Nat. Poiss., XV., 29, 1840; type *Galeichthys feliceps* C. & V.).

The genus *Arius*, distinguished from *Galeichthys* by having the nuchal shield ("occipital process") not covered by thick skin, cannot well be separated from *Arius*, as in several species (*dasycephalus*, *brandti* &c.) this character is simply sexual. For a full account of the species of this genus, found on the west coast of America, see Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 34.

[7] *Arius guatemalensis* Günther, V. 1864, 145; Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 48; Mazatlan to Panama.

[8] *Arius seemanni* Günther, V. 147; *Arius assimilis* Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 47 (not *A. assimilis* Günther); Mazatlan to Panama.

138. Galeichthys felis Linnæus. N. S. (110, 111)
139. Galeichthys platypogon[1] Günther. P.
140. Galeichthys brandti[2] Steindachner. P.

56.—ÆLURICHTHYS Baird & Girard. (58)

141. Ælurichthys marinus Mitchill. S. (112)
142. Ælurichthys panamensis[3] Gill. P.
143. Ælurichthys pinnimaculatus[4] Steindachner. P.

ORDER N.—EVENTOGNATHI. (L)

Family XXXI.—CATOSTOMIDÆ. (30)

57.—ICTIOBUS Rafinesque. (59, 60, 61)

§ *Sclerognathus* Cuv. & Val. (59)

144. Ictiobus cyprinella Cuv. & Val. Vw. (113)

§ *Ictiobus.* (60)

145. Ictiobus urus Agassiz. Vw. (114)
146. Ictiobus bubalus Rafinesque. Vw. (115)

§ *Carpiodes* Rafinesque. (61)

147. Ictiobus carpio[5] Rafinesque. Vw. (116)
148. Ictiobus velifer[6] Rafinesque. Vw. (120)
148 b. *Ictiobus velifer bison* Agassiz. Vw. (119)
148 c. *Ictiobus velifer tumidus* Baird & Girard. wV. (117)

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[1] *Arius platypogon* Günther, V. 147; Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 44; Mazatlan to Panama.

[2] *Arius brandti* Steindachner, Ichthyol, Beitr., IV, 21, 1875; Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 39; Mazatlan to Panama.

[3] *Ælurichthys panamensis* Gill. Proc. Ac. Nat. Sci., Phila., 1863, 172 = *Ælurichthys nuchalis* Günther, V, 179, 1865 = *Ælurichthys panamensis* Jordan & Gilbert. Bull. U. S. Fish Comm., 1882, 35; Mazatlan to Panama.

[4] *Ælurichthys pinnimaculatus* Steindachner, Ichth., Beitr., IV, 15, 1875, Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 34; Mazatlan to Panama.

[5] This species is very distinct from the others referred to *Carpiodes*. Its body is almost fusiform, the depth about 3 times in length, the head 4⅗, and the first ray of the dorsal not more than half the length of the base of the fin.

[6] Excepting *I. carpio*, all the other specimens of *Carpiodes* which I have examined from points west of the Allegheny Mountains seem to me to belong to a single extremely variable or polymorphous species, *I. velifer*. As varieties, we may perhaps recognize *tumidus* (= *grayi*), with high back and small eye; *bison* (= *damalis*), with large eye, moderate fins, and snout little obtuse; *velifer*, with snout little obtuse, and the dorsal fin very high, and *difformis*, with very blunt snout, large eye, and very high fins. These forms, however, appear to intergrade perfectly.

148 d. *Ictiobus velifer difformis* Cope. Vw. (121)
149. **Ictiobus cyprinus**[1] Le Sueur. Ve.

58.—CYCLEPTUS Rafinesque. (62)

150. **Cycleptus elongatus** Le Sueur. Vw. (122)

59.—PANTOSTEUS Cope. (63)

151. **Pantosteus plebeius**[2] Baird & Girard. R. (123, 124, 125)
152. **Pantosteus generosus**[3] Girard. R. (126, 127)
153. **Pantosteus guzmaniensis**[4] Girard. R. (128)

60.—CATOSTOMUS Le Sueur. (64)

154. **Catostomus aræopus** Jordan. T. (134)
155. **Catostomus clarki**[5] Baird & Girard. R. (144)
156. **Catostomus discobolus** Cope. R. (129)
157. **Catostomus latipinnis** Baird & Girard. R. (130)
158. **Catostomus nebulifer** Garman. R. (130c.)
159. **Catostomus retropinnis** Jordan. R. (130)
160. **Catostomus catostomus**[6] Forster. Vn. Y. (132)
161. **Catostomus tahoensis** Gill & Jordan. R. (133)
162. **Catostomus labiatus** Ayres. T. (133)
163. **Catostomus macrochilus** Girard. T. (136)
164. **Catostomus occidentalis** Ayres. T. (137)

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[1] All the specimens of *Carpiodes* from east of the Allegheny Mountains examined by me belong to a species closely related to *I. velifer*, but with the opercle nearly smooth, instead of strongly striate, as in the western species. In the eastern form, *I. cyprinus*, the eye is quite small, the body rather deep, and the dorsal fin rather high.

[2] *Pantosteus bardus* and *delphinus* are almost certainly identical with *P. plebeius*. The type of the latter species has the scales 90–30, less crowded forwards than in *P. generosus;* those before the dorsal much less reduced in size. Dorsal rays, 9; head, $4\frac{2}{5}$; depth, 5; snout moderately broad, projecting; fins much lower than in *P. guzmaniensis*.

[3] *Pantosteus platyrhynchus* is based on shriveled specimens of *P. generosus*.

[4] The type of *Catostomus guzmaniensis*, lately examined by me, is a *Pantosteus*, and I am unable to distinguish it from the type of *P. virescens* on comparison of the two specimens. Lat. l. 100 in *guzmaniensis*. Scales before dorsal, 46 to 53; fins high.

[5] The type of *Catostomus clarki*, lately found, belongs to a species very closely related to *C. arœopus*, having the restricted fontanelle and cartilaginous lips of the latter species, but with the scales less crowded anteriorly, there being but 23 in a line before the dorsal instead of 42, as in *C. arœopus*. D. 11; lat. l. 70. *C. discobolus*, *C. arœopus*, and *C. clarki* mark a transition from *Catostomus* toward *Pantosteus*.

[6] Called in the text, *Catostomus longirostris*. The form described by Mr. Mather under the name of *Catostomus nanomyzon* should apparently be referred to this species. Brown; male with a red lateral band in the breeding season; head slender, flattened above; the snout shorter than in *C. catostomus;* lips thick, the lower with 3 or 4 rows of tubercles; eye large, 4 in head, $1\frac{1}{2}$ in snout. Scales smaller anteriorly, but little crowded; dorsal higher than long; pectorals reaching front of dorsal; head, 4; depth, 5; D. 1, 10; A. 7; V. 9; scales, 14–99–11; L. (spawning specimens) $4\frac{1}{4}$ inches. Big Moose Lake, Adirondack region. Apparently a dwarfed brook variety of *C. catostomus*, but inhabiting the same region and spawning at a much smaller size. (*Mather.*) (*Catostomus nanomyzon*, Twelfth Rept. Survey Adirondack Region, 1884, 36.)

165. **Catostomus bernardini**[1] Girard. T. (138)
166. **Catostomus ardens** Jordan & Gilbert. R. (139)
167. **Catostomus fecundus** Cope & Yarrow. R. (140)
168. **Catostomus cypho** Lockington. R. (141)
169. **Catostomus insignis**[2] Baird & Girard. E. (142)
170. **Catostomus teres**[3] Mitchill. R. (143)

61.—**HYPENTELIUM**[4] Rafinesque.

171. **Hypentelium nigricans** Le Sueur. Vw. (145)

62.—**CHASMISTES** Jordan. (65)

172. **Chasmistes liorus** Jordan. R. (146)
173. **Chasmistes brevirostris** Cope T. (147)
174. **Chasmistes luxatus** Cope. T. (148)
175. **Chasmistes cujus**[5] Cope. R.

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[1] The type of *Catostomus bernardini* is closely related to *C. occidentalis*, differing chiefly in the less conic form of the head and in the larger lower fins. Scales much crowded forwards; 31 before the dorsal (40 in *C. occidentalis*), 75 in the lateral line. Fontanelle large; lips broad, without cartilaginous sheath, formed as in *C. occidentalis*, the lower deeply incised; fins high, the dorsal longer than high, with 12 rays; caudal lobes equal; head 4½ in length.

[2] *Catostomus insignis* (type lately found) is closely related to *C. teres*, differing chiefly in the broader upper lip, which has several rows of tubercles upon it. Fontanelle rather small; no cartilaginous sheath on lower lips; scales considerably crowded anteriorly, much more so than in *C. clarki;* 27 scales before dorsal; 56 in lateral line. D. 11.

[3] Called in the text, *Catostomus commersoni*. Although the *Cyprinus commersoni* of Lacépède is probably a sucker and may be this species, there is no certainty in so identifying it, the description being very imperfect and the type said to have been observed by Commerson in the East Indies; a statement apparently derived from a confusion of manuscripts of Commerson with those of Bosc. We think it better to retain for this species the later name of *teres*, concerning which no doubt exists. To this species apparently should be referred the small "June sucker" of the Adirondacks, described by Mather as *Catostomus utawana*. Olivaceous, white below; males without red in the breeding season; body slender; head not small, flattened above; snout little prominent; upper lip with two rows of papillæ; eye 4 in head; 2 in snout; dorsal as long as high; pectorals nearly reaching front of dorsal; head 4; D. 1, 11; A. 5; V. 9. Scales 9–67–8; length of adult 4½ inches. Blue Mountain Lakes, Adirondack region. (*Mather.*) Apparently a mountain race of *C. teres*. (Mather. Twelfth Rept., Survey Adirondack Region, N. Y., 35.)

"This small fish I was at first disposed to consider as a dwarfed mountain form of *C. commersoni*, but the fact that the latter fish is found in waters inhabited by this species, and while it grows to a length of 12 or more inches there, this little sucker barely reaches five. Added to this the fact that the larger species had finished spawning in the inlets in May, while this fish was found in masses in the swift mountain streams which tumble rapidly over rocks in the latter part of June, depositing their eggs, thereby showing that they are adult fish." (*Mather.*)

[4] In view of the peculiar form of the cranium in *Catostomus nigricans*, contrasting with that seen in all the other *Catostominæ*, it is probably well to regard it as the type of a distinct genus, *Hypentelium* Rafinesque.

[5] *Chasmistes cujus* Cope. *Couia.*

Pale olive; head broad and flat; upper lip very thin; lower lip represented by folds on each side, which do not connect around the symphysis; eye 8½ in head; in-

63.—ERIMYZON Jordan. (66)

176. Erimyzon sucetta[1] Lacépède. Vs. (150)
176 b. *Erimyzon sucetta oblongus* Mitchill. Vn. (149)

64.—MINYTREMA Jordan. (67)

177. Minytrema melanops Rafinesque. Vw. (151)

65.—MOXOSTOMA Rafinesque. (68)

178. Moxostoma papillosum Cope. Vse. (152)
179. Moxostoma velatum Cope. Vw. (153)
180. Moxostoma pidiense Cope. Vse. (155)
181. Moxostoma coregonus Cope. Vse. (156)
182. Moxostoma album Cope. Vse. (157)
183. Moxostoma thalassinum Cope. Vse. (158)
184. Moxostoma valenciennesi[2] Jordan. Vn. (159)
185. Moxostoma macrolepidotum Le Sueur. Ve. (160)
185 b. *Moxostoma macrolepidotum duquesnei* Le Sueur. Vw.
186. Moxostoma aureolum[3] Le Sueur. Vn. (161)
187. Moxostoma crassilabre Cope. Vse. (162)
188. Moxostoma congestum[4] Cope. Vsw. (166)

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terorbital space 4½; air-bladder with two cells; D. 12; A. 1, 8; scales, 13-65-11. Pyramid Lake, Nevada; in deep water. (*Cope.*) (*Chasmistes cujus* Cope, Proc. Ac. Nat. Sci., Phila., 1883, 149.)

This paper "On the Fishes of the Recent and Pliocene Lakes of the Western Part of the Great Basin and of the Idaho Pliocene Lake" contains an important discussion of the fish fauna of Nevada, Oregon, and Idaho, with description of numerous fossil forms not long extinct and closely allied to recent *Cyprinidæ* and *Catostomidæ*.

[1] The two forms of *Erimyzon* described in the Synopsis as *E. sucetta* and *E. goodei* seem to be geographical varieties of one species, southern specimens having the scales considerably larger and more regularly arranged than in northern ones. To the southern form belong the typical examples of *Moxostoma kennerlyi* Girard and *Erimyzon goodei* Jordan. Specimens of this form have been examined by me, from streams of South Carolina, Georgia, Florida, Alabama, Louisiana, Illinois, and Texas. From Alabama, Louisiana, and Illinois I have seen specimens more or less distinctly intermediate, while from Virginia to Indian Territory (types *M. claviformis*) and northward only the small-scaled form occurs. It is probable that the original description of *Cat. sucetta* Lac. belongs to the southern form (*kennerlyi* = *goodei*). The northern form may then retain Mitchill's name, *oblongus*.

[2] *Moxostoma valenciennesi* Jordan, Proc. U. S. Nat. Mus., 1885 = *Catostomus carpio* C. & V., not of Raf.

[3] I now omit from the list, *Moxostoma bucco* Cope, based on the young of some species, probably of *M. aureolum*.

[4] I have recently found the types of *Catostomus congestus* and *Ptychostomus albidus*. They belong to the same species, a species shown by the late explorations of Jordan & Gilbert in Texas, to be very abundant in the waters of that State. The type of *P. albidus* has 44 scales in the lateral line instead of 56 as shown in Girard's figure. The specimens from Ash Creek, Arizona, referred with doubt to this species by Cope & Yarrow (Lieutenant Wheeler's Expl. Zoölogy, V. 680, 1876) belong apparently to *M. congestum*. The following account is taken from specimens taken by us in Lampasas River, at Belton, Tex.:

General form of *M. aureolum*, rather robust, moderately compressed, the back somewhat elevated. Head comparatively short, rather broad above and pointed anteriorly;

189. Moxostoma conus Cope. Vse. (163)
190. Moxostoma anisurum Rafinesque. Vw. (164)
191. Moxostoma pœcilurum Jordan. Vsw. (165)
192. Moxostoma cervinum Cope. Vse. (167)

66.—PLACOPHARYNX Cope. (69)

193. Placopharynx carinatus Cope.[1] Vw. (168)

67.—QUASSILABIA Jordan & Brayton. (70)

194. Quassilabia lacera Jordan & Brayton. Vw. (169)

Family XXXII.—CYPRINIDÆ. (31)

68.—CAMPOSTOMA Agassiz. (71)

195. Campostoma ornatum[2] Girard. Vsw. (170)
196. Campostoma anomalum Rafinesque. Vw. (171)
196 b. *Campostoma anomalum prolixum* Storer. Ve. (172)
197. Campostoma formosulum[3] Girard. Vsw. (173)

69.—OXYGENEUM Forbes.

198. Oxygeneum pulverulentum[4] Forbes. Vw.

70.—ACROCHILUS Agassiz. (72)

199. Acrochilus alutaceus Agassiz & Pickering. T. (174)

71.—ORTHODON Girard. (73)

200. Orthodon microlepidotus Ayres. T. (175)

72.—LAVINIA Girard. (74)

201. Lavinia exilicauda Baird & Girard. T. (176)

73.—CHROSOMUS Rafinesque. (75)

202. Chrosomus erythrogaster Rafinesque. V. (177, 179)
203. Chrosomus oreas[5] Cope. Ve. (178)

74.—ZOPHENDUM Jordan. (76)

204. Zophendum siderium Cope. R. (180)
205. Zophendum plumbeum Girard. Vsw. (181)

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the snout a little projecting, mouth rather small, the lower lip full, formed as in *M. aureolum;* eye small, about 5 in head; dorsal fin unusually low and small, little elevated in front, its first ray, when depressed, reaching about to the middle of the last ray; caudal not deeply forked, the lobes equal; lower fins moderate.

Smoky yellowish-brown above, yellowish-silvery below; lower fins whitish; none of the fins red in life; the membranes of the dorsal always dusky. Head $4\frac{1}{2}$ to $4\frac{2}{3}$; depth 4; D. 12; scales 6-45-5; teeth as in *M. aureolum.* Streams of Texas to Arizona.

[1] Professor Gilbert thinks that this species may be the original *Moxostoma anisurum* of Rafinesque.

[2] The types of *Campostoma ornatum* have 73 scales in the lateral line. Those of *C. nasutum* agree in all respects with the ordinary *C. anomalum.*

[3] The types of *Campostoma formosulum* have 46 scales in the lateral line.

[4] *Oxygeneum pulverulentum* Forbes, Bull. Ills. Lab. Nat. Hist., 1885, 136. Peoria, Ills.

[5] *Chrosomus oreas* is a doubtful species, which I have not yet examined. *C. eos* is doubtless indentical with *C. erythrogaster.*

75.—DIONDA[1] Girard. (77 *pt.*)

206. Dionda melanops Girard. Vsw. (189)
207. Dionda punctifera Garman. Vsw. (188*b*.)
208. Dionda fluviatilis Girard. Vsw. (188)
209. Dionda amara Girard. Vsw. (183)
210. Dionda episcopa[2] Girard. Vsw. (184, 187)
211. Dionda serena[3] Girard. Vsw. (185)
212. Dionda nubila[4] Forbes. Vw. (206)
213. Dionda (?) hæmatura[5] Cope. Vn. (204)

76.—HYBOGNATHUS Agassiz. (78)

214. Hybognathus meeki[6] Jordan & Gilbert. Vw.
215. Hybognathus argyritis[7] Girard. Vnw.
216. Hybognathus nuchalis[8] Agassiz. V. (182)
216 b. *Hybognathus nuchalis placita*[9] Girard. Vw. (186)

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[1] The genus *Dionda* may perhaps be recognized as distinct from *Hybognathus*. Its teeth are shorter than those of *Hybognathus*, and more or less distinctly hooked. The species are small in size and mostly dusky in coloration, being especially characteristic of the Rio Grande region.

[2] *Dionda episcopa* Girard, *Dionda texensis* Girard, *Dionda argentosa* Girard (types of these three examined by us) = *Hybognathus flavipinnis* Cope. Fairly described in the Synopsis under the name of *Hybognathus flavipinnis*. The number of scales in the lateral line is about 37 in the types of *episcopa* and *argentosa*, 37 to 39 in *texensis*, and 41 in *flavipinnis*. The anterior suborbitals are of moderate width in *D. episcopa*, about as in *Hybognathus nuchalis*.

[3] *Dionda serena* Girard = *Dionda chrysitis* Grd. = *Hybognathus nigrotæniatus* Cope. Fairly described in the Synopsis under the latter name. The eye is smaller in *serena* than in *episcopa*, and the scales are larger (34 in the type of *D. serena*).

[4] Described in the Synopsis, page 167, as *Cliola nubila*. The species belongs, however, to *Dionda*, as has been already noticed by Professor Forbes. *D. nubila* is very close to *D. episcopa*, but from the specimens compared it appears to differ from the latter in the more pointed snout and in the larger mouth, the cleft of the mouth forming about one-fourth the length of the head, instead of one-fifth, as in *D. episcopa*.

[5] A doubtful species, unknown to me. The description points rather to this genus or *Cliola*, than to *Notropis*.

[6] *Hybognathus meeki* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. Ozark region of Missouri and Arkansas; abundant.

[7] The types of *Hybognathus argyritis* from the Upper Missouri belong to a species distinct from *H. nuchalis*, and are distinct from the species heretofore called *H. argyritis* by different authors. The suborbitals in *H. argyritis* are broad, as in *H. nuchalis* and *H. placita*, the anterior being about twice as long as deep; the mouth is larger than in the other species, its cleft extending nearly to the eye; the jaws subequal, the lower being acutish at tip. The species is known only from the Upper Missouri and the Red River of the North. *Hybognathus evansi* Girard is possibly the same, but the types are lost and the description is too brief for identification. It is more likely *H. nuchalis*.

[8] This species ranges from New Jersey to South Carolina, Texas, and Dakota. *H. osmerinus* and *H. regius* being indistinguishable from it. It has the suborbitals broad, the mouth small, the lower jaw short, blunt, and subhorizontal, and the eye large, about 4 in head.

[9] *Hybognathus placita*, now known from the Arkansas and Missouri Rivers, is closely related to *H. nuchalis*, but has the eye smaller, about 5 in head, the snout depressed and rather blunt; mouth very small.

216 c. *Hybognathus nuchalis regia* Girard. Vse.
217. Hybognathus hayi[1] Jordan. Vs. (182*b*.)

77.—PIMEPHALES[2] Rafinesque. (78, 79, 80)

218. Pimephales promelas[3] Rafinesque. V. (190, 191)
218 b. *Pimephales promelas confertus* Girard. Vnw. (192)
219. Pimephales notatus[4] Rafinesque. V. (193, 194)

78.—EXOGLOSSUM Rafinesque. (81)

220. Exoglossum maxillingua Le Sueur. Ve. (195)

79.—COCHLOGNATHUS Baird & Girard. (82)

221. Cochlognathus ornatus Baird & Girard. Vsw. (196)
222. Cochlognathus biguttatus Cope. Vsw. (197)

80.—CLIOLA[5] Girard. (84 *pt.*)

223. Cliola vigilax[6] Baird & Girard. Vw. (202, 203, 215)

81.—NOTROPIS[7] Rafinesque. (83, 84, 85)

§ *Hemitremia.* (83)

224. Notropis bifrenatus Cope Ve. (199)
225. Notropis maculatus Hay. Vs. (200)
226. Notropis heterodon[8] Cope. Vn. (201)

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[1] *Hybognathus hayi* Jordan, Proc. U. S. Nat. Mus., 1884. Streams of Alabama, Mississippi, and the Lower Mississippi Valley. This species is correctly distinguished from *H. nuchalis* in the Synopsis, p. 968., under the erroneous name of *H. argyritis.* The species was first observed by Professor Hay.

[2] The genus *Hyborhynchus* is not distinct from *Pimephales*, the character of the lateral line being subject to many variations in *P. promelas.*

[3] *Coliseus parietalis* is, in my opinion, the young of *Pimephales promelas. Hyborhynchus confertus* is scarcely distinguishable from *P. promelas*, western specimens, Illinois to Texas, having the lateral line often complete, although usually more or less broken or irregular.

[4] *Hyborhynchus superciliosus* is not distinct from *Pimephales notatus.* The skin at the angle of the mouth is thickened and produced in the males, but there is no true barbel.

[5] CLIOLA Girard (type *Cliola vigilax*) = *Hypargyrus* Forbes, Proc. U. S. Nat. Mus., 1884, 200 (type *Hybopsis tuditanus* Cope), may be regarded as a genus distinct from *Notropis*, having the short intestines, curved teeth, and other characters of *Notropis*, with the separated first dorsal ray, and the general appearance of *Pimephales notatus.*

[6] *Cliola vigilax* B. & G. = *Cliola velox* Girard = *Cliola vivax* Girard = *Hybopsis tuditanus* Cope = *Alburnops taurocephalus* Hay. This widely-diffused and abundant species is described in detail by Professor Gilbert, Proc. U. S. Nat. Mus., 1884, 200, under the name of *Hypargyrus tuditanus.*

[7] I find it impossible to maintain the distinctions given in the Synopsis, of *Hemitremia, Cliola* and *Minnilus.* I therefore follow Professor Gilbert (Proc. U. S. Nat. Mus., 1884, 201) in uniting all these little fishes in a single genus, *Notropis*, the latter generic name being the earliest applied to any of the group.

[8] *Hemitremia vittata* is here omitted. The species is perhaps not distinct from *N. bifrenatus* or *N. heterodon.* In any case the name *vittatus* is preoccupied in *Notropis.* The number of teeth, 4–5, assigned to *H. vittata* by Professor Cope is probably an accidental variation or an error of observation. In some specimens, which as yet we are unable to separate from *N. heterodon*, the lateral line is complete, and the teeth 2, 4–4, 2. See Gilbert, Proc. U. S. Nat. Mus., 1884, 207.

§ *Alburnops* Girard.

227. **Notropis anogenus**[1] Forbes. Vw.
228. **Notropis spectrunculus** Cope. Vs. (205)
229. **Notropis illecebrosus**[2] Girard. Vw.
230. **Notropis? fretensis**[3] Cope. Vn. (207)
231. **Notropis longirostris** Hay. Vs. (208)
232. **Notropis nitidus**[4] Girard. Vsw.
233. **Notropis deliciosus**[5] Girard. Vw. (213)
233 b. *Notropis deliciosus stramineus* Cope. Ve. (209)
233 c. *Notropis deliciosus longiceps* Cope. Ve. (211)
233 d. *Notropis deliciosus volucellus* Cope. Vn. (210)
234. **Notropis procne** Cope. Ve. (214)
235. **Notropis gilberti**[6] Jordan. Vw.

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[1] *Notropis anogenus* Forbes. Bull. Ill. Lab. Nat. Hist., 1885, 138. Fox R., Ills.

[2] For description of this species see Proc. U. S. Nat. Mus., 1885. The original types of *N. illecebrosus* closely resemble those of *N. blennius*, differing especially in the form of the anterior suborbital which is in this species very narrow. The snout is less convex than in *N. blennius*. Abundant in Western Arkansas. We are unable to find Girard's type of *Alburnops shumardi*, and regard that species as doubtfully a synonym of *A. illecebrosus*.

[3] A doubtful species, unknown to me.

[4] *Moniana nitida* Girard, Proc. Ac. Nat. Sci., Phila., 1856, 201, eroneously referred, in the Synopsis (p. 175), to the synonymy of *Notropis deliciosus*. From the latter species Girard's types differ mainly in the larger, more oblique, and less inferior mouth. The following description is from the original type, from Cadereita, Nuevo Leon:

Head, $3\frac{3}{5}$; depth, $3\frac{3}{4}$; D. 8; A. 7; scales, 5–32–4. Body, stout, rather deep; eye, smallish, $3\frac{1}{2}$ in head; about equal to snout, and about $\frac{1}{5}$ less that interorbital area, which is quite flat; margin of upper lip on level with pupil; mouth rather large, oblique; snout little pointed; maxillary reaching slightly past vertical from front of orbit, its length about $3\frac{1}{6}$ in head; lower jaw shorter than upper, included when the mouth is closed; origin of dorsal slightly nearer tip of snout than base of caudal; about 12 scales in front of dorsal; tips of rays of dorsal all coterminous when the fin is deflexed; length of longest ray of dorsal $1\frac{1}{2}$ in head; base of fin scarcely 2 in head; anal similar to dorsal; longest, ray 2 in head; base, 3 in head; pectorals reaching $\frac{4}{5}$ distance to ventrals, $1\frac{3}{5}$ in head; ventrals reaching $\frac{3}{5}$ distance to anal, $1\frac{3}{5}$ in head; teeth, 4–4, little hooked; color, brownish, a faint silvery band along sides, little wider than diameter of eye, a very small faint dark spot at base of caudal; fins all plain. Two specimens from Cadereita.

[5] The types of *Moniana deliciosa* Girard, Proc. Acad. Nat. Sci. Phila., 1856, 199, are identical with the species described in the Synopsis as *Cliola missuriensis*. This form differs from *N. stramineus* Cope only in the somewhat greater size of the scales, there being 32 to 35 in the lateral line in *deliciosus*, 34 to 38 in *N. stramineus*. The latter, in our view, represents a slight variety found from Wisconsin to Tennessee, the true *deliciosus* ranging from Iowa to Texas.

Hybopsis longiceps Cope, from Virginia, appears also to represent a slight variety of *N. deliciosus*, with a more distinct dark lateral stripe, a rather longer preorbital region and slightly higher fins. Cope's type had the scales 5–33–2. A specimen from Fairfax, Va., has lat. l. 36. The identification of Rafinesque's *Minnilus microstomus* is too uncertain to warrant the use of his name.

Hybopsis volucellus Cope is unknown to me. It will probably prove to represent a variety of *N. deliciosus* with rather higher fins than usual.

[6] *Notropis gilberti* Jordan & Meek, Proc. U. S. Nat. Mus. 1884. It is abundant with *N. deliciosus* in the streams of Iowa, Kansas, and Missouri. From the latter it is readily distinguished by the smaller eye and soiled coloration.

236. **Notropis scylla** Cope. Vw. (212)
237. **Notropis nocomis**[1] Jordan & Gilbert. Vsw.
238. **Notropis phenacobius**[2] Forbes. Vw.
239. **Notropis chlorus** Jordan. Vnw. (216)
240. **Notropis comalis**[3] Jordan & Gilbert. Vsw.
241. **Notropis piptolepis**[4] Cope. (256)
242. **Notropis topeka**[5] Gilbert. V.
243. **Notropis boops**[6] Gilbert. V.
244. **Notropis blennius**[7] Girard. V. (275)
245. **Notropis simus** Cope. Vsw. (218)

§ *Hudsonius* Girard.

246. **Notropis hudsonius**[8] Clinton. Vne. (221)
246 b. *Notropis hudsonius amarus* Girard. Vse. (219, 220, 222)

§ *Codoma* Girard

247. **Notropis ornatus** Girard. Vsw. (226)

§ *Moniana* Girard.

248. **Notropis leoninus**[9] Girard. Vsw. (230)
249. **Notropis lutrensis**[10] Baird & Girard. Vw. (223, 224, 228, 229, 231, 238, 240)

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[1] *Notropis nocomis* Jordan & Gilbert, Proc. U. S. Nat. Mus. 1885. Rio Comal, Texas.

[2] *Notropis phenacobius* Forbes, Bull. Ills. Lab. Nat. Hist., 1885, 137. Peoria, Ills.

[3] *Notropis comalis* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. Rio Comal, Texas.

[4] *Photogenis piptolepis* Cope. Cope's description is repeated in the Synopsis, p. 183, under the erroneous name of *Cliola zonata* (Ag.). Agassiz's species is a very different one, allied to *N. coccogenis*.

[5] *Cliola topeka* Gilbert, Bull. Washburn, Lab. Nat. Hist. Kas., 1884, I, 13; description reproduced, Proc. U. S. Nat. Mus., 1884 Western Iowa and Kansas. The male of this species is bright red in life.

[6] *Notropis boops* Gilbert, Proc. U. S. Nat. Mus., 1884, 201. Indiana to Missouri.

[7] *Alburnops blennius* Girard, Proc. Ac. Nat. Sci. Phila., 1856, 194. This species closely resembles *N. illecebrosus*, but its suborbital bones are very much broader than in the latter species, and its anterior profile is more decurved. One of Girard's types has the teeth 1, 4–4, 0. Arkansas River at Fort Smith.

[8] *Clupea hudsonia* Clinton, Ann. Lyc. N. H. N. Y., 1824 = *Hudsonius fluviatilis* Girard, Proc. Ac. Nat. Sci. Phila., 1856, 210 = *Luxilus selene* Jordan, Bull. U. S. Nat. Mus. X, 60, 1877. Great Lakes and streams eastward as far south as the Susquehanna. Southward (Maryland to Georgia) it is replaced by the subspecies *amarus*, which, as stated in the text, differs only in having the teeth 1, 4–4, 0 or I, instead of 2, 4–4, 2 or I, as in the typical *hudsonius*. *Alburnops saludanus* Jordan & Brayton, and *Hudsonius euryopa* Bean seem to be simply color variations of *amarus*. *Rutilus storerianus* Kirtland has been incorrectly identified with *N. amarus*, it being a species of *Hybopsis*, (= *Ceratichthys lucens* Jordan).

[9] *Moniana leonina, complanata,* and *frigida* Girard. Of these nominal species I have found the types of *M. frigida* only. These seem to represent a species distinct from *N. lutrensis*, having the caudal peduncle more elongate, and 37 scales in the lateral line.

[10] *Leuciscus lutrensis* Baird & Girard = *Hypsilepis iris* Cope = *Moniana jugalis* Cope = *Moniana gibbosa* Girard = *Cyprinella forbesi* Jordan = *Moniana pulchella* Girard = *Moniana couchi* Girard = *Moniana gracilis* Girard = *Moniana lætabilis* Grd. = *Moniana rutila* Grd. = *Cyprinella billingsiana* Cope = ? *Cyprinella suavis* Girard.

Examination of the original types of the above nominal species, and of thousands

250. **Notropis proserpina**[1] Girard. Vsw. (233)
251. **Notropis formosus** Girard. Vsw. (234)
252. **Notropis callisema** Jordan. Vsc. (227)

§ *Cyprinella* Girard.

253. **Notropis bubalinus**[2] Baird & Girard. Vw. (235, 236, 337)
254. **Notropis lepidus** Girard. Vw. (239)
255. **Notropis ludibundus** Girard. Vw. (242)
256. **Notropis garmani**[3] Jordan. Vsw. (236*b*.)
257. **Notropis macrostomus** Girard. Vsw. (241)
258. **Notropis notatus**[4] Girard. Vsw. (243)
259. **Notropis venustus** Girard. Vsw. (244)
260. **Notropis cercostigma**[5] Cope. Vsw. (276)
260b. *Notropis cercostigma stigmaturus* Jordan. Vs. (245, 253)
261. **Notropis whipplei**[6] Girard. Vn. (246, 247)
262. **Notropis galacturus** Cope. Vs. (248)
263. **Notropis camurus**[7] Jordan & Meek. Vw.
264. **Notropis eurystomus** Jordan. Vse. (249)
265. **Notropis niveus** Cope. Vse. (250)
266. **Notropis callistius** Jordan. Vs. (251)
267. **Notropis trichroistius** Jordan & Gilbert. Vs. (252)
268. **Notropis cœruleus** Jordan. Vs. (254)
269. **Notropis chloristius** Jordan & Brayton. Vse. (255)
270. **Notropis xænurus** Jordan. Vse. (257)
271. **Notropis pyrrhomelas** Cope. Vse. (258)
272. **Notropis hypselopterus** Günther. Vs. (259)

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of specimens collected by the writer in different streams from Iowa to Southern Texas have convinced me that all belong to a single species, variable in depth of body according to sex and circumstances, but otherwise very constant.

[1] *Moniana proserpina* Girard, Proc. Ac. Nat. Sci. Phila., 1856, 199. This species is well separated from the others with which Dr. Girard has associated it, and seems to be the same as his *Moniana aurata*.

[2] *Leuciscus bubalinus* Baird & Girard = *Cyprinella umbrosa* Girard = *Cyprinella gunnisoni* Girard. The types of *C. umbrosa* have 32 scales in the lateral line; those of *C. gunnisoni* 34; the latter are young examples of the same species.

[3] *Cyprinella rubripinna* Garman, Bull. Mus. Comp. Zool., 1881, VIII, 91. The name *rubripinna* (*rubripinnis*) is twice preoccupied in the genus *Notropis*, as here understood.

[4] *Cyprinella notata* Girard. This is apparently a valid species, very close to *N. cercostigma*, but with larger scales (34) and a much fainter caudal spot. Specimens from Austin, Tex., agree fairly with Girard's types, which are in very bad condition.

[5] *Cyprinella cercostigma* Cope = *Luxilus chickasavensis* Hay = *Cliola urostigma* Jordan & Meek, Proc. U. S. Nat. Mus., 1884, 475. Specimens examined from Pearl River, Mississippi, and from nearly all the rivers of Texas from the Red to the Nueces. In all these specimens the number of scales in the lateral line is 37 to 39, while in specimens from the Alabama Basin (Etowah, Coosa, Alabama, Black Warrior) the number is from 42 to 44. I regard these as an Eastern variety, *stigmaturus* (*Photogenis stigmaturus* Jordan = *Cyprinella calliura* Jordan). Excepting the size of the scales and the more orange coloration of the fins in the var. *cercostigma*, I can detect no constant difference.

[6] I cannot distinguish *N. analostanus* from *N. whipplei*. Arkansas specimens have the body usually a little more elongate, but are not otherwise different.

[7] *Cliola camura* Jordan & Meek, Proc. U. S. Nat. Mus., 1884, 474. Arkansas Basin, Colorado to Missouri.

§ *Luxilus* Rafinesque.

273. **Notropis megalops**[1] Rafinesque. Vn. (260, 272)
273 b. *Notropis megalops frontalis* Agassiz. Vn.
273 c. *Notropis megalops cyaneus* Cope. Ve.
274. **Notropis coccogenis** Cope. Vse. (262)
275. **Notropis zonatus**[2] Agassiz. Vw.
276. **Notropis zonistius** Jordan. Vse. (263)

§ *Hydrophlox*[3] Jordan & Brayton.

277. **Notropis roseus** Jordan. Vs. (264)
278. **Notropis rubricroceus** Cope. Vse. (265)
279. **Notropis lutipinnis** Jordan & Brayton. Vse. (266)
280. **Notropis chlorocephalus** Cope. Vse. (267)
281. **Notropis chiliticus** Cope. Vse. (268)
282. **Notropis chalybæus** Cope. Ve. (269)
283. **Notropis chrosomus** Jordan. Vs. (270)
284. **Notropis xænocephalus** Jordan. Vs. (271)
285. **Notropis lacertosus** Cope. Vs. (273)
286. **Notropis ariommus**[4] Cope. Ve. (277)
287. **Notropis scabriceps** Cope. Vw. (278)
288. **Notropis jejunus** Forbes. Vw. (279)
289. **Notropis leuciodus** Cope. Vs. (280)
290. **Notropis spilurus**[5] Gilbert & Swain. Vs.
291. **Notropis altipinnis** Cope. Vs. (281)
292. **Notropis amabilis** Girard. Vsw. (282)
293. **Notropis socius** Girard. Vsw. (283)
294. **Notropis swaini**[6] Jordan & Gilbert. Vsw.
295. **Notropis ? bivittatus** Cope. Vw. (284)

§ *Lythrurus* Jordan.

296. **Notropis ardens**[7] Cope. Vs. (289)
296 b. *Notropis ardens lythrurus* Jordan. Vn. (288)
296 c. *Notropis ardens atripes* Jordan. Vw. (287)
296 d. *Notropis ardens cyanocephalus* Copeland. Vn. (286)

[1] *Cyprinus megalops* Rafinesque, Amer. Monthly Magazine and Crit. Review, I, 121, December, 1817 = *Cyprinus cornutus* Mitchill, Amer. Monthly Mag., II, 324, February, 1818. The name of Rafinesque has, therefore, priority.

Hybopsis plumbeolus Cope seems to have been based on a young specimen of this species.

[2] *Alburnus zonatus* Agassiz, Bull. Mus. Comp. Zool., 1, 9, 1863. Abundant in the Ozark region of Missouri and Arkansas; a beautiful species, closely allied to *N. coccogenis*, but with smaller mouth and different coloration. For detailed description see Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885.

[3] As the typical species of *Alburnops* Girard (*blennius*) has the teeth 1, 4–4, 0, the name *Hydrophlox* may be adopted for this section, while *Alburnops* should supersede *Miniellus*.

[4] *Notropis spilurus* Gilbert & Swain, Proc. U. S. Nat. Mus., 1885. Northern Alabama.

[5] *Alburnellus megalops* Girard. The name *megalops* is preoccupied in this genus. For a description of this abundant species, see Jordan, Proc. U. S. Nat. Mus., 1885.

[6] I now regard the forms called in the Synopsis, *diplæmius* (*Minnilus diplæmius* Auct. (not *Semotilus diplæmius* Rafinesque) = *Notropis lythrurus* Jordan, Proc. U. S. Nat. Mus., 1884, 476), *atripes*, *cyanocephalus*, and *ardens* as varieties of a single species, of which the oldest tenable specific name is that of *ardens* Cope.

[7] *Alburnellus umbratilis* Girard = *Minnilus nigripinnis* Gilbert, Bull. Washb. Lab. N. H., 1, 1884, 14 = *Luxilus lucidus* Girard = ? *Notropis macrolepidotus* Forbes. Bull. Ills. Lab. Nat. Hist., 1885. 138. Iowa to Arkansas, very abundant. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885.

297. **Notropis umbratilis**[1] Girard. Vw. (296, 416)
298. **Notropis punctulatus** Hay. Vs. (290)
299. **Notropis roseipinnis**[2] Hay. Vs. (291)
300. **Notropis bellus** Hay. Vs. (292)
301. **Notropis matutinus** Cope. Vse. (293)
302. **Notropis lirus**[3] Jordan. Vs. (294)
303. **Notropis metallicus** Jordan & Meek. Vse.

§ *Notropis.*

304. **Notropis scepticus** Jordan & Gilbert. Vse. (297)
305. **Notropis photogenis** Cope. Vse. (298)
306. **Notropis telescopus** Cope. Vs. (299)
307. **Notropis stilbius** Jordan. Vs. (300)
308. **Notropis atherinoides**[4] Rafinesque. Vn. (302)
309. **Notropis dilectus**[5] Girard. Vw. (295, 303, 305)
310. **Notropis rubrifrons**[6] Cope. Vn. (301, 304)
311. **Notropis micropteryx** Cope. Vw. (306)

§ *Protoporus*[7] Cope. (86)

312. **Notropis ? domninus** Cope. R. (307)
313. **Notropis ? timpanogensis** Cope. R. (285)

82.—ERICYMBA Cope. (87)

314. **Ericymba buccata** Cope. Ve. (308)

83.—PHENACOBIUS Cope. (88)

315. **Phenacobius teretulus** Cope. Ve. (309)
316. **Phenacobius mirabilis** Girard. Vw. (310, 310*b*.)
317. **Phenacobius catastomus** Jordan. Vs. (311)
318. **Phenacobius uranops** Cope. Vs. (312)

84.—TIAROGA Girard.

319. **Tiaroga cobitis** Girard. R. (217)

85.—RHINICHTHYS Agassiz. (89)

320. **Rhinichthys cataractæ**[8] Cuv. & Val. Vn. (313)
320 b. *Rhinichthys cataractæ dulcis* Girard. Vw. (314)

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[1] *Notropis roseipinnis* Hay, nom. sp. nov., for *Minnilus rubripinnis* Hay. The name *rubripinnis* is preoccupied in this genus. *Argyreus rubripinnis* Heckel = *Notropis megalops.*

[2] *Notropis alabamæ* Jordan & Meek, Proc. U. S. Nat. Mus., 1884, 476, seems to be identical with *Notropis lirus,* which again is doubtfully distinct from *N. matutinus.*

[3] *Notropis metallicus* Jordan & Meek, Proc. U. S. Nat. Mus., 1884, 475. Allamaha (Suwannee) River, Georgia.

[4] *Notropis atherinoides* Rafinesque = *Alburnus rubellus* Agassiz =? *Minnilus dinemus* Rafinesque. The synonymy of this and related species is at present in much confusion.

[5] The types of *Alburnellus jemczanus* are shriveled and distorted. I am unable to see how they differ from *N. dilectus.*

[6] *Alburnellus percobromus* Cope seems to be indistinguishable from *N. rubrifrons.*

[7] The genus *Protoporus* is extremely doubtful, both the species referred to it being probably the young of *Squalius* or *Phoxinus.*

[8] Examination of large numbers of specimens of *Rhinichthys* from various parts of the United States has convinced me that not more than two distinct species can be

320 c. *Rhinichthys cataractæ transmontanus* Cope. R. (315)
321. **Rhinichthys atronasus** Mitchill. Vn. (316, 317)

86.—AGOSIA Girard. (90)

§ *Agosia.*

322. **Agosia chrysogaster** Girard. R. (318)
323. **Agosia metallica** Girard. R. (319)
324. **Agosia novemradiata**[1] Cope. R.

§ *Apocope* Cope. (91)

325. **Agosia carringtoni** Cope. R. (320)
326. **Agosia nubila**[2] Girard. R. (321, 322, 323, 324)
327. **Agosia oscula**[3] Girard. R. (325)

87.—HYBOPSIS[4] Agassiz (92)

§ *Nocomis* Girard.

328. **Hybopsis biguttatus**[5] Kirtland. V. (325, 327)

§ *Hybopsis.*

329. **Hybopsis cumingi** Günther. T. ? (329)
330. **Hybopsis storerianus**[6] Kirtland. Vw. (330)

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recognized. *R. transmontanus* represents a tangible variety, occurring west of the Rocky Mountains and having a greater number of scales below the lateral line than I have ever seen in *R. cataractæ*. *Rh. dulcis* has the snout shorter and blunter than usual in *cataractæ*, projecting little beyond the mouth. Garman's review of this genus (Science Observer, 1881, 57) seems to me worse than useless.

[1] *Agosia novemradiata* Cope, Proc. Ac. Nat. Sci. Phila., 1883, 141. Silvery, dusted with smoky above and marked on sides with several rows of dusky spots; bases of lower fins and upper lip red; head elongate, especially the muzzle, which projects a little; eye 4½ in head, 1½ in muzzle, and in interorbital width; dorsal inserted behind ventrals; caudal peduncle rather deep; head 4; depth 5; D. always 1, 9; A. 1, 7; scales 11–60–11. Weber River, at Echo, Utah. (*Cope.*)

[2] On comparison of many examples, including the original types of *Apocope nubila*, *vulnerata*, and *henshavii*, I am unable to appreciate any permanent specific distinctions. The genus *Apocope* is scarcely distinct from *Agosia*.

[3] *Argyreus osculus* Girard = *Argyreus notabilis* Girard = *Apocope ventricosa* Cope. This species differs from *A. nubila* chiefly in the much smaller size of the scales. The original type of *A. osculus* has 90 scales in the lateral line, which is nearly complete.

[4] There is little doubt of the identity of *Hybopsis gracilis* Agassiz with *Ceratichthys amblops*. The name *Hybopsis* is therefore prior both to *Nocomis* and *Ceratichthys* as the designation of this genus.

[5] *Ceratichthys micropogon* Cope is probably based on an abnormal individual of *H. biguttatus*.

[6] *Rutilus storerianus* Kirtland = *Ceratichthys lucens* Jordan. By a curious mistake, Kirtland's species has been confounded by several recent writers with *Notropis amarus*, a species similar in appearance but lacking barbels. This handsome species reaches a length of 10 inches and is abundant in the lakes and river channels of the Mississippi Valley and the lake region. The teeth are usually 1, 4–4, 0.

331. **Hybopsis amblops** Rafinesque. Vw. (331)
331b. *Hybopsis amblops rubrifrons* Jordan. Vse. (332)
332. **Hybopsis hypsinotus** Cope. Vse. (333)

§ *Erinemus* Jordan.

333. **Hybopsis dissimilis** Kirtland. Vn. (334)
334. **Hybopsis monachus** Cope. Vs. (340)
335. **Hybopsis zanemus** Jordan & Brayton. Vse. (339)
336. **Hybopsis labrosus** Cope. Vse. (338)
337. **Hybopsis hyostomus**[1] Gilbert. Vw.
338. **Hybopsis montanus**[2] Meek. Vw.
339. **Hybopsis marconis**[3] Jordan & Gilbert. Vsw.
340. **Hybopsis æstivalis**[4] Girard. Vsw. (335, 336)
341. **Hybopsis gelidus**[5] Girard. Vnw. (337)

88.—COUESIUS Jordan. (93)

342. **Couesius squamilentus** Cope. Vnw. (341)
343. **Couesius dissimilis**[6] Girard. Vnw. (342.)
344. **Couesius plumbeus**[7] Agassiz. Vn. (343)
345. **Couesius physignathus** Cope. Vnw. (344)

89.—PLATYGOBIO Gill.

346. **Platygobio gracilis**[8] Richardson. Vnw. (345, 346)

90.—SEMOTILUS Rafinesque. (95)

347. **Semotilus atromaculatus**[9] Mitchill. V. (347)
348. **Semotilus thoreauianus** Jordan. Vs. (348)
349. **Semotilus bullaris** Rafinesque. Vne. (349)

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[1] *Nocomis hyostomus* Gilbert, Proc. U. S. Nat. Mus, 1884, 203. Indiana, Iowa, to Tennessee; not rare in river channels.

[2] *Hybopsis montanus* Meek, Proc. U. S. Nat. Mus, 1884. Upper Missouri region.

[3] *Hybopsis marconis* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. Rio San Marcos, Texas.

[4] *Gobio æstivalis* Girard = *Ceratichthys sterletus* Cope. This species is allied to *H. hyostomus*, but has a much smaller eye; 4 to 4½ in head.

[5] *Hybopsis gelidus* is very pale in color, nearly or quite immaculate. The lower lobe of the caudal is dusky; the eye is small, 4 in head; and the scales are smaller than in related species, there being 44 in the lateral line. The barbel in these small fishes (*H. gelidus; æstivalis; hyostomus; zanemus; montanus; marconis,*) is much more developed than in any other of the American *Cyprinidæ*.

[6] The description in the Synopsis, of *Couesius dissimilis* is somewhat confused with that of *C. plumbeus*.

From the latter species *C. dissimilis* differs in the larger scales (60 instead of 68), the more decurved lateral line, and the more robust body. Mouth oblique, subterminal, resembling that of *Semotilus*. It is thus far known only from the Upper Missouri region.

[7] *Gobio plumbeus* Agassiz = *Nocomis milneri* Jordan = *Ceratichthys prosthemius* Cope. Adirondack region, northwest to Manitoba.

[8] I am unable to distinguish *Platygobio pallidus*, by the description, from *Platygobio gracilis*.

[9] The original *Cyprinus corporalis* of Mitchill is *Semotilus bullaris*. This species must therefore stand as *Semotilus atromaculatus*.

91.—POGONICHTHYS Girard. (96, 97)

350. Pogonichthys macrolepidotus[1] Ayres. T. (350, 351)

92.—STYPODON Garman. (97*b*.)

351. Stypodon signifer Garman. R. (352)

93.—MYLOCHILUS Agassiz. (98)

352. Mylochilus caurinus Richardson. T. (353)

94.—MYLOPHARODON Ayres. (99)

353. Mylopharodon conocephalus Baird & Girard. T. (225)

95.—PTYCHOCHILUS Agassiz. (100)

354. Ptychochilus oregonensis Richardson. T. (355)
355. Ptychochilus rapax[2] Girard. T. (356)
356. Ptychochilus harfordi Jordan & Gilbert. T. (357)
357. Ptychochilus lucius Girard. T. (358)

96.—GILA Baird & Girard. (101)

358. Gila elegans Baird & Girard. R. (359)
359. Gila robusta Baird & Girard. R. (360)
360. Gila grahami Baird & Girard. R. (361)
361. Gila affinis Abbott. R. (362)
362. Gila gracilis Baird & Girard. R. (363)
363. Gila emorii Baird & Girard. R. (364)
364. Gila nacrea Cope. R. (365)
365. Gila seminuda Cope & Yarrow. R. (366)

97.—PHOXINUS[3] Agassiz. (102, 103)

§ *Clinostomus* Girard.

366. Phoxinus elongatus Kirtland. Vn. (367)
367. Phoxinus vandoisulus Cuv. & Val. Vc. (368)
368. Phoxinus estor Jordan & Brayton. Vs. (369)
369. Phoxinus funduloides Girard. Vc. (370)

§ *Tigoma* Girard.

370. Phoxinus hydrophlox Cope. R. (371)
371. Phoxinus tænia Cope. R. (372)
372. Phoxinus montanus Cope. R. (373)
373. Phoxinus humboldti Girard. R. (374)

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[1] The type of *Pogonichthys* (*Symmetrurus*) *argyriosus* is a young specimen of *Pogonichthys macrolepidotus*.

[2] The chief character in which the single known example of *P. rapax* differs from *P. oregonensis* is in the small size of the scales before the dorsal fin, there being 49 in *P. rapax* and about 42 in *P. oregonensis*.

[3] The character of the imperfection of the lateral line, which alone distinguishes *Phoxinus* from *Squalius*, as understood in the Synopsis, is of such slight importance and subject to such variations that I think best to merge the two groups in one. The name *Phoxinus* seems to have priority.

374. Phoxinus galtiæ[1] Cope. R.
375 Phoxinus cruoreus Jordan & Gilbert. R. (375)
376. Phoxinus ardesiacus Cope. R. (376)
377. Phoxinus pandora Cope. R. (377)
378. Phoxinus margaritus Cope. Vc. (378)
379. Phoxinus gula Cope. R. (379)
380. Phoxinus pulcher Girard. R. (380)
381. Phoxinus egregius Girard. R. (381)
382. Phoxinus lineatus Girard. R. (382)
383. Phoxinus gracilis Girard. R. (383)
384. Phoxinus conformis Girard. T. (384)
385. Phoxinus bicolor Girard. T. (385)
386. Phoxinus obesus Girard. R. (386)
387. Phoxinus purpureus Girard. R. (387)
388. Phoxinus pulchellus Baird & Girard. R. (388)
389. Phoxinus intermedius Girard. R. (389)
390. Phoxinus aliciæ Jouy. R. (390)
391. Phoxinus copei Jordan & Gilbert. R. (391)
392. Phoxinus niger Cope. R. (392)
393. Phoxinus conspersus Garman. R. (393)

§ *Siboma* Girard.

394. Phoxinus crassicauda[2] Baird & Girard. T. (394)

§ *Squalius* Bonaparte.

395. Phoxinus atrarius[3] Girard. R. (395, 397)
396. Phoxinus squamatus Gill. (396)
397. Phoxinus crassus Girard. T. (398)

§ *Cheonda* Girard.

393. Phoxinus cœruleus Girard. T. (399)
399. Phoxinus cooperi Girard. T. (400)
400. Phoxinus nigrescens[4] Girard. R. (401)
401. Phoxinus modestus Garman. R. (402)

§ *Phoxinus.* (103)

402. Phoxinus neogæus Cope. Vn. (403)
403. Phoxinus flammeus Jordan & Gilbert. Vs. (404)
404. Phoxinus milnerianus Cope. Vnw. (405)
405. Phoxinus phlegethontis Cope. R. (406)

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[1] *Squalius galtiæ* Cope, Proc. Ac. Nat. Sci. Phila., 1883, 148. Olive above as far as a plumbeous band which extends from the operculum to base of caudal. Below this line, sides and belly silver, except a broad band of crimson from the gill opening to front of anal; side of head with a dusky band. Dorsal inserted a little behind front of ventrals; muzzle short; mouth oblique, without prominent chin, the end of the maxillary reaching a little beyond front of orbit. Interorbital region gently and regularly convex as wide as eye. Head, 4; depth, 4¼; eye, 3 in head; D. 1, 8; A (probably) 8, scales 12–60–5; teeth 1, 4–5, 1, without grinding surface. Pyramid Lake, Nevada; abundant. (*Cope.*)

[2] The earlier name, *Leuciscus gibbosus* Ayres, is preoccupied by *Leuciscus gibbosus* Storer.

[3] I have no doubt that *Squalius rhomaleus* Jordan & Gilbert is the adult form of *P. atrarius*. *P. squamatus* is, perhaps, also the same species. Several of the species of *Phoxinus* here admitted are of very doubtful validity.

[4] *Tigoma nigrescens* Girard = *Squalius lemmoni* Rosa Smith, Proc. Cal. Ac. Sci., 1883. *P. modestus* is perhaps also this species.

98.—ALGANSEA[1] Girard. (104)

406. **Algansea obesa** Girard. R. (408)
407. **Algansea symmetrica**[2] Baird & Girard. T. (409)
408. **Algansea bicolor** Girard. T. (410)
409. **Algansea parovana**[3] Cope. R. (411)
410. **Algansea thalassina**[4] Cope.
411. **Algansea antica** Cope. Vsw. (412)
412. **Algansea olivacea**[5] Cope. R.
413. **Algansea dimidiata**[6] Cope. R.

§ *Siphateles* Cope.

414. **Algansea vittata**[7] Cope. R.

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[1] *Leucos* Heckel (preoccupied) = *Algansea* Girard = *Myloleucus* Cope. Professor Cope (Proc. Ac. Nat. Sci. Phila., 1883, 142) recognizes *Myloleucus* and *Leucus* as distinct genera; the former with teeth 4–5; the latter 5–5. Besides these, he proposes a third genus, *Siphateles* (*l. c.* 146), having the teeth 5–5, with grinding surface, and the lateral line incomplete. Such minute subdivision seems to me undesirable.

[2] *Pogonichthys symmetricus* Baird & Girard (Proc. Ac. Nat. Sci. Phila., 1854, 136) = *Algansea formosa* Girard (*l. c.* 1856, 183). The original type of *P. symmetricus* has the teeth 4–5, the maxillary without barbel, the head 4 in length, the depth 4½. Scales 9–53–6. I cannot distinguish it from *Algansea formosa*.

[3] Professor Cope regards *Myloleucus parovanus* as distinct from *Algansea bicolor*. It is described as follows:

Translucent, with a plumbeous lateral band; ventrals and pectoral, dusky; dorsal and caudal shaded with dark; body, rather stout; muzzle, short, conical; mouth, very broad, the maxillary reaching front of orbit; profile, gently arched; eye, large, 3 in head, equal to interorbital width; pectorals reaching little more than half way to ventrals; the latter just to vent. Head, 3½; depth, 4¼. D. 1, 9; A. 1, 8. Scales, 10–48–5. Teeth, 4–5. L., 12 inches (*Cope*). Beaver River, Utah; Goose Lake and Klamath Lake, Oregon; abundant.

(*Myloleucus parovanus* Cope, Proc. Am. Phil. Soc. Phila., 1874, 136; Cope & Yarrow, Zoöl. Wheeler Son, V. 669, 1876; Cope, Proc. Ac. Nat. Sci. Phila., 1883, 143.)

[4] *Myloleucus thalassinus* Cope. Slenderer than *M. parovanus*, and the color a light translucent green, quite unlike the heavy olivaceous of the latter. Head, 3⅗; depth, 4½. A. 1, 9. Scales, 9–46–4. Teeth, 4–5. L., 6 inches. One specimen known, from Goose Lake, Oregon. (*Cope*, Proc. Ac. Nat. Sci. Phila., 1883, 143.)

[5] *Leucus olivaceus* Cope. Dusky olive; the belly silvery; no lateral band; fins dusky; body fusiform, compressed; head narrowed to the muzzle, the mouth opening obliquely forwards and upwards; maxillary concealed in the closed mouth, its tip extending a little beyond front of eye. Eye 1⅛ in snout, 1⅗ in interorbital space, 5 in head, middle of front flat, its edges sloping to the superciliary border. Head, 3⅗; depth 4. A. 1, 8. Scales, 13–58–7. Teeth, 5–5, sharp edged. L., 1 foot. Pyramid Lake, Nevada; very abundant. (*Leucus olivaceus* Cope. Proc. Ac. Nat. Sci. Phila., 1883, 145.)

[6] *Leucus dimidiatus* Cope. Light brown above, becoming plumbeous lower, the belly pure silver-white. Eye equal to interorbital width, 3½ in head, a little more than length of muzzle. Mouth oblique, the maxillary reaching front of eye. Ventral a little behind front of dorsal. Head, 4; depth 4½. A. 1, 8. Scales, 14–65–8. Teeth, 5–5. L., 4 inches. Pyramid Lake, Nevada; very abundant.

(*Leucus dimidiatus* Cope, Proc. Ac. Nat. Sci. Phila., 1883, 146.)

[7] *Siphateles vittatus* Cope. Brownish above, belly and sides silvery; a straight lateral band of lead-color interrupted at base of caudal by a vertical band of straw-yellow, which has a dark posterior edge. Lateral line very imperfect. Eye, 3 in head, a little less than interorbital width. Mouth oblique, the maxillary not quite reaching front of eye. Ventral fins beneath anterior part of dorsal. Head 4; depth,

99.—OPSOPŒODUS[1] Hay. (105, 106)

415. **Opsopœodus emiliæ** Hay. Vs. (413, 414)

100.—LUXILINUS[2] Jordan, (gen. nov.).

416. **Luxilinus occidentalis** Baird & Girard. T. (418)

101.—NOTEMIGONUS Rafinesque. (107)

417. **Notemigonus gardoneus** Cuv. & Val. Vse. (415)
418. **Notemigonus chrysoleucus**[3] Mitchill. Vn. (417)
418 b. *Notemigonus chrysoleucus bosci* Cuv. & Val. Vse. (419)

102.—RICHARDSONIUS Girard. (108)

419. **Richardsonius balteatus** Richardson. T. (421)
420. **Richardsonius lateralis** Girard. T. (422)

103.—LEPIDOMEDA Cope. (109)

421. **Lepidomeda vittata** Cope. R. (423)
422. **Lepidomeda jarrovii** Cope. R. (424)

104.—MEDA[4] Girard. (110, 111)

423. **Meda fulgida** Girard. R. (425)
424. **Meda argentissima** Cope. R. (426)

4½. D. 1, 8; A. 1, 8. Scales, 11–55–5. Teeth, 5–5, with well developed grinding surface. L., 3 inches. Pyramid Lake, Nevada. (Cope, Proc. Ac. Nat. Sci. Phila., 1883, 146.)

[1] The genus *Trycherodon* should be suppressed, its typical species, *T. megalops*, being identical with *Opsopœodus emiliæ*.

[2] LUXILINUS Jordan.

(Genus nova: type *Luxilus occidentalis* B. and G.) Ventral edge of moderate width; scaled over and not at all carinated; otherwise essentially as in *Notemigonus*. Gill rakers slender, of moderate length. Teeth 5–5 with entire edges and well developed grinding surface, their tips little hooked. Intestines of the short type, but longer than in most related genera. Anal basis elongate. (Name, a diminutive of *Luxilus*; from *lux*, light.)

[3] Specimens from Virginia, South Carolina, Georgia, and Florida (var. *bosci*) have 43 to 50 scales in the lateral line, and 15 to 17 rays in the anal fin. Specimens from various northern and western localities, Nova Scotia to Maryland, Louisiana, and Dakota (var. *chrysoleucus*) have 46 to 51 scales in the lateral line, and 12 to 14 anal rays. I regard the two forms as geographical varieties of one species. The name *Cyprinus americanus* is preoccupied, having been first given to a *Menticirrus*.

[4] The types of *Meda fulgida*, lately found by me, have the teeth 2, 5–5, 2, not 1,4–4, 1, as stated by Girard. The genus *Meda* is therefore identical with *Plagopterus*. The small barbel mentioned by Cope as a character of *Plagopterus*, I am unable to find either in *Meda* or *Plagopterus*.

Meda fulgida is closely allied to *Meda argentissima*, but has the eye a little larger, the snout shorter, the lower jaw more prominent. In form, size, coloration, and fin rays the two agree fully.

Family XXXIII.—CHARACINIDÆ. (32)

105.—TETRAGONOPTERUS Cuvier. (114)

§ *Astyanax* Baird & Girard.

425. **Tetragonopterus argentatus** Baird & Girard. Vsw. (429)

Order O.—ISOSPONDYLI. (M)

Family XXXIV.—ALEPOCEPHALIDÆ. (33)

106.—ALEPOCEPHALUS Risso. (115)

426. **Alepocephalus bairdii** Goode & Bean. B. (430)
427. **Alepocephalus agassizii**[1] Goode & Bean. B.
428. **Alepocephalus productus**[2] Gill. B.

Family XXXV.—ALBULIDÆ. (34)

107.—ALBULA (Gronow) Bloch & Schneider. (116)

429. **Albula vulpes** Linnæus. S. W. C. P. (116)

Family XXXVI.—HYODONTIDÆ. (35)

108.—HYODON Le Sueur. (117)

430. **Hyodon alosoides** Rafinesque. Vw. (432)
431. **Hyodon tergisus** Le Sueur. Vw. (433)
432. **Hyodon selenops** Jordan & Bean. Vsw. (434)

Family XXXVII.—ELOPIDÆ. (36)

109.—ELOPS Linnæus. (118)

433. **Elops saurus** Linnæus. S. W. P. (435)

110.—MEGALOPS Lacépède. (119)

434. **Megalops atlanticus** Cuv. & Val. S. W. (436)

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[1] *Alepocephalus agassizii* Goode & Bean.

Dusky; head and fins nearly black. Body a little deeper than in *A. bairdii*. Head compressed, the snout conically elongate, the lower jaw slightly produced; width of head 9½ in length of body (12 in *A. bairdii*). Eye 3½ in head (4⅓ in *A. bairdii*). Scales parchment-like. Dorsal inserted directly above vent, the distance from its origin to base of caudal one-third its distance from front of eye. Anal inserted under second ray of dorsal. Length of pectoral equal to diameter of eye and 10½ in body. Ventral about one-sixth of head. Head 3; depth 5. D. 15; A. 17. Scales 10-90-11. Gulf Stream, lat. 30°, in 922 fathoms. (*Goode & Bean.*) (Goode & Bean, Bull. Mus. Comp. Zoöl, 1882, 215.)

[2] *Alepocephalus productus* Gill, Proc. U. S. Nat. Mus., 1883, 256. Gulf Stream, in deep water.

Family XXXVIII.—CHANIDÆ.[1]

111.—CHANOS[1] Lacépède.

435. Chanos chanos[1] Forskål. P.

Family XXXIX.—CLUPEIDÆ.

112.—DUSSUMIERIA[2] Cuvier & Valenciennes.

436. Dussumieria stolifera[3] Jordan & Gilbert. W.

113.—ETRUMEUS[4] Bleeker. (120)

437. Etrumeus teres DeKay. S. (437)

114.—CLUPEA Linnæus. (122, 123)

§ *Clupea.*

438. Clupea harengus Linnæus. G. N. Eu. (437)
439. Clupea mirabilis[5] Girard. A. C. (438, 440)

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[1] Family CHANIDÆ.

Clupeoid fishes, with the body oblong, compressed, covered with small, firm, adherent scales. Lateral line distinct. Abdomen broad and flattish; snout depressed; mouth small, anterior, the lower jaw with a small symphyseal tubercle; no teeth. Premaxillary joined to upper anterior edge of maxillary. Gill membranes broadly united; free from the isthmus. Branchiostegals 4; pseudo-branchiæ well developed. An accessory branchial organ in a cavity behind the gill cavity. Dorsal fin opposite the ventrals; anal fin shorter than dorsal. Mucus membrane of œsophagus raised into a spiral fold. Intestine with many convolutions. Coloration silvery. Large fishes of the warmer parts of the Pacific. One genus and two species known (*Clupeidæ*; group *Chanina* Günther, VII, 473).

Genus CHANOS Lacépède.

(*Lutodeira* Kuhl.)

(Lacépède Hist. Nat. Poiss, V, 395, 1803; type *Mugil chanos* Forskål = *Chanos arabicus* Lacépède.) Characters of the genus included above. (Χάνος, the open mouth.) *Chanos chanos* (Forskål). Pacific and Indian Oceans; abundant in the Gulf of California and southward to Panama.

(*Mugil chanos* Forskål Descr. Anim., 74; *Mugil salmoneus* Forster, Bloch & Schneider, 121; *Chanos salmoneus* Günther, VII, 473, and of recent authors generally.)

[2] DUSSUMIERIA Cuvier & Valenciennes.

(Hist. Nat. Poiss., XX, 467; type *Dussumieria acuta* Cuv. & Val.)

Body rather elongate, somewhat compressed; the abdomen rounded and without serratures. Mouth terminal, of moderate width, formed as in *Clupea*, but the maxillary more slender. Very small teeth in patches on jaws, palatines, pterygoids, and tongue. Scales cycloid, entire, very deciduous. Branchiostegals numerous, very slender. Ventrals inserted below middle or posterior part of dorsal; anal low, of moderate length. Pseudobranchiæ well developed; pyloric cœca numerous. (Dedicated to M. Dussumier, a correspondent of Valenciennes, and the original discoverer of the typical species.)

[3] *Dussumieria stolifera* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 25. Key West, Fla.

[4] The name *Etrumeus* is from *Etrumeiwasi*, the Japanese name of *Etrumeus micropus*. The genera, *Etrumeus* and *Spratelloides*, seem scarcely separable from *Dussumieria*.

[5] *Spratelloides bryoporus* Cope, the types of which species I have examined, seems to be identical with *Clupea mirabilis*.

§ *Sardinia* Poey.

440. Clupea sagax Jenyns. C. (441)
441. Clupea pseudohispanica Poey. W. (441*b*.)

§ *Pomolobus* Rafinesque.

442. Clupea chrysochloris Rafinesque. V. S. (442)
443. Clupea mediocris Mitchill. N. (443)
444. Clupea vernalis Mitchill. N. S. Ana. (444)
445. Clupea æstivalis Mitchill. N. S. Ana. (445)

§ *Alosa* Cuvier.

446. Clupea sapidissima Wilson. N. S. Ana. (446)

§ *Harengula* Cuv. & Val. (123)

447. Clupea sardina[1] Poey. W.
448. Clupea thrissina[2] Jordan & Gilbert. P.
449. Clupea pensacolæ Goode & Bean. S. W. (447)
450. Clupea stolifera[3] Jordan & Gilbert. P.

115.—OPISTHONEMA[4] Gill. (124)

451. Opisthonema oglinum[5] Le Sueur. S. W. (448)

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[1] *Clupea sardina* (Poey) *Sardina de ley, "Pilchard."*

Greenish, sides silvery, the scales often shaded with light orange and dotted with black; a yellow scapular blotch; lips and dorsal fin yellow; older specimens with faint orange streaks along the rows of scales; tips of dorsal and caudal blackish. Body comparatively deep and compressed; lower jaw projecting; teeth in broad patches on jaws, vomer, palatines, and tongue; maxillary reaching nearly to middle of eye, $2\frac{3}{5}$ in head. Eye very large, considerably longer than snout, $2\frac{3}{4}$ in head; cheeks and opercles striate; gill rakers not very long, comparatively few; scales rather large, firm, each crossed by several conspicuous vertical ridges; scales not adherent, readily deciduous. Insertion of dorsal little before that of ventrals at a point considerably nearer snout than base of caudal. Dorsal a little higher than long, its free edge concave; anal low; pectorals nearly reaching ventrals, $1\frac{1}{5}$ in head. Head, $3\frac{1}{5}$; depth, $3\frac{1}{5}$; D. 1, 15; A. 18. Lat. l., 36. Ventral acutes about 15 + 10. L., 8 inches. Florida Keys to Cuba; abundant in schools. Readily distinguished from *Cl. pensacolæ* by the large eye and loose scales.

(*Harengula sardina* Poey, Memorias Cuba, II, 310, 1860; *Harengula sardina* Poey, Enum. Pisc. Cubens., 1875, 147; ? ? *Clupea macrophthalma* Ranz., Nov. Com. Ac. Sci. Inst. Bonon., 1842, 320; ? ? *Clupea humeralis* Cuv. & Val., XX, 293; not *Clupea macrophthalma* nor *Clupea humeralis* Günther. *Harengula sardina* Goode & Bean, Proc. U. S. Nat. Mus., 1879, 152; *Clupea sardina* Jordan, Proc. U. S. Nat. Mus., 1881, 106.)

[2] *Clupea thrissina* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 353. Cape San Lucas.

[3] *Clupea stolifera* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 339. Mazatlan to Panama.

[4] *Opisthonema oglinum* (Le Sueur) Goode & Bean.

Omit from the synonymy *Clupea thrissa*[5] Osbeck, and add:

(*Megalops oglina* and *M. notata* Le Sueur, Journ. Ac. Nat. Sci. Phila., 1, 359, 361; *Chatoëssus signifer* DeKay, New York Fauna Fishes, 1842, 264: *Opisthonema oglinum* Goode & Bean MSS.)

[5] The original basis of *Clupea thrissa* L. was a fish brought by Lagerström from China and described by Linnæus's pupil, Odhel, in the Amœn. Academ., V, 251, as *Clupea thryza*. This is a species of *Dorosoma*. To this latter genus belongs also the *Clupea thrissa* of Osbeck. In the synonymy of *Clupea thrissa* of the tenth edition of the *Systema Naturæ*, several references to *Opisthonema* are included, while the *Clupea thrissa*, described in the twelfth edition as being received from Dr. Garden, is *Dorosoma cepedianum*. The *Clupea thrissa* of Broussonet and of most later authors is the *Opisthonema*, but the Linnæan name must go with the original intention of its author.

452. **Opisthonema libertate**[1] Günther. P.

116.—BREVOORTIA Gill. (125)

453. **Brevoortia tyrannus** Latrobe. N. S. (450)
453 b. *Brevoortia tyrannus patronus* Goode. S. (449)

117.—OPISTHOPTERUS[2] Gill.

454. **Opisthopterus lutipinnis**[3] Jordan & Gilbert. P.

Family XL.—DOROSOMIDÆ. (38)

118.—DOROSOMA Rafinesque. (126)

455. **Dorosoma cepedianum** Le Sueur. V: S. N. (451)
456. **Dorosoma mexicanum** Günther. S. (451 *b*)

Family XLI.—ENGRAULIDÆ. (39)

119.—STOLEPHORUS Lacépède. (127)

457. **Stolephorus ringens** Jenyns. C. P. (452)
458. **Stolephorus macrolepidotus**[4] Kner & Steindachner. P.
459. **Stolephorus opercularis**[5] Jordan & Gilbert. P.
460. **Stolephorus browni** Gmelin. N. S. W. (453)
461. **Stolephorus perthecatus**[6] Goode & Bean. S.

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[1] *Meletta libertatis* Günther, Proc. Zool. Soc., Lond., 1866, 303; *Clupea libertatis* Günther, VII, 433; *Opisthonema libertate* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 622; Mazatlan to Panama, abundant.

[2] OPISTHOPTERUS Gill.

(Proc. Ac. Nat. Sci. Phil., 1861; 31; type *Pristigaster tartoor* Cuv. & Val.)

Body elongate, very much compressed, with the abdomen prominent and strongly serrated. Scales thin, deciduous, of moderate size. Lower jaw projecting; teeth rather small, in villiform bands on both jaws, palatines, pterygoids and tongue; vomer toothless. Dorsal fin small, considerably behind middle of body. Anal fin very long. Ventrals wanting. Caudal deeply forked. Tropical parts of the Pacific. (*Ὄπισθη*, behind; *πτέρον*, fin, the dorsal being placed farther backward than in the closely related genus *Pristigaster*.)

[3] *Pristigaster lutipinnis* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 340. Gulf of California and southward.

[4] *Stolephorus macrolepidotus* Kner & Steindachner. Body comparatively short and deep. Head one-fourth longer than deep. Snout very short, not projecting far beyond lower jaw. Jaws toothless. Maxillary narrow, rounded behind, extending to angle of preopercle. Abdomen slightly compressed. Scales adherent. Origin of dorsal slightly behind middle of body. Silvery, sides with an indistinct bluish band. Head 3½; depth 3, D. 12, A. 28. Scales 35-9. Mazatlan to Panama, one of the largest of the American species of *Stolephorus*.

(*Engraulis macrolepidotus* Kner & Steindachner, Abhandl. Bayer, Akad. Wiss. X, 1864; *Engraulis macrolepidotus* Günther, VII, 385.)

[5] *Stolephorus opercularis* Jordan & Gilbert. Proc. U. S. Nat. Mus., 1881, 275. (Gulf of California.)

[6] *Stolephorus perthecatus* Goode & Bean., Proc. U. S. Nat. Mus., 1882, 434.

Pensacola, Fla. Apparently distinguished from *S. browni* by the short anal and from *S. perfasciatus* by the long maxillary.

462. Stolephorus ischanus[1] Jordan & Gilbert. P.
463. Stolephorus perfasciatus[2] Poey. W.
464. Stolephorus eurystole[3] Swain & Meek. N. (455)
465. Stolephorus curtus[4] Jordan & Gilbert. P.
466. Stolephorus mitchilli Cuv. & Val. N. S. (454 *b.*)
467. Stolephorus exiguus[5] Jordan & Gilbert. P.
468. Stolephorus miarchus[6] Jordan & Gilbert. W. P.
469. Stolephorus delicatissimus Girard. C.
470. Stolephorus lucidus[7] Jordan & Gilbert. P.
471. Stolephorus compressus Girard. C.

Family XLII.—ALEPIDOSAURIDÆ. (40)

120.—PLAGYODUS[8] Steller. (128)

472. Plagyodus ferox Lowe. B. (458)
473. Plagyodus æsculapius Bean. A. (458 *b.*)
474. Plagyodus borealis Gill. C. A. (459)

Family XLIII.—PARALEPIDIDÆ. (41)

121.—SUDIS Rafinesque. (129)

§ *Sudis.*

475. Sudis ringens Jordan & Gilbert. B. P. (459)

§ *Arctozenus* Gill.

476. Sudis borealis[9] Reinhardt. G. A. B. (461, 462)

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[1] *Stolephorus ischanus* Jordan & Gilbert., Proc. U. S. Nat. Mus., 1881, 340. Mazatlan southward. Closely related to *S. browni.*

[2] *Stolephorus perfasciatus* (Poey).

Body rather elongate; snout compressed and pointed, shorter than eye. Top of head with a slight keel. Eye 3½ in head. Maxillary and lower jaw finely toothed; maxillary unusually short, its posterior end rounded, not extending quite to margin of preopercle; gill rakers numerous; pectoral 1⅔ in head, not reaching ventrals; insertion of anal below last rays of dorsal, the fin short; origin of dorsal midway between root of caudal and pupil. Color of *S. browni,* the lateral band rather narrower, well defined, its width about ⅔ eye; no dark punctulations except on base of caudal and sometimes on anal. Head 4¼; depth 6, D. 12, A. 14 to 16, L. 2 to 3 inches. (*Swain & Meek.*) Florida Keys to Cuba, common, but much less abundant than *S. browni.*

(*Engraulis perfasciatus* Poey, Mem. Cuba, II, 313, 1858. *Engraulis perfasciatus* Günther, VII, 391; not of Swain. Bull. U. S. Fish. Comm., 1882, 55, nor of Jor. & Gilb., Synopsis, 273; Swain & Meek, Proc. Ac. Nat. Sci. Phila. 1884.)

[3] *Stolephorus eurystole* Swain & Meek, Proc. Ac. Nat. Sci. Phila. 1884, 35. Wood's Holl, Mass. This is the species described in the Synopsis, p. 273, under the erroneous name of *S. perfasciatus.*

[4] *Stolephorus curtus* Jordan & Gilbert. Proc. U. S. Nat. Mus., 1881, 343. Mazatlan.

[5] *Stolephorus exiguus* Jordan & Gilbert. Proc. U. S. Nat. Mus., 1881, 342.

[6] *Stolephorus miarchus* Jordan & Gilbert. Proc. U. S. Nat. Mus., 1881, 344; 1882, 622; 1884, 106, Key West; Mazatlan, Panama. The smallest of the American anchovies.

[7] *Stolephorus lucidus* Jordan & Gilbert. Proc. U. S. Nat. Mus., 1881, 341. Mazatlan.

[8] It is probably best to substitute Steller's name, *Plagyodus,* for the later *Alepidosaurus.*

[9] *Sudis coruscans* is probably not specifically distinct from *S. borealis.*

Family XLIV.—SYNODONTIDÆ.[1] (42 part.)

122.—SYNODUS (Gronow) Bloch & Schneider.

§ *Synodus.*

477. **Synodus fœtens** Linnæus. S. (463)
478. **Synodus spixianus**[2] Poey. W.
479. **Synodus scituliceps**[3] Jordan & Gilbert. P.
480. **Synodus lucioceps** Ayres. C. (464)
481. **Synodus anolis**[4] Cuv. & Val. W. (464*b*.)

§ *Trachinocephalus* Gill.

482. **Synodus myops** Forster. S. W. (465)

123.—BATHYSAURUS[5] Günther.

483. **Bathysaurus agassizii** Goode & Bean. B.

Family XLV.—SCOPELIDÆ. (42)

124.—MYCTOPHUM Rafinesque. (131)

484. **Myctophum crenulare** Jordan & Gilbert. C. (466)

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[1] Apparently those genera of the group called in the synopsis *Scopelidæ*, which have the maxillary rudimentary and adnate to the premaxillary, or sometimes entirely wanting, should be detached from *Scopelidæ*, to form a separate family, which has been called *Synodontidæ* by Professor Gill. To this group belong, in our fauna, the genera *Synodus* and *Bathysaurus*, as well as the Old World genera of *Harpodon* and *Saurida*.

[2] *Synodus spixianus* Poey. *Lagarto : Soap-fish.*

Sandy gray, light or dark, much mottled above with darker olive; branchiostegals pale yellowish; top of head without distinct vermiculations; dorsal scarcely barred; caudal dusky; other fins pale, with little or no yellow in life; lower parts of head mottled with dusky. No scapular spot; tip of snout not black. General form and appearance of *S. fœtens*, the teeth rather stronger; the jaws a little longer; the upper 1½ in head. Dorsal fin shorter and higher, its free edge more oblique than in *S. fœtens*, its anterior rays when depressed extending beyond the tips of the posterior, 1¾ in head. Scales about as in *S. fœtens*. Pectorals 2 in head; ventrals 1¼. D. 1, 9. A. 11 or 12. Lat. l. 60. Florida Keys and Cuba. Abundant.

(*Saurus spixianus* Poey. Memorias Cuba, ii, 304, 1860; Poey, Enum. Pisc. Cubens., 1875, 141, Jordan, Proc. U. S. Nat. Mus., 1884, 107.)

For a detailed account of this and other American species of *Synodus*, see Meek, Proc. Ac. Nat. Sci. Phila., 1884, 130.

[3] *Synodus scituliceps* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 344. Mazatlan to Panama.

[4] The species described in the Synopsis (p. 889) as *Synodus intermedius*, is not that species, but a different one, *Saurus anolis* Cuv. & Val., xxii, 1849, 438 = *Synodus cubanus* Poey, Enum. Pisc. Cubens. 1875, 143. *Saurus intermedius* Agassiz & Spix. = *Synodus intermedius* Poey, Enum. Pisc. Cubens. 1875, 143, has the mouth smaller than in *S. anolis*, the scales larger (lat. l. 45), the scapular region without distinct black spot, and the coloration less variegated. *S. intermedius* is common in Cuba, but has not yet been noticed in our waters. In the adult of *S. anolis*, the lower parts are marked by stripes formed by an orange spot on each scale; the number of cross-bars is usually doubled by the presence of a shorter one between each pair.

[5] BATHYSAURUS Günther.

(Günther Ann. Mag. Nat. Hist., Aug., 1878, 181); type *Bathysaurus ferox* Günther.) Body formed as in *Synodus*, subcylindrical, elongate, covered with small scales.

485. Myctophum mülleri[1] Gmelin. G. (467)

486. Myctophum boops[2] Richardson. A.

125.—MAUROLICUS[3] Cocco. (132)

487. Maurolicus borealis Nilsson. B. (468)

Head depressed, with the snout produced, flat above. Cleft of the mouth very wide, with the lower jaws projecting; premaxillary very long, styliform, tapering, not movable; maxillary obsolete. Teeth in the jaws in broad bands, not covered by lips, curved, unequal in size, and barbed at the end; a series of similar teeth along the whole length of each side of the palate; a few teeth on the tongue, and groups of small teeth on the hyoid; eye moderate, lateral. Pectoral moderate; ventrals 8-rayed, inserted close behind pectoral. Dorsal fin median, of about 18 rays; adipose fin present or absent; anal moderate; caudal emarginate. Gill openings very wide, the gill membranes separate, free from the isthmus. Branchiostegals 11 or 12. Gill laminæ well developed; gill-rakers tubercular; pseudobranchiæ well developed. Scales rather small. Deep-sea fishes. (*Βαθύς*, deep; *σαυρος*, *saurus* = *Synodus*.)

Bathysaurus agassizii Goode & Bean.

Body elongate, subterete. Head alligator-like, naked, except on cheek and occiput, with strong nasal and interorbital ridges; its greatest width more than half its length; gape of mouth very wide, one-sixth length of body, extending behind eye for a distance equal to interorbital width. Premaxillary with two irregular rows of depressible teeth, some of them barbed, those of inner row much the largest; lower jaw enormously strong, its sides projecting beyond the upper jaw; its dentary edge thickly studded with depressible teeth, many of them, especially the larger inner ones, strongly barbed; those in front, claw-like, recurved; three rows of teeth on the palatines, the middle ones very much enlarged and most of them strongly barbed, these being the largest of all the teeth. On the tongue a few weaker teeth, and groups of similar teeth on the vomer. Insertion of dorsal behind snout at a distance a little more than its own base and about one-third the total length; longest ray equal to greatest depth of body. No adipose dorsal (in the specimen known); anal inserted considerably behind last ray of dorsal, its base about half that of the dorsal. Ventrals well apart, inserted just in front of dorsal, their length half head. Pectoral as long as lower jaw, its seventh ray prolonged to a length equal to that of head. Caudal slightly forked; scales thin, cycloid, deciduous, those of the lateral line larger. brownish; lining of gill cavity blue-black. Head, 3½; depth, 7. B. 10, D. 17, A. 11, C. 19, P. 15, A. 8. Scales, 8–78–8. Length, 18 inches.

Gulf Stream, lat. 33°, at a depth of 647 fathoms. (*Goode & Bean.*)

(Goode & Bean, Bull. Mus. Comp. Zoöl., 1882, 215.)

[1] This species should stand as *Myctophum mülleri* instead of *M. glaciale*. To the synonymy add: *Salmo mülleri* Gmelin, Syst. Nat. 1788, 1378; *Scopelus mülleri*, Collet, Norske Nordhavs Exped., 1880, Fiske, 158; *Scopelus mülleri* Goode & Bean, Bull. Mus. Comp. Zoöl., 1882, 223.

This species has been lately taken in the deep waters off Southern New England.

[2] *Myctophum boops* Richardson.

Depth of head 1⅚ in its length; eye nearly 3 in head; twice its distance from preopercle. Snout short, obtuse, its upper profile descending in a strong curve; jaws equal; maxillary reaching nearly to angle of preopercle, slightly and gradually dilated behind; cleft of mouth very slightly oblique. Origin of dorsal considerably nearer tip of snout than root of caudal, above base of ventrals; its last ray before origin of anal; pectoral reaching vent. Scales smooth, thin, and deciduous. Head 3½; depth 5. D. 14. A. 21, V. 8 Scales 3–38–5. L. 4½ inches. Vancouver's Island. (*Günther*).

(Richardson, Zoöl. Erebus and Terror. Fishes, 39, pl. 27. *Scopelus boops*, Günther, V, 408.)

[3] According to Professor Gill, the genus *Maurolicus* belongs to the *Scopelidæ* and not to the *Sternoptychidæ*.

Family XLVI.—HALOSAURIDÆ.[1]

126.—HALOSAURUS Günther.

488. **Halosaurus macrochir** Günther. B.

Family XLVII.—STOMIATIDÆ. (45)

127.—STOMIAS Cuvier. (134)

489. **Stomias ferox** Reinhardt. B. (470)

128.—HYPERCHORISTUS[2] Gill.

490. **Hyperchoristus tanneri** Gill. B.

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[1] Family HALOSAURIDÆ.

Body elongate, compressed posteriorly, tapering into a very long and slender tail, which becomes compressed and narrowed into a sort of filament. Abdomen rounded. Scales rather small, cycloid, deciduous. Sides of head scaly; lateral line present, running along the sides of the belly, its scales, in the known species, enlarged, each in a pouch of black skin with a phosphorescent organ at its base. No barbels. Head subconical, depressed anteriorly, the flattened snout projecting beyond the mouth. Mouth inferior, horizontal, of moderate size, its anterior margin formed by the pre-maxillaries, its lateral margin by the maxillaries, which are of moderate width. Teeth small, in villiform bands, on the jaws, vomer, palatines, and tongue. Eye rather large. Facial bones with large muciferous cavities. Preopercle produced behind in a large flat process, "replacing the sub- and interoperculum." Bones of head unarmed. Gills 4, a slit behind the fourth. Pseudobranchiæ none. Gill-rakers short. Gill membranes separate, free from the isthmus. Branchiostegals numerous (about 14). Dorsal fin short, rather high, inserted behind ventrals and before vent. No adipose fin; no caudal fin. Anal fin extremely long, extending from the vent to the tip of the tail (its rays about 200 in number). Ventrals moderate, not very far back. Pectorals rather long, narrow, inserted high. No axillary scales. Air bladder large, simple. Stomach cœcal; pyloric cœca in moderate number; intestines short. Ovaries closed. No phosphorescent spots. A single genus, with about 5 species; fishes of the deep sea. (*Halosauridæ* Günther, VII, 482.)

HALOSAURUS Johnson.

(Johnson, Proc. Zoöl. Soc. London, 1863, 406; type *Halosaurus oweni*, Johnson, from Madeira). Characters of the genus included above. (Ἅλς, sea; σαυρος, lizard.)

Halosaurus macrochir Günther.

Everywhere blackish, the color nearly uniform. Snout moderate, its length from mouth 7 in length of head; eye small, 7½ in head, 2 in interorbital space. Length of head slightly greater than its distance from ventral. Maxillary reaching vertical from front of eye; its length from tip of snout 2⅓ in head. Insertion of dorsal entirely behind the ventrals. Ventrals midway between preopercle and front of anal, their length 2⅝ in head. Pectorals nearly reaching ventrals, 1¼ in head. Base of dorsal 3½ in head, its longest ray 2. B. 12. D 1, 10, or 11, V. 9. Deep waters of the Atlantic; not rare in the Gulf Stream.

(Günther, Ann. Mag. Nat. Hist., 1878, 251; Goode & Bean, Bull. Mus. Comp. Zoöl., 1882, 219. *Halosaurus goodei* Gill, Proc. U. S. Nat. Mus., 1883, 257.)

[2] HYPERCHORISTUS Gill.

(Gill, Proc. U. S. Nat. Mus., 1883, 256; type, *Hyperchoristus tanneri* Gill.)

"Stomiatids, with a robust claviform body, naked skin, teeth on the jaws nearly uniserial, but in several groups, of which the successive teeth (about 4) rapidly

129.—ECHIOSTOMA Lowe. (135)

491. **Echiostoma barbatum** Lowe. B. (471)

130.—MALACOSTEUS[1] Ayres. (136)

492. **Malacosteus niger** Ayres. B. (472)

131.—ASTRONESTHES Richardson. (137)

493. **Astronesthes niger** Richardson. B. (473)

Family XLVIII.—ARGENTINIDÆ.[2] (46 part.)

132.—MICROSTOMA Cuvier. (138)

494. **Microstoma grœnlandicum** Reinhardt. G. (474)

133.—MALLOTUS Cuvier. (140)

495. **Mallotus villosus** Müller. A. G. (475, 476)

134.—THALEICHTHYS Girard. (141)

496. **Thaleichthys pacificus** Richardson. A. Ana. (477)

135.—OSMERUS Linnæus. (142)

497. **Osmerus thaleichthys**[3] Ayres. C. (478)
498. **Osmerus mordax** Mitchill. N. Ana. (480)
499. **Osmerus dentex** Steindachner. A. (481)

136.—HYPOMESUS Gill. (143)

500. **Hypomesus pretiosus** Girard. C. (482)
501. **Hypomesus olidus** Pallas. A. (483)

137.—ARGENTINA Linnæus.

502. **Argentina syrtensium** Goode & Bean. B. (484)

138.—HYPHALONEDRUS[4] Goode. (145)

503. **Hyphalonedrus chalybeius** Goode. B. (485)

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increase in size backwards, and teeth on the palate enlarged, one on each side of the vomer and several on the palatines; moderate dorsals obliquely opposed, forked caudal and pectorals, each with a separate and specialized uppermost ray." (Ὕπηρ, above; χοριστος, split, in allusion to the division of the pectorals.)

The species *H. tanneri* Gill, from the Gulf Stream in deep water, has not been described.

[1] According to Dr. Bean, the so-called barbel at the throat in *Malacosteus niger* is a muscle apparently concerned in the movement of the mandible.

[2] The *Argentininæ* may well be regarded as a family distinct from the *Salmonidæ*, differing in the form of the stomach, as stated in the Synopsis.

[3] *Osmerus attenuatus* Lockington, an extremely doubtful species, is here omitted, as also the land-locked varieties of *O. mordax*.

[4] This genus perhaps belongs to the *Scopelidæ*.

Family XLIX.—SALMONIDÆ. (46)

139.—COREGONUS Linnæus. (146)

§ *Prosopium* Milner.

504. **Coregonus williamsoni** Girard. R. (487)
505. **Coregonus quadrilateralis** Richardson. Vn. (488)
506. **Coregonus kennicotti** Milner. Y. (489)
507. **Coregonus nelsoni**[1] Bean. Y.

§ *Coregonus.*

508. **Coregonus clupeiformis** Mitchill. Vn. (490)
509. **Coregonus labradoricus** Richardson. Vn. (491)

§ *Argyrosomus* Agassiz.

510. **Coregonus hoyi** Gill. Vn. (492)
511. **Coregonus merki** Günther. Y. (493)
512. **Coregonus laurettæ** Bean. Y. (493 *b.*)
513. **Coregonus artedi** Le Sueur. Vn. (494)
514. **Coregonus nigripinnis** Gill. Vn. (495)

§ *Allosomus* Jordan.

515. **Coregonus tullibee** Richardson. Vn. (496)

140.—THYMALLUS Cuvier. (147)

516. **Thymallus signifer** Richardson. Y. Vn. (497)
516 b. *Thymallus signifer ontariensis*[2] Cuv. & Val. Vn. (497 *b.*)

141.—STENODUS[3] Richardson. (148)

517. **Stenodus mackenziei** Richardson. Y. Vn. (498)

142.—ONCORHYNCHUS Suckley. (149)

518. **Oncorhynchus gorbuscha** Walbaum. C. A. Ana. (499)

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[1] *Coregonus nelsoni* Bean, Proc. U. S. Nat. Mus., 1884; waters of Alaska.

[2] *Thymallus ontariensis* Cuvier & Valenciennes, XXI, 452, 1848 (specimens sent by Milbert from Lake Ontario)=*Thymallus tricolor* Cope. The following is a translation of Valenciennes' account: We have received from Lake Ontario a *Thymallus* very near to that of the lake of Geneva. It has, however, more naked space under the throat, although less than in *Thymallus gymnothorax*. The head is evidently more pointed, the body more elongate, the dorsal a little longer. The denticulations of the scales are more pronounced. The colors seem scarcely to differ from those of *Thymallus*, for our specimens are greenish, with a dozen gray lines along the flanks. The dorsal has 4 or 5 longitudinal streaks of red. Our specimens are a foot long; they have been sent by M. Milbert. (*Valenciennes l. c.*)

[3] The original diagnosis of *Stenodus* is said to be in "Appendix Bach's Voyage. Rept. N. Am. Zoöl., 1836."

According to Dr. Bean, our species is probably not distinct from the Asiatic species, *S. leucichthys* (Guldenstadt).

519. **Oncorhynchus keta** Walbaum. C. A. Ana. (500)
520. **Oncorhynchus tchawytcha** Walbaum. C. A. Ana. (501)
521. **Oncorhynchus kisutch** Walbaum. C. A. Ana. (502)
522. **Oncorhynchus nerka** Walbaum. C. A. Ana. (503)

143.—SALMO Linnæus. (150)

§ *Salmo.*

523. **Salmo salar L.** N. Eu. Ana. (504)
523 b *Salmo salar sebago* Girard. Vne.

§ *Salar*[1] Cuv. & Val.

524. **Salmo gairdneri** Richardson. C. A. (506)
524 b *Salmo gairdneri irideus*[2] Ayres. T. (505)
525. **Salmo purpuratus** Pallas R. C. A. (508)
525 b. *Salmo purpuratus bouvieri* Bendire. R.
525 c. *Salmo purpuratus stomias* Cope. R.
525 d. *Salmo purpuratus henshawi* Gill & Jordan. R.
525 e. *Salmo purpuratus spilurus* Cope. R. (507)

144.—SALVELINUS Richardson. (151)

§ *Cristivomer* Gill & Jordan.

526. **Salvelinus namaycush** Walbaum. Vn. (509)
526 b *Salvelinus namaycush siscowet* Agassiz. Vn.

§ *Salvelinus.*

527. **Salvelinus oquassa**[3] Girard. Vne. (510, 511, 516?)
528. **Salvelinus arcturus** Günther. Vne. (512)
529. **Salvelinus malma** Walbaum. Y. C. A. (513)
530. **Salvelinus fontinalis** Mitchill. Vne. (514, 515)
530 b *Salvelinus fontinalis immaculatus* H. R. Storer. N. Ana.
531. **Salvelinus stagnalis**[4] Fabricius. G. (517?, 518)

Family L.—PERCOPSIDÆ.

145.—PERCOPSIS Agassiz. (152)

532. **Percopsis guttatus** Agassiz. Vn. (519)

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[1] This subgenus is called *Fario* in the Synopsis, but the type of *Fario* is probably a genuine *Salmo*.

[2] *Salmo gairdneri* is probably the adult sea-run form of *Salmo irideus*.

[3] *Salvelinus rossi* may be omitted from the lists, as no diagnostic characters of importance occur in the description. It may be treated as a very doubtful synonym of *S. oquassa*. *S. naresi* agrees very closely with *S. oquassa*.

[4] *Salvelinus nitidus* may be omitted, as probably identical with *S. stagnalis*. For a description of this species see *Dresel*, Proc. U. S. Nat. Mus., 1884, 255.

Family LI.—STERNOPTYCHIDÆ.[1] (43)

146.—ARGYROPELECUS[2] Cocco.

533. Argyropelecus hemigymnus Cocco. O. Eu.
534. Argyropelecus olfersi Cuvier. O. Eu.

147.—STERNOPTYX[3] Hermann.

535. Sternoptyx diaphana Hermann. O. Eu.

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[1] A suborder *Iniomi*, to include the *Sternoptychidæ* and *Chauliodontidæ*, has been proposed by Dr. Gill, Proc. U. S. Nat. Mus., 1884, 350. The chief respect in which these families differ from the other *Isospondyli* is in the mode of articulation of the scapular arches, which connect with and impinge on the occiput behind and are otherwise free from the cranium. (*Ινίον*, nape; ὤμός, shoulder.)

Dr. Günther and others have stated that the *Sternoptychidæ* possess a "rudimentary spinous dorsal fin." This appearance is due to the projection of one or more of the neural spines beyond the muscles, and is in no proper sense a rudiment of a fin. (See Gill, l. c., 350.)

[2] ARGYROPELECUS Cocco.

(*Pleurothyris* Lowe.)

(Cocco, Giorn. Sci. Sicil., 1829, fasc. 77, p. 146; type, *Argyropelecus hemigymnus* Cocco.)

Body much elevated and compressed, passing abruptly into the slender tail; no scales, the skin covered with silvery pigment; series of phosphorescent spots along the lower side of the head, body, and tail. Head large, compressed, and elevated, the bones thin but ossified. Cleft of mouth wide, vertical, the lower jaw prominent. Margin of upper jaw formed by the maxillary and premaxillary, both of which have a sharp edge, which is beset with minute teeth; lower jaw and palatine bones with a series of small curved teeth. Eyes large, very close together, lateral, but directed upwards. Angle of preopercle with a spine usually directed downwards. Pectorals well developed; ventrals very small. Humeral arch and pubic bones prolonged into flat pointed processes, which project in the median line of the belly; a series of imbricated scales from the humeral bone to the pubic spine, forming a ventral serrature. Dorsal fin short, median, preceded by a serrated osseous ridge, consisting of several neural spines prolonged beyond the muscles. Adipose fin rudimentary; anal fin short; caudal forked. Gill opening very short, the outer branchial arch extending forward to behind the symphysis of the lower jaw, and beset with very long gill rakers; branchiostegals nine; pseudobranchiæ and air-bladder present. Four pyloric cœca. Small pelagic fishes. (*Αργυρος*, silvery; *πελεκυς*, hatchet.)

Argyropelecus hemigymnus Cocco. Depth of body equal to distance between gill-openings and base of caudal; posterior corner of mandible and angle of preopercle each with a small triangular spine; tail without spines; pectoral fin nearly reaching anal. B. 9, D. 7 or 8, A. 11, P. 9, V. 5, L. 2 inches, (*Günther*). Atlantic and Mediterranean in deep water; not rare in the Gulf Stream off Southern New England.

(Cocco, l. c., Cuv. & Val. XXII, 398; Günther, V, 385; Goode & Bean, Bull. Mus. Comp. Zoöl., 1882, 220.)

Argyropelecus olfersi (Cuvier) C. & V. Depth nearly or quite equal to distance from shoulder to root of caudal; tail as deep at base as long. Mandible with a short flat spine at its posterior corner; preopercular spine directed downwards; tail without spines; pectoral fin reaching ventrals. B. 9, D. 9, A. 11, P. 10, V. 6 (*Günther*). Coast of Norway, lately taken in the Gulf Stream, off Southern New England.

(*Sternoptyx olfersi* Cuvier, Règne Animal., ed. 2d, II, 316; Cuv. & Val. XXII, 408; Günther, V, 386; *Pleurothyris olfersi* Lowe, Fish. Madeira, 64.)

[3] STERNOPTYX Hermann.

(Hermann, Naturforscher, 1771, XVI, 8; type *Sternoptyx diaphana* Hermann.)

Trunk much elevated and compressed, the slender tail very short; abdominal out-

Family LII.—CHAULIODONTIDÆ. (44)

148.—CHAULIODUS Bloch & Schneider. (133)

536. Chauliodus sloani Bloch & Schneider. B. Ev. (469)

149.—CYCLOTHONE[1] Goode & Bean.

537. Cyclothone lusca Goode & Bean. B.

150.—SIGMOPS[2] Gill.

538. Sigmops stigmaticus Gill. B.

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line nearly continuous, in a sigmoid curve; teeth of the jaws in several series, the largest teeth in the inner row; a single spike-like neural spine before dorsal; branchiostegals, 5. Otherwise essentially as in *Argyropelecus*. (*Στερνον*, breast: *πτυξ*, fold or plait.)

Sternoptyx diaphana Hermann.

Depth equal to distance between tip of snout and base of the very short tail. Interorbital space slightly concave; posterior limb of preopercle bordering hind part of orbit, and descending very obliquely, ending in two points. Pectoral scarcely reaching ventrals, which are very small. B. 5, D. 9, A. 13, P. 10, V. 3. (*Günther.*) Atlantic; lately taken in the Gulf Stream, about lat. 33°.

(Hermann, l. c.; Günther, V, 387; Goode & Bean, Bull. Mus. Comp. Zoöl., 1882, 220.)

[1] CYCLOTHONE Goode & Bean.

(Goode & Bean, Bull. Mus. Comp. Zoöl., 1882, 221; type *Cyclothone lusca* G. & B.)

Body elongate, somewhat compressed (apparently covered with rather large, thin, very caducous scales); lower parts with a series of luminous spots. Head conical; cleft of mouth very wide, oblique extending behind eye, the lower jaw strongly projecting. Maxillary long and slender, sickle-shaped, closely connected with the short premaxillary. Upper jaw with a single series of rather large close-set sharp teeth, about every fourth one slightly longer than the rest, and directed slightly outward. Lower jaw with similar teeth, subequal, directed forward, with a few canines in front. A small patch of minute teeth on vomer; palatines smooth. Eye small, inconspicuous. Gill openings very wide, the membranes free from the isthmus. Gill rakers numerous, long and slender. Pseudobranchiæ none. Branchiostegals (apparently 7 to 9). No air-bladder. Dorsal and anal well developed, opposite each other. No adipose fin. Caudal forked, its peduncle long and slender. Deep-sea fishes of small size, closely related to the European genus *Gonostoma*. (*Κυκλος*, round; *οθωνη*, veil.)

Cyclothone lusca Goode & Bean.

Uniform black, the mucous pores inconspicuous. Maxillary extending backward to a distance from tip of snout equal to length of head without snout; eye as long as snout, 7 in head. Distance from snout to dorsal three times length of lower jaw, its base as long as head. Second ray longest, $\frac{2}{3}$ base of fin. Insertion of anal under second ray of dorsal, its longest rays a little higher than those of dorsal. Pectoral, $7\frac{2}{3}$ in length of body. Distance from snout to ventral twice head; ventral 7 in body. Head, $4\frac{2}{3}$; depth, $7\frac{2}{3}$. D. 1, 11, A. 1, 16, P. 10, V. 5. Gulf Stream, in deep water off south coast of New England, not rare.

(Goode & Bean, Bull. Mus. Comp. Zoöl. 1882, 221.)

[2] SIGMOPS Gill.

(Gill, Proc. U. S. Nat. Mus., 1883, 256; type *Sigmops stigmaticus* Gill.)

No scales or pseudobranchiæ; body elongate, claviform; dorsal short; anal long, the insertions of the two fins opposite each other; teeth moderately elongate, alter-

ORDER P—HAPLOMI. (N)

Family LIII.—AMBLYOPSIDÆ. (48)

151.—AMBLYOPSIS De Kay. (153)

539. **Amblyopsis spelæus** De Kay. Vw. (520)

152.—TYPHLICHTHYS Girard. (154)

540. **Typhlichthys subterraneus** Girard. Vw. (521)

153.—CHOLOGASTER Agassiz. (155)

541. **Chologaster cornutus** Agassiz. Vse. (522)
542. **Chologaster agassizii** Putnam. Vw. (523)
543. **Chologaster papillifer** Forbes. Vw. (523*b*.)

Family LIV.—CYPRINODONTIDÆ. (49)

154.—JORDANELLA Goode & Bean. (156)

544. **Jordanella floridæ** Goode & Bean. Vw. (524)

155.—CYPRINODON Lacépède. (157)

545. **Cyprinodon variegatus** Lacépède. N. S. (525)
545 b. *Cyprinodon variegatus gibbosus* Girard. S. (526)
546. **Cyprinodon riverendi**[1] Poey. W.
547. **Cyprinodon bovinus**[2] Girard. Vsw. (526)
548. **Cyprinodon eximius**[2] Girard. Vsw. (526*b*.)
549. **Cyprinodon latifasciatus** Garman. Vsw. (527)
550. **Cyprinodon elegans** Baird & Girard. Vsw. (528)
551. **Cyprinodon californiensis** Girard. C? (529)
552. **Cyprinodon macularius** Girard. R. (530)
553. **Cyprinodon mydrus**[3] Goode & Bean. S. W.
554. **Cyprinodon carpio** Günther. (531)

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nating with short ones, in a row on the maxillaries as well as premaxillaries and mandible. Deep-sea fishes. (Σίγμα, S; ὤψ, eye.)

Sigmops stigmaticus Gill.

"Its distinct inferior pearly spots, arranged in two rows on each side of the abdomen, are well marked, and the upper have wax-like guttiform spots connected with them below; there is also a broad longitudinal silvery band or sheen." Gulf Stream, lat. 38, at 2,361 fathoms.

(Gill, Proc. U. S. Nat. Mus., 1882, 256.)

[1] *Cyprinodon riverendi* Poey; *Trifarcius riverendi* Poey, Memorias Cuba, II, 306, 1860; *Cyprinodon riverendi* Jordan, Proc. U. S. Nat. Mus., 1884, 109; Key West to Cuba. Very closely related to *C. gibbosus*, but with larger scales (24–12), smaller head and the anal edged with black. The genus *Trifarcius* Poey, of which this species is the type, is founded on the erroneous statement of Valenciennes that *Cyprinodon variegatus* has but five branchiostegals.

[2] A doubtful species, unknown to me.

[3] *Cyprinodon mydrus* Goode & Bean, Proc. U. S. Nat. Mus., 1882, 433; Jordan and Gilbert, Proc. U. S. Nat. Mus., 1884, 110; Pensacola to Key West. A strongly marked and handsome species, possibly identical with *C. carpio*.

156.—CHARACODON[1] Günther.

555. Characodon furcidens Jordan & Gilbert. P.

157.—ADINIA Girard.

556. Adinia multifasciata[2] Girard. S. (545*b*.)

158.—FUNDULUS Lacépède. (158)

§ *Hydrargyra.*

557. Fundulus majalis[3] Walbaum. N. (532)
558. Fundulus similis Baird & Girard. S. (534)
559. Fundulus parvipinnis Girard. C. P. (536)

§ *Fundulus.*

560. Fundulus zebrinus[4] Jordan & Gilbert. Vsw. (535)

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[1] CHARACODON Günther.

(Günther, Cat. Fish. Brit. Mus., VI, 1866, 308; type *Characodon lateralis* Günther.)

This genus differs from *Cyprinodon*, chiefly in the presence of a small band of villiform teeth behind the incisors. The incisors are bicuspid or Y-shaped, and the vertical fins are longer than in *Cyprinodon;* fresh waters of Mexico and Central America; two species known. (Χάραξ, a sharp stake; ὀδών, tooth.) *Characodon furcidens* Jordan & Gilbert, Proc. U. S. Nat Mus., 1882, 354; streams tributary to the Gulf of California, and southward; abundant.

§[2] The group *Adinia*, defined on page 891 in the Synopsis, may be recognized as a distinct genus, intermediate between *Cyprinodon* and *Fundulus*, having the form of body and restricted gill openings of the former and the dentition of the latter. The single species (*Fundulus xenicus* Jor. & Gilb.) may stand as *Adinia multifasciata.*

[3] *Fundulus swampina*, a doubtful species probably based on a confusion of several species, is here omitted.

[4] *Fundulus zebrinus* is thus redescribed by Professor Gilbert (Bull. Washburn Lab. Nat. Hist., 1, 1884, 15), from specimens taken at Ellis, Kans.:

"Head and body shaped much as in *Fundulus similis*, but the snout somewhat less elongate. Width of preorbital about 6½ in length of head; eye moderate, 4 to 4½ in head, 1⅗ in interorbital width; posterior margin of orbit in middle of length of head; teeth in both jaws in a villiform band, with the external series much enlarged; interorbital width 2⅗ in head; snout 3⅗.

"Branchiostegals 5.

"Dorsal fin long and rather low, the base longer and the rays higher in males than in females; origin of dorsal nearly equidistant between snout and margin of caudal, slightly nearer the snout in males, and nearer end of caudal in females; base of dorsal in males 6 to 6½ in total length, the highest dorsal ray about half head; in females the base is 7½ in total length. Origin of anal opposite that of dorsal in males, behind it in females; in the latter the anal is sharply angulated, the anterior rays more than thrice the height of the posterior, and more than two-thirds length of head. In males the margins of both dorsal and anal fins are evenly rounded, the anal is the highest, its rays beset with minute white prickles. Oviduct forming a low sheath along base of anterior half of anal. Pectorals not reaching base of ventrals, equaling distance from snout to preopercular margin. Ventrals about reaching vent. Caudal truncate, 1⅓ in head.

"Scales very small, in about 60 oblique series from opercle to base of caudal; about 21 in an oblique series from vent upwards to middle of back; no enlarged humeral scale. In males the margins of scales are rough with minute tubercles.

"Head 3½ to 3⅗ in length; depth 4½ to 4⅗. D. 14 or 15; A. 13 or 14. L. 3 inches.

"Color: Greenish above, sides and below silvery-white, the sides tinged with sul-

561. **Fundulus seminolis**[1] Girard. Vsw. (537)
562. **Fundulus extensus**,[2] Jordan & Gilbert. P.
563. **Fundulus diaphanus**[3] Le Sueur. Vn. N. (538, 540)
564. **Fundulus confluentus** Goode & Bean. S. (539)
565. **Fundulus adinia** Jordan & Gilbert. Vsw. (541)
566. **Fundulus heteroclitus**[4] Linnæus. N. S. (543)
566b. *Fundulus heteroclitus grandis* Baird & Girard. S. (543 *b*.)
567. **Fundulus ocellaris** Jordan & Gilbert. S. (542 *b*.)
568. **Fundulus vinctus**[5] Jordan & Gilbert. P.

§ *Xenisma* Jordan.

569. **Fundulus catenatus** Storer. Vs. (544)
570. **Fundulus stellifer** Jordan. Vs. (545)

159.—ZYGONECTES Agassiz. (159)

571. **Zygonectes rubrifrons** Jordan. Vse. (546)
572. **Zygonectes henshalli** Jordan. Vse. (547)
573. **Zygonectes floripinnis** Cope. R. (548)
574. **Zygonectes lineatus** Garman. R. (549).
575. **Zygonectes sciadicus** Cope. Vnw. (555)
576. **Zygonectes notatus** Rafinesque. Vw. (550)
577. **Zygonectes dispar** Agassiz. Vw. (553)
578. **Zygonectes craticula** Goode & Bean. Vse. (553 *b*.)
579. **Zygonectes zonifer**[6] Jordan & Meek. Vse.
580. **Zygonectes chrysotus**[7] Günther. Vse. (556, 557)
581. **Zygonectes luciæ**[8] Baird. Ve. (558)

160.—LUCANIA Girard. (160)

582. **Lucania venusta** Girard. S. (559)
583. **Lucania parva** Baird & Girard. N. S. (560)
584. **Lucania goodei** Jordan. S. (561)

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phur-yellow; the greater part of each scale on back rendered dusky by black points; sides with from 14 to 18 dusky bars from back to ventral region, occasionally meeting on ventral line; these bars are very variable in width, seemingly narrower in females, in which half-bars are frequently inserted between the others; the interspaces are as wide as the bars, or usually wider. Fins yellowish, without distinct markings, in the males all very dusky except the anal."

[1] This species is redescribed by Jordan (Proc. U. S. Nat. Mus., 1884, 322).

[2] *Fundulus extensus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 355. Cape San Lucas.

[3] *Fundulus menona* appears to be identical with *F. diaphanus*.

[4] *Fundulus nigrofasciatus* seems to be the young of *Fundulus heteroclitus*.

[5] *Fundulus vinctus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 355. Cape San Lucas.

[6] *Zygonectes zonifer* Jordan & Meek, Proc. U. S. Nat. Mus., 1884. Allamaha R., Ga.

[7] ? *Fundulus cingulatus* Cuv. & Val. = *Haplochilus chrysotus* Günther = *Fundulus zonatus* C. & V., not *Esox zonatus* Mitchill, which is a young *Fundulus*. For descriptions of this species see Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 586, and Jordan, op. cit., 1884, 320. It is best to use the name of *chrysotus* for this species, as *cingulatus* cannot be positively identified, and *zonatus* was originally given to some other fish.

[8] The description of *Zygonectes cingulatus* given in the Synopsis (p. 342) belongs to this species. It is probably distinct from *Z. chrysotus*, as the latter has no dorsal ocellus in either sex.

161.—GAMBUSIA Poey. (161)

585. Gambusia patruelis[1] Baird & Girard. Vs. (551, 552, 562)
586. Gambusia humilis[2] Günther. Vsw. (554, 463)
587. Gambusia arlingtonia[3] Goode & Bean. Vse. (564)
588. Gambusia affinis[3] Baird & Girard. Vsw. (565)
589. Gambusia nobilis[3] Baird & Girard. Vsw. (566)
590. Gambusia senilis[3] Girard. Vsw. (566 *b.*)

162.—MOLLIENESIA Le Sueur. (162)

591. Mollienesia latipinna[4] Le Sueur. S. (567, 567 *b.*)

163.—PŒCILIA Bloch & Schneider. (163)

592. Pœcilia couchiana Girard. Vsw. (568)

164.—HETERANDRIA[5] Agassiz. (164)

593. Heterandria formosa Agassiz. Vse. (164)
594. Heterandria occidentalis Baird & Girard. R. (570)
595. Heterandria ommata[6] Jordan. Vse.

Family LV.—UMBRIDÆ. (50)

165.—UMBRA Müller. (169)

596. Umbra limi Kirtland. Vnw. (571)
596 b. *Umbra limi pygmæa* DeKay. Ve.

Family LVI.—ESOCIDÆ. (51)

166.—ESOX Linnæus. (167)

§ *Picorellus* Rafinesque.

597. Esox americanus Gmelin. Ve. (573)
598. Esox vermiculatus Le Sueur. Vw. (574)
599. Esox reticulatus[7] Le Sueur. Ve. (575)

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[1] *Zygonectes atrilatus, Zygonectes inurus, Haplochilus melanops, Gambusia holbrooki*, and probably *Gambusia arlingtonia* also, are identical with *Gambusia patruelis.*

[2] *Gambusia humilis* Günther=*Zygonectes brachypterus* Cope, seems to be distinct from *Gambusia patruelis.* It abounds in the streams of Texas, and may be known at once from *G. patruelis* by the absence of the black suborbital spot.

[3] Doubtful species, unknown to me.

[4] *Mollienesia lineolata* is identical with *M. latipinna.*

[5] The name *Heterandria* Agassiz, Amer. Journ. Sci. Arts., 1853, as now restricted is identical with *Girardinus*, and must supersede this later name. The type is *Heterandria formosa* Agassiz. As originally defined, both *Gambusia* and *Girardinus* were included in *Heterandria.* See Jordan & Meek, Proc. U. S. Nat. Mus., 1884, 236.

[6] *Heterandria ommata* Jordan, Proc. U. S. Nat. Mus., 1884, 323. Indian R., Florida.

[7] This species should stand as *Esox vermiculatus*, instead of *Esox salmoneus* or *Esox umbrosus.*

To the synonymy add:

(*Esox vermiculatus, Esox lineatus*, and ? *Esox lugubrosus* Le Sueur MSS. in Cuv. & Val., XVIII, 333, 335, 338, 1846.)

§ *Esox.*

600. **Esox lucius** Linnæus. Eu. Vn. (576)

§ *Mascalongus* Jordan.

601. **Esox nobilior** Thompson. Vn. (577)

Order Q.—XENOMI.[1]

Family LVII.—DALLIIDÆ.

167.—DALLIA Bean. (166)

602. **Dallia pectoralis** Bean. Y. (572)

Order R.—COLOCEPHALI.[2]

Family LVIII.—MURÆNIDÆ. (52.)

168.—MURÆNOBLENNA[3] Lacépède.

603. **Muræenoblenna nectura** Jordan & Gilbert. P.

169.—MURÆNA Linnæus. (168)

604. **Muræna retifera** Goode & Bean. S. (578)
605. **Muræna pinta**[4] Jordan & Gilbert. P.

170.—SIDERA Kaup.

606. **Sidera castanea**[5] Jordan & Gilbert. P.
607. **Sidera mordax** Ayres. C. (579)
608. **Sidera dovii**[6] Günther. P.
609. **Sidera ocellata** Agassiz. S. (580)

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[1] The genus *Dallia*, although agreeing in many external characters with *Umbra*, has very little affinity with that group or any other of our fishes. Its skeleton is so peculiar in structure that it has been taken by Dr. Gill as the representative of a peculiar order or suborder, *Xenomi*, which is thus defined:

"Teleosts with the scapular arch free from the cranium laterally and only abutting on it behind, coracoids represented by a simple cartilaginous plate without developed actinosts, and with the intermaxillary and supramaxillary bones coalescent." (Ξένος, strange; ὦμος, shoulder.)

[2] Order *Colocephali* Cope, Trans. Am. Philos. Soc., 1871, 456 (includes the *Murænidæ*).

[3] Muraenoblenna Lacépède.

(*Gymnomuræna* Günther, not of Lacépède, as restricted by Kaup.)

(Lacépède, His. Nat. Poiss., V, 652, 1803; type *Murænoblenna olivacea* Lacépède.)

This genus differs from *Muræna* chiefly in the reduction of the fins to a short fold, surrounding the tail. Posterior nostrils not tubular. Gape, moderate. Tropical seas. (*Μυραίνα*, eel; *βλεννα*, slime. "Blenna en grec, signifié mucosité." Lacépède.) *Murænoblenna nectura* = *Gymnomuræna nectura* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 356. Cape San Lucas.

[4] *Muræna pinta* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 345. Gulf of California and southward.

[5] *Sidera castanea* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1883, 208. Mazatlan and southward. In this paper is an analysis of the characters of the species of *Sidera* found on the Pacific coast of America.

[6] *Muræna dovii* Günther, VIII, 103, 1870; = *Muræna pintita* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 346; 1883, 209. Mazatlan to Gallapagos Islands.

610. **Sidera funebris**[1] Ranzani. P. (580 *b.*)
611. **Sidera moringa** Cuvier. P. (580 *c.*)

ORDER S.—ENCHELYCEPHALI.[2] (0.)

Family LIX.—CONGRIDÆ.[3] (53 part.)

171.—ICHTHYAPUS[4] Barneville.

612. **Ichthyapus selachops** Jordan & Gilbert. P.

172.—LETHARCHUS Goode & Bean. (168 *b.*)

613. **Letharchus velifer** Goode & Bean. S. (580 *b.*)

173.—CALLECHELYS[5] Kaup. (169)

614. **Callechelys scuticaris** Goode & Bean. S. (581)
615. **Callechelys teres** Goode & Bean. S. (581 *b.*)
616. **Callechelys bascanium**[6] Jordan. W.

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[1] The species called in the Synopsis (p. 895) *Murœna afra* should stand as *Murœna* or *Sidera funebris.*

In life this species is bright yellowish green, with some oblique dark streaks on the fins. It reaches a very large size and is much dreaded by fishermen. To its synonymy add: *Gymnothorax funebris* Ranzani, Nov. Comm. Ac. Sci. Inst. Bonon., IV, 1840, 76; *Murœna lineopinnis* Richardson, Voy. Erebus & Terror, 1844, 89; *Murœna infernalis* Poey, Memorias Cuba, II, 347, 1861; *Murœna afra* Günther, IX, 123; apparently not *Gymnothorax afer*, Bloch, Ausl. Fische, 1797, IX, 85, tab. 417, a fish from Guinea, described as being brown, marbled, and banded with white. The present species is always unicolor, green in life, and brown in spirits.)

[2] *Enchelycephali* Cope, Trans. Am. Philos. Soc., 1871, 455.

[3] The family of *Anguillidæ*, as given in the text, is not a natural one. For the present we may subtract the aberrant genera *Anguilla* and *Simenchelys*, leaving the remaining genera in one group, *Congridæ*.

[4] ICHTHYAPUS Barneville.

(*Ophisuraphis* Kaup; *Apterichthys* Duméril.)

(Barneville, Revue Zoologique, 1847, 219; type *Ichthyapus acutirostris* Barneville.)

This genus differs from *Ophichthys* chiefly in the entire absence of fins. The snout projects beyond the small mouth, giving a shark-like physiognomy, and the teeth are small, mostly uniserial. (Ἰχθύς, fish; ἄπους, without feet.) *Ichthyapus selachops* = *Apterichthys selachops* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 356. Cape San Lucas.

[5] *Callechelys* Kaup (see Synopsis, p. 897), is distinguished from *Cœcula* by the development of the dorsal fin, which begins on the head. In *Cœcula* (*Sphagebranchus*), it begins behind the gill opening.

[6] *Callechelys bascanium* Jordan.

Dark brown, nearly uniform; fins a little paler. Body extremely slender, subterete, its greatest depth little more than two-fifths length of head; head short; snout 7 in head; mouth very small, the lower jaw thin, included, not extending to the anterior nostril, which is in a short tube; teeth short, subconic, bluntish, a little unequal, their points directed backwards; lower teeth nearly uniserial; upper teeth uniserial laterally, partly biserial anteriorly; vomerine teeth forming a rhombic patch. Eye moderate, its length more than half that of snout, its center nearly over middle of upper jaw; cleft of mouth 3¾ in length of head. Gill openings vertical, about as wide as isthmus; its upper edge on level of upper base of pectoral; pectoral developed, small, a little broader than long, nearly as long as snout; dorsal fin very low, beginning at a point midway between front of eye and gill opening; anal similar to dorsal.

174.—OPHISURUS[1] Lacépède. (170 *b.*)

617. Ophisurus acuminatus[2] Gronow. W. (584 *b.*)
618. Ophisurus xysturus[3] Jordan & Gilbert. P.

175.—OPHICHTHYS[1] Ahl. (170)

619. Ophichthys miurus[4] Jordan & Gilbert. P.
620. Ophichthys triserialis Kaup.' C. P. (583)
621. Ophichthys ocellatus Le Sueur. P. (584)
622. Ophichthys guttifer[5] Bean & Dresel. W.
623. Ophichthys macrurus Poey. W. (583 *b.*)
624. Ophichthys chrysops Poey. W. (583 *c*)
625. Ophichthys zophochir[6] Jordan & Gilbert. P.
626. Ophichthys schneideri[7] Steindachner. W. (582)
627. Ophichthys intertinctus[8] Richardson. W.

Head 11½ in distance from top of snout to vent; head and trunk a little longer than tail. Length of type, 31 inches; head, 1⅝; trunk, 14⅘. Egmont Key, Florida; distinguished from *C. teres* by the very short head.

(*Cæcula bascanium* Jordan, Proc. Ac. Nat. Sci., Phila., 1884, 43.)

[1] For a discussion of the correct application of the names *Ophichthys*, *Ophisurus*, and *Cæcula* see Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 648.

[2] As stated in the Synopsis, p. 974, the name *acuminatus* should supersede *longus* for this species.

[3] *Ophichthys xysturus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 346. Mazatlan to Panama.

[4] *Ophichthys miurus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 357. Cape San Lucas.

[5] *Ophichthys guttifer* Bean & Dresel.

Allied to *O. ocellatus* Le Sueur. Greatest depth equal to distance from angle of mouth to tip of snout. Dorsal fin beginning at a distance behind vertical from tip of pectoral equal to length of snout. Pectoral nearly 3½ in head; head 8 in total length, 2⅗ in trunk. Eye 1½ in snout; 9 in head. Twenty-one or 22 small white spots along median line. Gulf of Mexico. (Bean & Dresel, Proc. Biol. Soc., Washington, II, 1884, 99.)

[6] *Ophichthys zophochir* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 347. Mazatlan.

[7] The specimens which we have referred to *Ophichthys punctifer* (*mordax*) belong rather to *Ophichthys schneideri* Steindachner.

Yellowish brown; head with small dark brown elongate spots; sides with about three rows of rather large oval spots, the lower disappearing behind the vent, number of rows becoming greater anteriorly; broad half spots along upper margin of dorsal, and bordered with blackish. Head 3½ in trunk; snout conical, blunt anteriorly. Cleft of mouth very long, 2 in head; eye 11; snout 7. Teeth in both jaws in two rows, those of the outer row in both very sharp, unequal, some of them quite long, those of the inner row smaller and subequal; *vomerine teeth* rather small, *in two rows*, diverging forward; one or two long canines in front, behind the two series of the upper jaw. Both nostrils with short tubes. Pectoral 4 in head; dorsal beginning about 1½ eye's diameters behind the point of the pectoral. Tail longer than the rest of the body by 1½ head's lengths. (*Steindachner.*) West Indies, occasionally taken from the stomachs of Red Snappers at Pensacola. Apparently distinct from *O. punctifer* (=*O. mordax*), having the vomerine teeth in two rows instead of three.

Crotalopsis mordax Goode & Bean, Proc. U. S. Nat. Mus., 1879, 154; not *Macrodonophis mordax* Poey; Steindachner, Ichth. Beitr., VIII, 67, 1879; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1883, 143.)

[8] *Ophichthys intertinctus.*

Dark brown above, paler below; sides and back with about three rows of large ovate brown spots, somewhat irregular in size and position, those of the upper row smallest, the large and small ones of the lower rows somewhat alternating. Spots on head small and numerous. Dorsal with an interrupted dark margin; anal with

176.—MYRICHTHYS Girard. (171)

628. **Myrichthys tigrinus** Girard. C. (585)

177.—MYROPHIS Lütken. (171 *b.*)

629. **Myrophis lumbricus** Jordan & Gilbert. S. (585 *b.*)
630. **Myrophis punctatus**[1] Lütken. W. (585 *c.*)
631. **Myrophis vafer**[2] Jordan & Gilbert. P.
632. **Myrophis egmontis**[3] Jordan. W.

178.—NEOCONGER Girard. (172)

633. **Neoconger mucronatus** Girard. W. (586)

179.—NETTASTOMA[4] Rafinesque.

634. **Nettastoma procerum** Goode & Bean. B.

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a darker edge; pectorals blackish. Gill openings wide, the isthmus rather narrow; head $3\frac{1}{2}$ in trunk. Cleft of mouth very wide, nearly half length of head. Teeth sharply pointed, with a few large fixed canines in both jaws, and one or two larger ones in front of upper jaw; about 4 moderate canines near front of lower jaw; teeth in both jaws in double series, those of the inner series in the upper jaw depressible. Vomer with a double series confluent behind. Eye small, $1\frac{1}{2}$ in snout, which is about $6\frac{1}{2}$ in head. Pectoral about 5 in head. Dorsal commencing a little behind end of pectoral. Tail rather longer than rest of body. West Indies, north to Egmont Key, Florida.

(*Ophisurus intertinctus* Richardson, Ereb. & Terr. Fish., 102; *Echiopsis intertinctus* Kaup, Apodes, 13, 1858; Günther, VIII, 57; *Ophichthys intertinctus* Jordan, Proc. Ac. Nat. Sci. Phila., 1884, 43.)

[1] *Myrophis punctatus* Lütken=*Myrophis microstigmius* Poey. To the synonymy, add—(Lütken, Vid. Med. Naturh. Foren. Kjobenh., 1851, 1; *Myrophis longicollis* Kaup, Apodes, 30, 1858; Jordan, Proc. Ac. Nat. Sci. Phila., 1883, 282; not of Günther, VIII, 51,=*M. vafer* Jor. & Gilb.)

[2] *Myrophis vafer* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 645. Guaymas to Panama.

[3] *Myrophis egmontis* Jordan.

Dark brown, apparently uniform, somewhat paler below; head small, slender, moderately pointed; anterior nostril in a short tube; posterior, large, labial directly behind it; cleft of mouth rather short, extending to beyond the rather large eye, which is more than half the length of the snout; cleft of mouth, $3\frac{1}{6}$ in head; teeth on both jaws subequal, pointed, slightly compressed, arranged in single series, those of both jaws directed somewhat backward; the lower teeth larger and more oblique than the upper; about four small fixed canines in front of upper jaw; no teeth on vomer in two specimens examined; tongue not free; lower jaw considerably shorter than upper, its edge considerably curved, concave in outline. Nape somewhat elevated; top of head with large pores. Head $5\frac{1}{3}$ in distance from snout to vent; head and trunk a little shorter than tail; body slender, its greatest depth a little more than length of gape. Pectoral short and broad, slightly longer than snout; the gill opening short, oblique, extending downward and backward from near the middle of the base of the pectoral. Dorsal fin beginning behind vent, at a distance about equal to length of gape; the fin very low in front, becoming gradually higher towards the tip of tail; anal low, but well developed, considerably higher than dorsal, highest anteriorly, uniting with the dorsal around the tail. Length, 15 inches. Egmont Key, Florida.

(Jordan, Proc. Ac. Nat. Sci. Phila., 1884, 44.)

[4] NETTASTOMA Rafinesque.

(*Hyoprorus* Kölliker; larva.)

(Rafinesque, Caratteri di Alcuni Nuovi Generi, &c., 1810, 66; type *Nettastoma melanura* Raf.)

Scaleless. Tail tapering into a point. Snout much produced, depressed; jaws and

180.—MURÆNESOX[1] McClelland.

635. **Muræuesox coniceps** Jordan & Gilbert. P.

181.—CONGER[2] Cuvier. (174)

636. **Conger conger** Linnæus. N. S. W. Eu. P. (588)
637. **Conger caudicula** Bean. W. (588 *b*.)

Family LX.—ANGUILLIDÆ.

182.—ANGUILLA[3] Thunberg. (173)

638. **Anguilla anguilla rostrata** De Kay. V. N. S. W. (587)

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vomer with bands of cardiform teeth, those along the median line of the vomer being somewhat the larger. Vertical fins well developed, the dorsal commencing behind gill opening; no pectorals. Gill openings moderate. Nostrils on upper surface of head, valvular, the anterior near end of snout, the posterior above anterior angle of eye. Air bladder present. (*Νεττα*, duck; *ςτόμα*, mouth.)

Nettastoma procerum Goode & Bean.

Body extremely elongate, compressed, especially so posteriorly, the tail tapering to a very attenuate point. Head slender, conical, the jaws somewhat depressed, the upper heavier and thicker, projecting beyond the lower a distance equal to the diameter of the eye. Numerous pores on both jaws and on the nape. Snout with a slender filamentous tip, twice as long as the eye. Teeth arranged as in *N. melanurum*, but excessively small. Dorsal commencing above gill opening. Insertion of anal at a distance from snout equal to 3⅗ times length of head. Tail twice as long as head and body. Lateral line well developed, in a deep furrow. Height of dorsal and anal about half depth of body, brownish; peritoneum black. (Gulf Stream, in deep water, at about lat. 34°. (*Goode & Bean.*)

(Goode & Bean, Bull. Mus. Comp. Zoöl., 1882, 224.)

[1] MURÆNESOX McClelland.

(*Cynoponticus* Costa.)

Form of *Conger:* Body scaleless; snout long; posterior nostrils opposite upper part of eye; tongue not free; jaws with several series of small, close-set teeth, with canines in front; vomer with several series of strong teeth, those of the median series enlarged and usually compressed; gill openings wide; pectorals well developed; dorsal beginning above the gill opening, continuous with the anal around the tail. Large eels of the tropical seas.

Muræuesox coniceps Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 348. Mazatlan to Panama.

[2] The name *Conger* should probably be retained for this genus. It does not appear to be entirely certain that *Leptocephalus morrisi* is a larval Conger. *Echelus* Rafinesque (1810) is based in part on Congers, but most of the numerous typical species remain unidentified.

[3] Mr. S. E. Meek (Bull. U. S. Fish Comm., 1883, 430), after a careful comparison of American and European eels, concludes that "in American specimens the dorsal fin is proportionately farther from the end of snout, making the distance between front of dorsal and front of anal a little shorter than in European specimens. Otherwise no permanent difference seems to exist. We should not, therefore, in my opinion, consider the two as distinct species, but rather as geographical varieties of the same species."

In *A. rostrata*, according to Mr. Meek, the distance from tip of snout to front of dorsal is, on an average, .33½ of the length; the distance from front of dorsal to front of anal, .09⅘, or less than length of head (.12½).

In the European *Anguilla anguilla* the first distance is .30½, the second, .13⅘, or a little more than length of head (.13⅓). Cuban specimens (*Anguilla cubana* Kaup) agree fully with *A. rostrata*. as also Texan ones (*Anguilla "tyrannus"* or *"texana"*).

Probably our eel should be regarded as a subspecies (*rostrata*) of *A. anguilla.*

Family LXI.—SIMENCHELYIDÆ.

183.—SIMENCHELYS Gill. (174)

639. Simenchelys parasiticus Gill. B. (589)

Family LXII.—SYNAPHOBRANCHIDÆ. (54)

184.—SYNAPHOBRANCHUS Johnson. (176)

640. Synaphobranchus pinnatus Gronow. B. (590)

185.—HISTIOBRANCHUS[1] Gill.

641. Histiobranchus infernalis Gill. B.

Family LXIII.—NEMICHTHYIDÆ Richardson. (56)

186.—NEMICHTHYS Richardson. (178)

642. Nemichthys scolopaceus Richardson. B. (592)
643. Nemichthys avocetta Jordan & Gilbert. B. C. (593)

187.—LABICHTHYS[2] Gill & Ryder.

644. Labichthys carinatus[3] Gill & Ryder. B.
645. Labichthys elongatus[4] Gill & Ryder. B.

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[1] HISTIOBRANCHUS Gill.

(Gill, Proc. U. S. Nat. Mus., 1883, 255; type, *Histiobranchus infernalis* Gill).

"Synaphobranchid, with the dorsal fin protracted almost as far forward as the base of the pectoral fin, and an isolated small patch of teeth on the vomer, behind that on its head." (Ἵστιον, sail, *i. e.*, dorsal fin; βραγχος, gill; dorsal commencing above gill opening).

Histiobranchus infernalis Gill, Proc. U. S. Nat. Mus., 1882, 255. Gulf Stream, latitude 38°, at a depth of 1,731 fathoms.

[2] LABICHTHYS Gill & Ryder.

(Gill & Ryder, Proc. U. S. Nat. Mus., 1883, 261; type, *Labichthys carinatus* Gill & Ryder.)

"*Nemichthyids* with the head behind the eyes, contracted, with very attenuated jaws, the branchiostegous membrane connected to the throat, and the branchial apertures limited to the sides, with small conical teeth in a band along the vomer, and otherwise dentition of *Nemichthys*, a black epidermis, and the tail abruptly truncated. (Λαβίς, a pair of forceps; ἰχθύς, fish.) This genus and the two which follow are very insufficiently described. In none of them is the character of the posterior dorsal rays described.

[3] *Labichthys carinatus* Gill & Ryder, Proc. U. S. Nat. Mus., 1883, 261. Gulf Stream, latitude 41°, at 906 fathoms.

[4] *Labichthys elongatus* Gill & Ryder, l. c., 1883, 262. Gulf Stream, latitude 39°, at 1,628 fathoms.

188.—**SPINIVOMER**[1] Gill & Ryder.

646. **Spinivomer goodei** Gill & Ryder. B.

189.—**SERRIVOMER**[2] Gill & Ryder.

647. **Serrivomer beani** Gill & Ryder. B.

Order T—LYOMERI[3]

Family LXIV.—SACCOPHARYNGIDÆ. (55)

190.—**SACCOPHARYNX** Mitchill. (177)

648. **Saccopharynx ampullaceus**[4] Harwood. B. (591)

Family LXV.—EURYPHARYNGIDÆ.[5]

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[1] SPINIVOMER Gill & Ryder.

(Gill & Ryder, Proc. U. S. Nat. Mus., 1883, 261; type, *Spinivomer goodei* G. & R.)

"*Nemichthyids* with a rectilinear occipitorostral outline, with very attenuated jaws, high mandibular rami, the branchial aperture nearly confluent, enlarged acute conic teeth in a median row on the vomer, and with a silvery epidermis and filiform tail." (Latin, *spina*, spine; *vomer*, vomer.)

Spinivomer goodei Gill & Ryder, l. c., 261. Gulf Stream, latitude 38°, at 2,361 fathoms.

[2] SERRIVOMER Gill & Ryder.

(Gill & Ryder, Proc. U. S. Nat. Mus., 1883, 260; type, *Serrivomer beani* G. & R.)

"*Nemichthyids* with the head behind eyes of an elongated parallelogramic form, with moderately attenuated jaws, branchiostegal membrane confluent at posterior margin, but with the branchial aperture limited by an isthmus except at the margin, and with lancet-shaped vomerine teeth in a crowded (sometimes doubled) row."

(Latin, *serra*, saw; *vomer*, vomer.)

Serrivomer beani Gill & Ryder, l. c., 261. Gulf Stream, latitude 41°, at 855 fathoms.

[3] Order T.—LYOMERI.

"Fishes with five branchial arches (none modified as branchiostegal or pharyngeal) far behind the skull, an imperfectly ossified cranium articulating with the first vertebra by a basioccipital condyle alone, only two cephalic arches, both freely movable, (1) an anterior dentigerous one, the palatine, and (2) the suspensorial, consisting of the hyomandibular and quadrate bones, without maxillary bones or distinct bony elements to the mandible, with an imperfect scapular arch remote from the skull, and with separately ossified but imperfect vertebræ." (Gill & Ryder.)

Two families are recognized (*Saccopharyngidæ* and *Eurypharyngidæ*), deep sea fishes of remarkable appearance, allied to the eels. The species are little known, and are possibly all forms of a single one. (*Λυος*, loose; *μερος*, part or segment.) (*Lyomeri* Gill & Ryder, Proc. U. S. Nat. Mus., 1883, 263.)

[4] The name *Saccopharynx flagellum* was not given by Mitchill, but by Cuvier (Règne Animal, Ed. II) in 1829. The name *ampullaceus* of Harwood has therefore priority, it really referring to the same species. For an exhaustive discussion of our knowledge of *Saccopharynx* and its relationships see Gill, Proc. U. S. Nat. Mus., 1884, 48.

[5] The family *Eurypharyngidæ* is thus defined by Gill & Ryder:

"*Lyomeri* with the head flat above and with a transverse rostral margin, at the outer angles of which the eyes are exposed, with the eyes excessively elongated backwards and the upper parallel and closing against each other as far as the articulation

191.—GASTROSTOMUS[1] Gill & Ryder.

649. **Gastrostomus bairdii** Gill & Ryder. B.

Order U.—OPISTHOMI. (P)

Family LXVI.—PTILICHTHYIDÆ.[2] (56 *b.*)

192.—PTILICHTHYS Bean. (179)

650. **Ptilichthys goodei** Bean. A. (594.)

Family LXVII.—NOTACANTHIDÆ.

193.—NOTACANTHUS Bloch. (180)

651. **Notacanthus chemnitzi** Bloch. G. B. (595)
652. **Notacanthus phasganorus** Goode. B. (595 *f.*)
653. **Notacanthus analis**[3] Gill. B.

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of the two suspensorial bones, with minute teeth in both jaws, with a short abdomen and long, attenuated tail, branchial apertures narrow and very far behind, dorsal and anal fins continued nearly to the end of the tail, and minute pectoral fins.

"The mandibular rami are exceedingly narrow and slender, but the jaws are extremely expansible and the skin is correspondingly dilatable, consequently an enormous pouch may be developed. Inasmuch as the slenderness and fragility of the jaws and the absence of raptatorial teeth preclude the idea of the species being true fishes of prey, it is probable that they may derive their food from the water which is received into the pouch by a process of selection of the small or minute organisms therein contained." The skin of the pouch has a peculiar velvety appearance, like the wing membrane of a bat. Two species are known, provisionally referred to two genera, *Eurypharynx pelecanoides* Vaillant and *Gastrostomus bairdii*. Both are from great depths in the sea, the former having been taken by the "Travailleur," in 1882, off the coast of Morocco.

(*Eurypharyngidæ* Gill & Ryder, Proc. U. S. Nat. Mus., 1883, 264.)

[1] GASTROSTOMUS Gill & Ryder.

Gill & Ryder, Proc. U. S. Nat. Mus., 1883, 271; type *Gastrostomus bairdii* G. & R.

This genus is supposed to be distinguished from *Eurypharynx* by the following characters: Cranium short, nearly as broad as long; dentigerous bones almost seven times length of cranium; jaws with minute, acute, conic teeth depressed inwards, in a very narrow band; no enlarged teeth at tip of mandible; tail with a rayless membrane under its tip. (*Γαστηρ*, stomach; *στόμα*, mouth.)

(*Gastrostomus bairdii* Gill & Ryder, l. c., 1883, 271. Gulf Stream, lat. 40°, in deep water.)

Eurypharynx pelecanoides (Vaillant, Comptes Rendus Acad. Sci. Paris, 1882, 1232) is supposed to differ in having the "cranium prolonged backwards, the dentigerous bones little more than three times as long as the cranium; faint dentary granulations on both jaws and at the extremity of the mandible two hooked teeth; the tail ending in a point." It is not unlikely that the two species may prove identical.

[2] It is almost certain that *Ptilichthys* has little relation to the *Mastacembelidæ*. It should probably be regarded as a distinct family, *Ptilichthyidæ*, but whether this family belongs to the *Opisthomi* or to the *Acanthopteri* cannot be ascertained without examination of the skeleton.

[3] *Notacanthus analis* Gill. Proc. U. S. Nat. Mus. 1883, 255. Gulf Stream, latitude 40°, at a depth of 548 fathoms.

ORDER V.—SYNENTOGNATHI. (Q)

Family LXVIII.—BELONIDÆ.[1] (57 *pt.*)

194.—TYLOSURUS[2] Cocco. (181)

654. **Tylosurus hians** Cuv. & Val. W. (696)
655. **Tylosurus fodiator**[3] Jordan & Gilbert. P.
656. **Tylosurus crassus**[4] Poey. W. (600 *b.*)
657. **Tylosurus caribbæus** Le Sueur. W. (597)
658. **Tylosurus notatus** Poey. W. (598)
659. **Tylosurus sagitta**[5] Jordan & Gilbert. W.
660. **Tylosurus marinus** Bloch & Schneider. N. S. (599)
661. **Tylosurus exilis** Girard. C. (600)
662. **Tylosurus stolzmanni**[6] Steindachner. P.

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[1] According to Dr. Gill the structure of the skeleton in *Belone*, *Tylosurus* and *Potamorrhaphis* differs so much from that of the other *Scomberesocidæ* that these genera should be placed in a distinct family, *Belonidæ*.

[2] The identification of our species of *Tylosurus* may be aided by the following key:

a. Body strongly compressed, somewhat band-like, about twice as deep as broad; beak slender, the upper jaw strongly arched at base; dorsal and anal very long, the posterior rays elevated; D. 24; A. 25..........HIANS.

aa. Body subcylindrical, or not greatly compressed.

b. Dorsal and anal long, each with 20 or more rays, their posterior rays prolonged in the young, short in the adult; scales small; beak strong, with large teeth; lateral line passing into a dark-colored keel on tail, no bluish lateral band; size large.

c. Beak very strong, not twice as long as rest of head; body comparatively stout; depth about 14.

d. Dorsal rays about 19; anal 17..........FODIATOR.

dd. Dorsal rays about 23. A. 23..........CRASSUS.

cc. Beak twice or more length of rest of head; body comparatively slender; depth about 18, D. about 25, A. about 24..........CARIBBÆUS.

bb. Dorsal and anal short, each with less than 20 rays; the last rays not prolonged; beak long and slender; sides with a bluish lateral band; size small.

e. Caudal peduncle posteriorly compressed, the lateral line not dark and not forming a keel.

f. Body very broad, robust; dorsal very short, its lobe orange-red in life; maxillary hidden by preorbital. D. 13; A. 14..........NOTATUS.

ff. Body very slender, subterete; dorsal moderate, not red; maxillary not hidden by preorbital. Eye small. D. 14, A. 16..........SAGITTA.

e. Caudal peduncle posteriorly depressed; lateral line forming a slight keel which is blackish in color; eye rather large; D. 15; A. 18..MARINUS.

ee. Caudal peduncle depressed, with a strong keel; maxillary not entirely hidden. D. 15 or 16; A. 17.

g. Pectorals plain olivaceous; dorsal and anal lobe pale..........EXILIS.

gg. Pectorals abruptly black at tip; dorsal and anal lobes blackish ... STOLZMANNI.

[3] *Tylosurus fodiator* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 459. Mazatlan.

[4] *Belone crassa* Poey, Memorias Cuba, II, 1860, 291 = *Tylosurus gladius* Bean, Proc. U. S. Nat. Mus., 1882, 430 = *Tylosurus crassus* Jordan, Proc. U. S. Nat. Mus., 1884, 112 (not *Belone jonesi* Goode). Pensacola southward.

[5] *Tylosurus sagitta* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 25. Key West.

[6] *Belone stolzmanni* Steindachner, Ichthyol. Beiträge, VII, 21, 1878 = *Tylosurus sierrita* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 458. Gulf of California to Peru.

195.—SCOMBERESOX Lacépède. (182)

663. **Scomberesox saurus** Walbaum. N. S. O. Eu. (601)
664. **Scomberesox brevirostris** Peters. C. (602)

196.—HEMIRHAMPHUS Cuvier. (183)

665. **Hemirhamphus unifasciatus**[1] Ranzani. W.
666. **Hemirhamphus roberti**[2] Cuv. & Val. S. P. (603)
667. **Hemirhamphus rosæ** Jordan & Gilbert. C. (604)
668. **Hemirhamphus pleei**[3] Cuv. & Val. S. W. P. (604 *b.*)

197.—EULEPTORHAMPHUS Gill. (183 *b.*)

669. **Euleptorhamphus longirostris** Cuvier. O. (605)

198.—CHRIODORUS Goode & Bean. (183 *c.*)

670. **Chriodorus atherinoides** Goode & Bean. W. (605 *b.*)

199.—PAREXOCŒTUS Bleeker.

671. **Parexocœtus mesogaster**[4] Bloch. W. S. (607 *b.*)

200.—HALOCYPSELUS Weinland. (184)

672. **Halocypselus evolans**[5] Linnæus. S. (606; 607)

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[1] *Hemirhamphus unifasciatus* Ranzani. Clear greenish with bluish luster; a silvery lateral band; no red on fins; tip of lower jaw scarlet. Very close to *H. unifasciatus*, differing chiefly in the shorter beak, and the less compressed and more robust body. Lower jaw from end of upper jaw 6 to 7 in total length from its tip to base of caudal, (4½ in *H. roberti*) its length always less than that of rest of head; head with lower jaw, 3; body half deeper than broad; premaxillaries broader than long; eye less than interorbital width, ⅘ postorbital part of head; ventrals midway between eye and base of caudal; dorsal and anal densely scaly; back broad. Head 4⅗, depth 6½. D. 12 to 14, A. 15, lat. l. 52, length 12 inches. Florida Keys to Cuba and Panama, representing *H. roberti* southward.

Hemirhamphus unifasciatus Ranzani, Comm. Inst. Bon., 1842, V. 326, tab. 25; not of most recent authors; ? *Hemirhamphus picarti* Cuv. & Val. XIX, 1846, 25 (*Hemirhamphus richardi* Cuv. & Val., XIX, 1846, 26; *Hemirhamphus fasciatus* Poey, Memorias Cuba, II, 299, 1860, not of Bleeker; *Hemirhamphus poeyi* Gunther, VI, 262).

[2] The species called in the text *Hemirhamphus unifasciatus* should stand as *Hemirhamphus roberti* Cuv. & Val. Lower jaw longer than rest of head. South Atlantic coast of United States and southward, also on the Pacific coast southward.

Instead of the synonymy in the text read: (*Hemirhamphus roberti* Cuv. & Val., XIX, 1846, 24; Günther VI, 263, *Hemirhamphus unifasciatus* of most recent American authors, not of Ranzani, whose species is the short billed one.)

A discussion of the species of this genus is given by Meek & Goss, Proc. Ac. Nat. Sci. Phila., 1884.

[3] The species called in the Synopsis (p. 902), *Hemirhamphus brasiliensis*, should apparently stand as *Hemirhamphus pleei*.

[4] *Exocœtus mesogaster* Bloch, Ichthyol., XII, tab. 399 = *Exocœtus hillianus* Gosse. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 588.)

[5] *Exocœtus obtusirostris* Günther, seems to be identical with *H. evolans*.

201.—EXOCŒTUS[1] Linnæus. (185, 186)

673. **Exocœtus exiliens**[2] Gmelin. O. S. (613)
674. **Exocœtus rondeleti**[3] Cuv. & Val. S. O. Eu. (609)
675. **Exocœtus vinciguerræ**[4] Jordan & Meek. N. O. (609)
676. **Exocœtus volitans**[5] Linnæus. N. S. W. (611)
677. **Exocœtus heterurus** Rafinesque. N. S. Eu. (610, 613)
678. **Exocœtus furcatus** Mitchill. O. (612)
679. **Exocœtus californicus** Cooper. C. P. (608)
680. **Exocœtus gibbifrons** Cuv. & Val. O.

Order W.—LOPHOBRANCHII. (R.)

Family LXIX.—SYNGNATHIDÆ. (58, 59)

202.—SIPHOSTOMA Rafinesque (187)

681. **Siphostoma zatropis** Jordan & Gilbert. W. (618 *b.*)
682. **Siphostoma punctipinne** Gill. C. (618)
683. **Siphostoma californiense** Storer. C. (616)
684. **Siphostoma griseolineatum** Ayres. C. (616 *b.*)
685. **Siphostoma auliscus** Swain. C. (617 *b.*)
686. **Siphostoma barbaræ**[6] Swain & Meek. C. (616 *c.*)
687. **Siphostoma bairdianum**[7] Duméril. P.

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[1] It is probable that *Cypselurus* is a young stage of *Exocœtus*. I have found on specimens of *Exocœtus mesogaster* two short barbels at the symphysis of the lower jaw, while in adult examples there is no trace of these appendages. For a full account of our species of this genus, see Jordan & Meek, Proc. U. S. Nat. Mus. 1885.

[2] The following is Gmelin's account of *Exocœtus exiliens:*

* "*Exocœtus* pinnis ventralibus caudam attingentibus. D. 10, P. 15, V. 6, A. 11, C. 26. Habitat ad Carolinam, volitante statura simillimus, at vix digito longior, neque argenteus. Garden.

"Pinnæ pallidæ, fascia una alterave nigricante, ventrales * * apice pinnam caudæ attingentes, ¼ a caudæ remotæ, * * inter caput et anum mediæ, radio primo brevi, pectorales, radio primo et secundo brevibus; caudalis lobus inferior longior." (*Gmelin.*)

[3] *Exocœtus volador* Jordan, Proc. U. S. Nat. Mus., 1884, 34.

[4] *Exocœtus rondeletii*, Synopsis, p. 904, not of C. & V.; Lütken, Vid. Meddel. Naturh. Foren., 1876, 110.)

[5] *Exocœtus volitans* L. = *Exocœtus melanurus* Synopsis, p. 179; *nec* Cuv. & Val.; *Exocœtus exiliens* Synopsis, p. 904, not of Gmelin; *Exocœtus affinis* Günther, VI, 288; *Exocœtus roberti* Müller & Troschel, Schomburgk, Excurs. Barbadoes, 675 (probably).

[6] The species, called in the Synopsis, *Siphostoma bairdianum*, should stand as *Siphostoma barbaræ* Swain & Meek, Proc. U. S. Nat. Mus., 1884, 238. Santa Barbara.

[7] The original *Syngnathus bairdianus*, from the "coast of Mexico near California," proves to be a different species, having the technical characters of *S. affine*, but with the snout longer and the crest on top of head rather feebler. The following is Duméril's original description:

Head scarcely ⅐ of total length, a little longer than dorsal base; muzzle longer by a third than postocular part of head and equal to distance from front of eye to second ring; median crest of head and nape feeble; that of opercle very small. Rings 17 + 31. Tail at least half longer than trunk. Dorsal on 3 + 6 rings. P. 15, D. 30, A. 3, C. 6. Yellowish, sutures marked, except below, by a brown line. Coast of Mexico, near California.

688. **Siphostoma leptorhynchum** Girard. C. (617)
689. **Siphostoma floridæ** Jordan & Gilbert. S. (615 *b.*)
690. **Siphostoma affine** Günther. S. W. (614 *b.*)
691. **Siphostoma louisianæ** Günther. S. (615)
692. **Siphostoma fuscum** Storer. N. (614)
693. **Siphostoma mackayi**[1] Swain & Meek. W.
694. **Siphostoma crinigerum**[2] Bean & Dresel. S. W.

203.—DORYRHAMPHUS[3] Kaup.

695. **Doryrhamphus californiensis** Gill. P.

204.—HIPPOCAMPUS[4] Linnæus.

696. **Hippocampus ingens** Girard. C. P. (620)
697. **Hippocampus punctulatus** Guichenot. W. (619 *b.*)
698. **Hippocampus hudsonius** Dekay. N. S. (619 *c.*)
699. **Hippocampus stylifer** Jordan & Gilbert. S. (619 *d.*)
700. **Hippocampus zosteræ** Jordan & Gilbert. S. (619 *e.*)

ORDER X.—HEMIBRANCHII. (S)

Family LXX.—MACRORHAMPHOSIDÆ. (60)

205.—MACRORHAMPHOSUS[5] Lacépède. (189)

701. **Macrorhamphosus scolopax** Linnæus. Eu. (621)

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[1] *Siphostoma mackayi* Swain & Meek, Proc. U. S. Nat. Mus., 1884, 239; Key West. In this paper is a very useful analysis of the characters of the species of this genus, supplementary to a paper on the same subject by Mr. Swain, Proc. U. S. Nat. Mus., 1882, 307.

[2] *Siphostoma crinigerum* Bean & Dresel, Proc. Biol. Soc. Washington, II, 1884, 99. Swain & Meek, Proc. U. S. Nat. Mus., 1884, 239. Pensacola to Key West.

[3] DORYRHAMPHUS Kaup.

(Kaup, Lophobranchii, 1856, 54; type *Doryrhamphus excisus* Kaup.)

This genus differs from *Siphostoma* chiefly in the position of the egg-pouch of the male, which is under the abdomen instead of the tail. The angles of the body are strongly ridged. Tropical seas. (*Δορυ*, lance; *ῥαμφος*, snout.)

Doryrhamphus californiensis Gill.

Yellowish brown, with a black streak from snout to axil. Snout half as long as head, its crest formed of about ten irregular teeth, behind which are two others. Double frontal crest well serrated. Ridge under orbit unarmed, but on side of snout it is well serrated. Chin prominent but unarmed. Pectorals as long as opercle. Caudal as long as snout. D. 25. Rings 20+16. Cape San Lucas (*Gill*). The types are lost and no specimens have been since recorded.

(Gill, Proc. Ac. Nat. Sci. Phila., 1862, 284: *Doryichthys californiensis* Günther VIII, 186.)

[4] The family *Hippocampidæ* should be, apparently, reunited with the *Syngnathidæ*. I here omit *Hippocampus hippocampus* (= *heptagonus* Raf.; *antiquorum*, Leach), not believing that that species has been actually taken in American waters.

[5] The reasons for using the name *Macrorhamphosus* for this genus instead of *Centriscus* are stated in Proc. U. S. Nat. Mus., 1882, 575. The original type of *Centriscus* is C. *scutatus*.

A valuable discussion of "the mutual relations of the *Hemibranchiate* fishes" is given by Dr. Gill, Proc. Ac. Nat. Sci. Phila., 1884, 154.

Family LXXI.—FISTULARIIDÆ. (61)

206.—FISTULARIA Linnæus. (190)

702. **Fistularia tabaccaria** Linnæus. S. W. (622)
703. **Fistularia serrata** Cuvier. O. (623)
704. **Fistularia depressa**[1] Günther. P.

Family LXXII.—AULOSTOMIDÆ. (62)

207.—AULOSTOMA Lacépède. (191)

705. **Aulostoma maculatum** Valenciennes. W. (624)

Family LXXIII.—AULORHYNCHIDÆ. (63)

208.—AULORHYNCHUS Gill. (191)

706. **Aulorhynchus flavidus** Gill. C. A. (625)

Family LXXIV.—GASTEROSTEIDÆ. (64)

209.—PYGOSTEUS Brevoort.

707. **Pygosteus pungitius** Linnæus. N. Eu. (626)
707 b. *Pygosteus pungitius concinnus* Richardson. Vn.
707 c. *Pygosteus pungitius brachypoda* Bean. G.

210.—EUCALIA Jordan.

708. **Eucalia inconstans** Kirtland. Vn. (627)
708 b. *Eucalia inconstans cayuga* Jordan. Vne.

211.—GASTEROSTEUS Linnæus. (193)

709. **Gasterosteus williamsoni**[2] Girard. T.
710. **Gasterosteus microcephalus** Girard C. A. (628)
711. **Gasterosteus (gymnurus ?) cuvieri** Girard. G. (629)
711 b. *Gasterosteus (cuvieri?) wheatlandi* Putnam. N.
712. **Gasterosteus atkinsi** Bean. Vne. (630)
713. **Gasterosteus aculeatus** Linnæus. N. Eu. (631)
713 b. *Gasterosteus aculeatus cataphractus* Pallas. A. (631 *b*)

212.—APELTES Dekay. (194)

714. **Apeltes quadracus** Mitchill. N. (632)

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[1] *Fistularia depressa* Günther, Rept. Shore Fishes; Challenger, 1880, 69; East Indies, Australia, China, and Lower California. Abundant in the Gulf of California. Bones of the head less deeply sculptured than in *F. serrata*, but with the two upper lateral ridges of the snout also serrated; interorbital space nearly flat. Two middle ridges on upper surface of snout not very close together, diverging again on anterior half of length of snout, converging again finally on the foremost part. Body much depressed, nearly smooth, the skin being scarcely rough.

[2] For a description of this species, see Rosa Smith, Proc. U. S. Nat. Mus., 1883, 217. It is a true *Gasterosteus*, and not an *Eucalia*, although having the naked skin of the latter genus.

ORDER Y.—PERCESOCES.

Family LXXV.—MUGILIDÆ. (65)

213.—MUGIL Linnæus. (195)

715. Mugil cephalus[1] Linnæus. N. S. W. P. C. Eu. (633, 634)
716. Mugil gaimardianus[2] Poey. W.
717. Mugil curema[3] Cuvier & Valenciennes. N. S. W. P. (635)
718. Mugil trichodon[4] Poey. W.

214.—CHÆNOMUGIL[5] Gill.

719. Chænomugil proboscideus Günther. P.

215.—QUERIMANA[6] Jordan & Gilbert.

720. Querimana harengus Günther. P.
721. Querimana gyrans Jordan & Gilbert. S. W.

216.—AGONOSTOMUS[7] Bennett.

722. Agonostomus nasutus Günther. P.

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[1] The American species (*albula*) seems to be identical with the European (*cephalus*). For a detailed account of the American *Mugilidæ*, see Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 261.

[2] *Mugil gaimardianus* Poey, Ann. Lyc. Nat. Hist., N. Y., 1875, 64. Cuba, Key West. See Jordan & Swain, l. c.

[3] *Mugil curema* Cuv. & Val. = *Mugil brasiliensis* of authors, not of Agassiz. See Jordan & Swain, l. c.

[4] *Mugil trichodon* Poey. Cuba and Key West.

In the paper above cited, we have adopted the name *Mugil brasiliensis* for this species. This is perhaps too hasty, as the *Mugil brasiliensis* of Agassiz seems at least as likely to have been *Mugil liza*.

[5] CHÆNOMUGIL Gill.

(Gill, Proc. Ac. Nat. Sci., Phila., 1863, 169; type *Mugil proboscideus* Günther.)

Cleft of mouth lateral; lower jaw narrow; dentiform cilia in very many series, somewhat pavid; upper lip very thick; no adipose eyelid. Vertical fins scaly. One species known. (*Χαυω*, to gape; *Mugil.*)

Chænomugil proboscideus Günther = *Mugil proboscideus* Günther, iii, 1861, 459. Mazatlan to Panama.

[6] QUERIMANA Jordan & Gilbert.

(Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 588; type *Myxus harengus* Günther.

This genus differs from *Mugil* chiefly in the presence of but two spines in the anal fin. The species are of small size, and some of them swim in schools at the surface.

Querimana harengus Günther. *Myxus harengus* Günther, iii, 467, 1861 = *Querimana harengus* Jordan & Swain, Proc. U. S. Nat. Mus., 1882, 274. Mazatlan to Peru; abundant.

Querimana gyrans Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 26. Charleston to Key West.

[7] AGONOSTOMUS Bennett.

(*Cestræus*, *Dajaus* and *Nestis* Cuv. & Val.).

(Bennett, Proc. Comm. Zoöl. Soc., 1830, 166; type *Agonostomus telfairi* Bennett.)

Fresh water mullets with cleft of the mouth extending laterally about to front of eye. Small teeth in one or both jaws and sometimes on the vomer. Edge of lower lip rounded, not sharp. Stomach not gizzard like. Anal spines 3. Streams of mountainous regions in the tropics. (*Αγωνος*, not angulated; *στομα*, mouth.)

Agonostoma nasutum Günther, iii, 463; Jordan & Gilbert, Proc. U. S. Mus., 379. Streams of Lower California and Guatemala.

Family LXXVI.—ATHERINIDÆ. (66)

217.—ATHERINA Linnæus. (196)

723. **Atherina eriarcha**[1] Jordan & Gilbert. P.
724. **Atherina carolina** Cuv. & Val. S. (636)
725. **Atherina stipes**[2] Müller & Troschel. W. (637)
726. **Atherina aræa**[3] Jordan & Gilbert. W.

218.—LEURESTHES Jordan & Gilbert. (197)

727. **Leuresthes tenuis** Ayres. C. (638)

219.—LABIDESTHES Cope. (198)

728. **Labidesthes sicculus** Cope. Vc. (639)

220.—MENIDIA Bonaparte. (199)

729. **Menidia laciniata** Swain. S. (640)
730. **Menidia vagrans** Goode & Bean. S. (641)
731. **Menidia notata** Mitchill. N. (642)
732. **Menidia audens** Hay. Vs. (642*b*)
733. **Menidia beryllina** Cope. Ve. (643)
734. **Menidia menidia**[4] Linnæus. S. (644)
735. **Menidia peninsulæ** Goode & Bean. S. (645)

221.—ATHERINOPSIS Girard. (200)

736. **Atherinopsis californiensis** Girard. C. (646)

222.—ATHERINOPS Steindachner. (201)

737. **Atherinops affinis** Ayres. C. (647)

Family LXXVII.—SPHYRÆNIDÆ. (67)

223.—SPHYRÆNA Bloch. (202)

738. **Sphyræna argentea** Girard. C. P. (648)
739. **Sphyræna borealis**[5] De Kay. N. (649)
740. **Sphyræna guaguanche** Cuv. & Val. S. W. (650)
741. **Sphyræna picuda** Bloch & Schneider. S. W. (650 *b.*)
742. **Sphyræna ensis** Jordan & Gilbert. P.

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[1] *Atherinella eriarcha* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 348. Mazatlan to Peru.

[2] *Atherina stipes* Müller & Troschel = *Atherina laticeps* Poey = *Atherina velicana* Goode & Bean. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 116.

[3] *Atherina aræa* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 27. Key West.

[4] Called *Menidia bosci* in the Synopsis, pp. 408, 909.

[5] Called *Sphyræna spet* in the Synopsis, p. 411. Ours is, however, apparently distinct from the latter species, which is European.

[6] *Sphyræna ensis* Jordan & Gilbert, Bull. U. S. Fish Comm., 1881, 106, based on *Sphyræna forsteri* Steindachner, Ichth. Beiträge, VII, 4, 1878, not *Sphyræna forsteri* C. & V.

Body moderately elongate; eye 6 to 7 in head; snout 2¼; pectoral 2⅘. Pectoral reaching about to front of first dorsal. Ventrals inserted before first dorsal. Canine teeth of lower jaw, palatines, and inner row of premaxillary very large, much as in *S. picuda*. Maxillary reaching about to front of dorsal. Silvery, darker above, with traces of numerous vague darker cross-bars. Head 4; depth 8 or 9. D. V-1, 9; A. 11. 8. Lat. l. 110. Gulf of California to Panama.

For a detailed account of our species of this genus, see Meek & Newland, Proc. Ac. Nat. Sci. Phila., 1884.

Family LXXVIII.—POLYNEMIDÆ. (68)

224.—POLYNEMUS Linnæus.

743. **Polynemus virginicus**[1] Linnæus. W. (650*c*)
744. **Polynemus approximans**[2] Lay & Bennett. P.
745. **Polynemus opercularis**[3] Gill. P.
746. **Polynemus octonemus**[4] Girard. S.

ORDER Z.—PERCOMORPHI.[5]

Family LXXIX.—AMMODYTIDÆ. (69)

225.—AMMODYTES Linnæus. (204, 205)

747. **Ammodytes americanus** DeKay. N. (652, 656)
747b *Ammodytes americanus personatus* Girard. A. C. (653)
748. **Ammodytes alascanus** Cope. A. (654)
749. **Ammodytes dubius** Reinhardt. B. (655)

Family LXXX.—ECHENEIDIDÆ. (70)

226.—ECHENEIS. (206)

750. **Echeneis naucrates** Linnæus. N. S. O. W. P. C. (657)

227.—PHTHEIRICHTHYS Gill. (206*b*.)

751. **Phtheirichthys lineatus** Menzies. S. W. (657 *b*.)

228.—REMORA Gill. (206*c*)

752. **Remora remora** Linnæus. S. O. W. P. C. (658)
753. **Remora brachyptera** Lowe. W. O. (659)
754. **Remora albescens**[6] Temminck & Schlegel. P. S.

229.—RHOMBOCHIRUS Gill. (207)

755. **Rhombochirus osteochir** Cuvier. O. W. (660)

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[1] *Polynemus virginicus* L. Syst. Nat.=*Polydactylus plumieri* Lacépède. See Jordan, Proc. U. S. Nat. Mus., 1884, 118.

[2] *Polynemus approximans* Lay & Bennett, Beechey's Voyage, Zool. Fish, 57; Günther, Fish. Centr. Amer., 1869, 423. Gulf of California to Panama.

[3] *Trichidion opercularis* Gill, Proc. Ac. Nat. Sci. Phila., 1863, 169 = *Polynemus melanopoma* Günther, Fish. Centr. Amer. 1869, 421. Gulf of California to Panama.

[4] *Polynemus octofilis* Gill is without much doubt the adult form of *P. octonemus*. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 590. The pectoral fin grows darker in color and the pectoral filaments shorter with age in other species of *Polynemus* and probably in this one also.

[5] *Percomorphi* and *Pharyngognathi* Cope, Trans. Am. Philos. Soc. Phila., 1871, 458 (exclusive of the *Rhegnopteri*=*Polynemidæ*, which have the ventral fins truly abdominal and may be placed in the *Percesoces*.)

[6] *Echeneis albescens* Temminck & Schlegel, Fauna Japonica, Poiss., 272; Günther II, 377; Streets, Bull. U. S. Nat. Mus., 1877, VII, 54. Coasts of Eastern Asia, a specimen taken at La Paz, Gulf of California (*Streets*) and in the Gulf of Mexico (*Bean*). D. XIII–22; A. 22.

The *Echeneidida* are regarded by Dr. Gill as constituting a distinct suborder, *Discocephali*, defined by him Proc. U. S. Nat. Mus., 1882, 563.

Family LXXXI.—ELACATIDÆ. (71)

230.—ELACATE Cuvier. (208)

756. **Elacate canada** Linnæus. S. W. O. (661)

Family LXXXII.—XIPHIIDÆ. (72)

231.—XIPHIAS Linnæus. (209)

757. **Xiphias gladius** Linnæus. O. N. S. W. C. (662)

232.—TETRAPTURUS Rafinesque. (210)

758. **Tetrapturus albidus** Poey. W. S. (663)

233.—ISTIOPHORUS Lacépède. (211)

759. **Istiophorus americanus**[1] Cuv. & Val. (665)

Family LXXXIII.—TRICHIURIDÆ. (73)

234.—TRICHIURUS Linnæus. (212)

760. **Trichiurus lepturus** Linnæus. O. S W. P. (666)

235.—BENTHODESMUS Goode & Bean. (212*b*.)

761. **Benthodesmus elongatus** Clarke. B. (666*b*.)

236.—LEPIDOPUS Gouan.

762. **Lepidopus caudatus** Euphrasen. O. P.

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[1] The genuine *Istiophorus gladius* is an East Indian species, not known from our coasts. The American species is:

Istiophorus americanus Cuv. & Val. *Sail-fish; Spike-fish.* Bluish-black, paler below; dorsal dusky-bluish; its membranes with many nearly round black spots, from $\frac{1}{3}$ to $\frac{1}{2}$ diameter of orbit. Snout, from eye, $2\frac{1}{2}$ times length of rest of head. Lower jaw $2\frac{1}{2}$ in head. Front of eye nearly midway between tip of lower jaw and edge of opercle. Interorbital space broad, flattish, $1\frac{3}{5}$ in postorbital part of head. Maxillary reaching to slightly beyond eye, which is $3\frac{1}{2}$ in postorbital part of head and 10 in snout. Sword narrow, regularly tapering, depressed, its upper and lower surfaces both rounded, its edges blunt and rougher than its upper side. For its entire length it is nearly twice as broad as deep. Breadth of snout at the middle point between its tip and the eye contained 25 times in its length from the eye. Longest dorsal spine $\frac{4}{5}$ total length of head. Ventrals $1\frac{1}{6}$ in head. Pectorals $3\frac{3}{5}$. Caudal lobes $1\frac{1}{5}$. D. XLI-7; A. 9-7. Head $2\frac{3}{5}$ ($3\frac{1}{4}$ in length with caudal); depth about 6. Length of specimen described (Key West) 6 feet.

West Indies and warmer parts of the Atlantic, north to Cape Cod and France. Differing from the East Indian *I. gladius* in the longer and slenderer sword and in the shorter dorsal fin.

(? *Makaira nigricans* Lacépède, Hist. Nat. Poiss. IV, 688, 1803. *Histiophorus americanus* Cuv. & Val., VIII, 303, 1831; ? *Histiophorus gracilirostris* C. & V., VIII, 308; ? *Histiophorus ancipitirostris* Cuv. & Val., VIII, 309. I here restore the original orthography of the name *Istiophorus*.)

[2] LEPIDOPUS Gouan.

(Gouan, Hist. Poiss. 1770, 185; type *Lepidopus gouani* Bl. & Schn. = *Trichiurus caudatus* Euphrasen.)

This genus differs from *Trichiurus* chiefly in the less elongate form of the tail, which

Family LXXXIV.—SCOMBRIDÆ. (74)

237.—SCOMBER Linnæus. (213)

§ *Pneumatophorus* Jordan & Gilbert.

763. Scomber colias[1] Gmelin. Eu. N. S. P. C. (667, 667 *b*.)

§ *Scomber*.

764. Scomber scombrus Linnæus. N. S. O. Eu. (668)

238.—AUXIS Cuvier. (214)

765. Auxis thazard Lacépède. W. N. (Acc.) O. (669)

239.—SCOMBEROMORUS Lacépède. (215)

766. Scomberomorus concolor Lockington. C. (670)
767. Scomberomorus maculatus Mitchill. N. S. P. (671)
768. Scomberomorus regalis Bloch. W. (672)
769. Scomberomorus cavalla[2] Cuvier. W. S. (673)

240.—ACANTHOCYBIUM[3] Gill.

770. Acanthocybium solandri Cuv. & Val. W. O.

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is provided with a small, deeply forked caudal fin. The ventral fins are represented by a pair of scale-like appendages. A single species; pelagic. (Λέπις, scale; πούς, foot.)

Lepidopus caudatus. Scabbard-fish. For description, see Günther II, 344. Pelagic; a specimen taken by John Xantus at Cape St. Lucas.

[1] It is probable that *Scomber pneumatophorus* is identical with *Scomber colias*.

[2] This species was first indicated as *Cybium cavalla* Cuvier, Régne Animal, 1829. It is the king-fish of the Florida Keys, a food fish of the highest importance. For a detailed account of the species of *Scomberomorus* see Meek and Newland, Proc. Ac. Nat. Sci. Phila., 1884.

[3] ACANTHOCYBIUM Gill.

(Gill, Proc. Ac. Nat. Sci. Phila., 1862; type *Cybium sara* Bennett.)

This genus is allied to *Scomberomorus*, but shows several of the peculiarities of the sword-fishes, indicating a transition toward the *Xiphiidæ*. The head is very long, slender, and pointed, the mandible being longer than the upper jaw, the jaws forming a sort of beak; cleft of the mouth extending to below the eye; the posterior part of the maxillary covered by the preorbital; both jaws armed with a close series of trenchant teeth, ovate or truncate; their edges finely serrate; villiform teeth on vomer and palatines; gills formed as in *Xiphias*, their laminæ forming a net-work; scales small, scarcely forming a corselet; those along the base of dorsal enlarged and lanceolate; keel strong; caudal spinous dorsal very long, its spines about 25 in number.

Very large mackerels, pelagic; probably a single species widely distributed; most abundant about the Florida Straits. (Ακανθα, spine; Cybium.)

Acanthocybium solandri. Peto; Wahoo; Barracotta.

Iron gray, dark above; paler below; no distinct markings; fins colored like the body; eye 5 in snout; gape more than half length of head; premaxillaries in front prolonged in a sort of beak which is nearly half length of snout; teeth somewhat irregular, the posterior much largest. Dorsal spine mostly subequal, the highest, behind the middle of the fin, 5⅔ in head; dorsal and anal lobes low. Caudal lobes short, very abruptly spreading, their length about ⅔ head. Pectoral not quite half head. D. XXIV-1, 12-IX; A. 1, 12-IX. Length 4 to 8 feet. Tropical seas; not rare about Cuba, where it spawns; north to Key West.

(*Cybium solandri* Cuv. & Val., VIII, 1831, 192; *Cybium sara* Bennett, Beechey's Voyage, Zoölogy, 1849, 63; *Cybium sara* Günther, II, 373; *Cybium petus* Poey, Memorias Cuba, II, 234, 1860; *Acanthocybium petus* Poey, Enum. Pisc. Cubens., 1875, 73. Lütken, Spolia Atlantica, 1880, 481-597; *Cybium verany* Doderlein, Giorn. Sci. Natur. Econ. Palermo, 1872.

241.—SARDA Cuvier. (216)

771. **Sarda sarda** Bloch. Eu. N. (674)
772. **Sarda chilensis** Cuv. & Val. C. P. (675)

242.—ORCYNUS Cuvier. (217)

773. **Orcynus alalonga** Gmelin. Eu. S. C. O. (676)
774. **Orcynus thynnus** Linnæus. Eu. S. N. O. (677)

243.—EUTHYNNUS Lütken. (218)

775. **Euthynnus alliteratus** Rafinesque. S. W. Eu. (678)
776. **Euthynnus pelamys** Linnæus. Eu. S. O. (679)

Family LXXXV.—CARANGIDÆ.[1] (75)

244.—DECAPTERUS Bleeker. (220)

777. **Decapterus punctatus** Agassiz. S. W. (682)

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[1] The following analysis of genera of *Carangidæ* may be substituted for that given in the synopsis:

a. Premaxillaries protractile.
b. Pectoral fins long, falcate; anal similar to soft dorsal, its base longer than abdomen; maxillary with a supplemental bone. (*Caranginæ.*)
c. Dorsal outline more strongly curved than ventral outline.
d. Dorsal and anal each with a single detached finlet; body slender. DECAPTERUS.
dd. Dorsal and anal without finlets.
e. Lateral line with well-developed scutes for its entire length; body elongate .... TRACHURUS.
ee. Lateral line with scutes on its straight posterior portion only (these sometimes very few and small, especially in those species with the body much compressed).
f. Shoulder girdle with a deep cross-furrow at its junction with the isthmus, above which is a fleshy projection; body elongate .... TRACHUROPS.
ff. Shoulder girdle normal; its surface even; body deeper.
g. Body oblong or more or less elevated, not as below .... CARANX.
gg. Body broad-ovate, very strongly compressed, its outlines everywhere trenchant, the anterior profile nearly vertical; scutes almost obsolete .... VOMER.
eee. Lateral line without any scutes; body short and elevated, strongly compressed .... SELENE.
cc. Dorsal outline less strongly curved than ventral; body much compressed, its outlines everywhere trenchant; armature of lateral line obsolete or nearly so. CHLOROSCOMBRUS.
bb. Pectoral fin short, not falcate.
h. Maxillary without supplemental bone; anal fin similar to soft dorsal, its base much longer than abdomen; tail unarmed. (*Trachynotinæ.*)
d. Forehead convex; teeth small or deciduous .... TRACHYNOTUS.
hh. Maxillary with a distinct supplemental bone; anal fin shorter than soft dorsal, its base not longer than abdomen. (*Seriolinæ.*)
i. Dorsal spines low and weak; pectoral fins short.
j. Dorsal and anal fins without finlets.
k. Membrane of dorsal spines disappearing with age. NAUCRATES.
kk. Membrane of dorsal spines persistent .... SERIOLA.
jj. Dorsal and anal fins each with a detached two-rayed finlet. ELAGATIS.
ii. Dorsal spines strong, ending in very long filaments; pectoral fins elongate .... NEMATISTIUS.

778. **Decapterus macarellus** Cuv. & Val. W. S. (683)
778 b. *Decapterus macarellus hypodus*[1] Gill. P.

245.—TRACHURUS Rafinesque. (219)

779. **Trachurus picturatus** Bowdich. C. Eu. P. (680)
780. **Trachurus trachurus** Linnæus. W. P. (681)

246. TRACHUROPS Gill.

781. **Trachurops crumenophthalmus** Bloch. W. P. (684)

247.—CARANX Lacépède.

§ *Hemicaranx* Bleeker.

782. **Caranx amblyrhynchus** Cuv. & Val. S. W. (689)

§ *Uraspis* Bleeker.

783. **Caranx vinctus**[2] Jordan & Gilbert P.
784. **Caranx bartholomæi**[3] Cuv. & Val. W. (687, 688)

§ *Caranx*.

785. **Caranx chrysus** Mitchill. N. S. W. (685)
785 b. *Caranx chrysus caballus* Günther. P. W. (686)
786. **Caranx latus**[4] Agassiz. S. W. P. (690)
787. **Caranx hippos** Linnæus. N. S. W. P. (691)

§ *Gnathanodon* Bleeker.

788. **Caranx speciosus**[5] Forskål. P.

§ *Citula* Cuvier.

789. **Caranx dorsalis**[6] Gill. P.

§ *Blepharis* Cuvier.

790. **Caranx crinitus** Mitchill. N. S. W. P. (692)

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aa. Premaxillaries not protractile (except in the very young); pectoral fins short rounded; soft dorsal similar to anal, both much longer than abdomen; lateral line unarmed. (*Scombroidinæ.*)
l. Maxillary without supplemental bone; no pterygoid teeth; scales linear, imbedded.....................OLIGOPLITES.

A detailed account of the American species of *Caranginæ* is given by Jordan & Gilbert, Proc. U. S. Nat. Mus., 1883, 188.

[1] *Decapterus hypodus* Gill, Proc. Ac. Nat. Sci., Phila., 1862, 261; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 358; 1883, 190. Cape San Lucas.

[2] *Caranx vinctus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 349. Mazatlan.

[3] *Caranx bartholomæi* Cuv. & Val., IX, 1833, 100 = *Caranx cibi* Poey, Memorias Cuba, II, 224, 1860 = *Caranx beani* Jordan, Proc. U. S. Nat. Mus., 1880, 486. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 32.

[4] *Caranx latus* Agassiz; *Caranx fallax* Cuv. & Val. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1883, 200.

[5] *Scomber speciosus* Forskål, Descr. Anim., 1775, 54 = *Caranx panamensis* Gill, Proc. Ac. Nat. Sci. Phila., 1863, 166. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1883, 201. Mazatlan to Panama and west to the Red Sea.

[6] *Carangoides dorsalis* Gill, Proc. U. S. Nat. Mus., 1863, 166 = *Caranx otrynter* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1883, 202. Mazatlan to Panama.

248.—VOMER Cuvier.

791. **Vomer setipinnis** Mitchill. N. S. W. P. (694)

249.—SELENE Lacépède. (223)

792. **Selene œrstedi**[1] Lütken. P.
793. **Selene vomer** Linnæus. N. S. W. P. (693)

250.—CHLOROSCOMBRUS Girard. (224)

794. **Chloroscombrus chrysurus** Linnæus. S. W. (695)
795. **Chloroscombrus orqueta**[2] Jordan & Gilbert. P.

251.—TRACHYNOTUS Lacépède.

796. **Trachynotus carolinus** Linnæus. N. S. W. P.? (696)
797. **Trachynotus argenteus**[3] Cuv. & Val. N.
798. **Trachynotus rhodopus**[4] Gill. W. P. (698)
799. **Trachynotus kennedyi**[5] Steindachner. P.
800. **Trachynotus rhomboides** Bloch. S. W. (697)
801. **Trachynotus glaucus** Bloch. S. W. (699)
802. **Trachynotus fasciatus**[6] Gill. P.

252.—NAUCRATES Rafinesque. (226)

803. **Naucrates ductor** Linnæus. O. (700.)

253.—SERIOLA Cuvier. (227)

804. **Seriola zonata** Mitchill. N. (704)
804 b. *Seriola zonata carolinensis* Holbrook. S. (703)
805. **Seriola dumerili**[7] Risso. S. W. Eu.
805 b. *Seriola dumerili lalandi.* S. W. (701 *b*.)

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[1] *Selene œrstedi* Lütken, Spolia Atlantica, 1880, 144; Jordan & Gilbert, l. c. 205. Mazatlan to Panama.

[2] *Chloroscombrus orqueta* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 646. Magdalena Bay to Panama.

[3] *Trachynotus argenteus* Cuv. & Val., VIII, 413. According to Dr. Bean, this is probably a valid species, allied to *T. carolinus*, but with the body deeper, the depth being half the length without caudal. New York.

A review of the American species of *Trachynotus* is given by Meek and Goss in the Proc. Ac. Nat. Sci. Phila., 1884.

[4] The species called in the synopsis "*Trachynotus goreensis*" should stand as *Trachynotus rhodopus* Gill. *Permit. Palometa.* West Indies, north to Florida and Lower California. Instead of the synonymy in the synopsis read: *Trachynotus rhodopus* (young) and *T. nasutus* (very young) Gill, Proc. Ac. Nat. Sci. Phila, 1863, 85; *Trachynotus goreensis* Günther, II, 483, in part, not of Cuv. & Val.; *Trachynotus goreensis* of recent American writers; *Trachynotus carolinus* Poey, Enum. Pisc. Cubens., 86.

This species reaches a larger size than the others in our waters. It has fewer fin rays than *T. carolinus*, and young and old are much more elongate than in *T. rhomboides* or than in the African *T. goreensis*.

[5] *Trachynotus kennedyi* Steindachner, Ichth. Beitr., VI, 47. Mazatlan to Panama.

[6] *Trachynotus fasciatus* Gill, Proc. Ac. Nat. Sci. Phila. 1863, 86. Mazatlan to Panama.

[7] *Seriola dumérili* Risso. *Amber Jack.*

Grayish; silvery below; a gilt band through eye to base of caudal; another through temporal region to front of soft dorsal; no dark cross-bands; fins plain. Very close to *S. lalandi*, but reaching a smaller size, and with the body deeper and little com-

806. Seriola mazatlana[1] Steindachner. P.
807. Seriola dorsalis Gill. C. P. (701)
808. Seriola fasciata Bloch. S. (705)
809. Seriola rivoliana Cuv. & Val. S. W. Eu. (702, 702 *b*.)

254.—ELAGATIS Bennett. (228)

810. Elagatis pinnulatus Poey. W. (706)

255.—NEMATISTIUS[2] Gill.

811. Nematistius pectoralis Gill. P.

256.—OLIGOPLITES Gill. (229)

812. Oligoplites altus[3] Günther. P.
813. Oligoplites saurus Bloch & Schneider. S. W. P. (707)

Family LXXXVI.—POMATOMIDÆ. (76)

257.—POMATOMUS Lacépède. (230)

814. Pomatomus saltatrix Linnæus. N. S. W. Eu. O. (708)

Family LXXXVII.—NOMEIDÆ. (76 *b*.)

258.—NOMEUS Cuvier. (231)

815. Nomeus gronovii Gmelin. W. O. (709)

Family LXXXVIII.—STROMATEIDÆ. (77)

259.—STROMATEUS Linnæus. (232)

§ *Rhombus* Lacépède.

816. Stromateus paru Linnæus. S. W. (710)

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pressed; mouth larger than in *S. dorsalis*, about as in *S. lalandi*, the maxillary reaching middle of pupil, $2\frac{1}{10}$ in head. Lobes of dorsal and anal low, not quite half length of head. Nape scarcely carinated. Head $3\frac{1}{10}$; depth 3. D. VII–I, 32; A. II–I, 21; L. 24 inches. Mediterranean to West Indies, north to Key West and Pensacola.

(*Trachurus aliciolus* Rafinesque Caratteri, etc., 1810, 42; *Trachurus fasciatus* Rafinesque, Indice d'Ittiologia Sicil., 1810, 21; *Caranx dumérili* Risso, Ichthyologie Nice, 1810, 175; *Seriola dumérili* Cuv. & Val., IX, 201, 1833; Günther, II, 462; ? *Seriola semicoronata* Poey, Memorias Cuba, II, 1860, 232.)

An analysis of the characters of the species of *Seriola* is given by me in Proc. U. S. Nat. Mus., 1884, 123. A more recent (unpublished) study of these fishes by Mr. Rufus L. Green indicates the probable identity of *S. lalandi* with *S. aliciola* (*dumérili*), *S. falcata* with *S. rivoliana*, and (probably) *S. mazatlana* with *S. dorsalis*.

[1] *Seriola mazatlana* Steindachner, Ichth. Beiträge, V. 8, 1876. Mazatlan.

[2] NEMATISTIUS Gill.

(Gill, Proc. Ac. Nat. Sci. Phila., 1862, 258; type, *Nematistius pectoralis* Gill).

This genus differs from *Seriola* chiefly in the development of the spinous dorsal and pectoral fins, the former being composed of eight very long filamentous spines, the latter being acuminate and nearly twice as long as the ventrals. The lateral line is nearly straight and is not keeled on the caudal peduncle. Ventral rays, I, 5, the inner ray much branched to the base. One species known. Large fishes of an imposing appearance.

Nematistius pectoralis Gill, l. c. Gulf of California to Panama; not rare.

[3] *Chorinemus altus* Günther, Fishes Centr. Amer., 1869, 433. Mazatlan to Panama.

§ *Stromateus.*

817. **Stromateus medius**[1] Peters. P.
818. **Stromateus simillimus** Ayres. C. (711)

§ *Poronotus.*

819. **Stromateus triacanthus** Peck. N. (712)

260.—**LEIRUS** Lowe. (233)

820. **Leirus perciformis** Mitchill. N. (713)

Family LXXXIX.—LAMPRIDIDÆ. (78)

261.—**LAMPRIS** Retzius. (234)

821. **Lampris guttatus** Brünnich. O. (714)

Family XC.—CORYPHÆNIDÆ. (79)

262.—**CORYPHÆNA** Linnæus. (235.)

822. **Coryphæna hippurus**[2] Linnæus. O. S. W. (715, 716)

Family XCI.—BRAMIDÆ. (80)

263.—**PTERACLIS** Gronow. (236)

823. **Pteraclis carolinus** Cuv. & Val. O. (717)

264.—**BRAMA** Bloch & Schneider. (236 *b.*)

824. **Brama raji** Bloch. C. N. Eu. O. (717 *b.*)

Family XCII.—ICOSTEIDÆ.[3] (101)

265.—**ICOSTEUS** Lockington. (332)

825. **Icosteus ænigmaticus** Lockington. B. C. (969)

266.—**ICICHTHYS** Jordan & Gilbert. (333)

826. **Icichthys lockingtoni** Jordan & Gilbert. B. C. (970)

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[1] *Stromateus medius* Peters, Berliner Monatsberichte, 1869, 707; Jordan, Proc. Ac. Nat. Sci. Phila., 1883, 284.

[2] *Coryphæna equisetis* has not been authentically recorded from our coasts. It may, therefore, be omitted. The common Dolphin or Dorado of our South Atlantic and Gulf coasts is *Coryphæna hippurus* L.

This species is in life of a very bright greenish olive, with small round blue spots. The top of the head in the males is much elevated, forming a high sharp crest. Head $4\frac{3}{5}$; depth 5; ventral inserted slightly behind upper ray of pectoral, its length $1\frac{1}{4}$ in in head; pectoral $1\frac{1}{2}$. D. 59 to 63; A. 29. Pelagic, north on our coast to Cape Cod: very abundant from South Carolina to Texas. L 3 to 5 feet. The specific names *punctulata*, *globiceps*, *sueuri*, *dorado*, *guttata*, and *punctata* all belong to this species.

[3] The position of our family ICOSTEIDÆ is near or under the family BRAMIDÆ, as has been shown by Dr. Steindachner, Ichth. Beitr. XII, 22. The genus *Bathymaster* is apparently not a natural ally of *Icosteus*.

Family XCIII.—ZENIDÆ. (81)

267.—ZENOPSIS Gill. (237)

827. **Zenopsis ocellatus** Storer. B. (718)

Family XCIV.—BERYCIDÆ. (82)

268.—STEPHANOBERYX[1] Gill.

828. **Stephanoberyx monæ** Gill. B.

269.—CAULOLEPIS[2] Gill.

829. **Caulolepis longidens** Gill. B.

270.—PLECTROMUS[3] Gill.

830. **Plectromus suborbitalis** Gill. B.
831. **Plectromus crassiceps** Bean. B.

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[1] STEPHANOBERYX Gill.

(Gill, Proc. U. S. Nat. Mus., 1883, 258; type *Stephanoberyx monæ* Gill.

"Berycids with an elongated claviform contour, body covered with cycloid scales; scarcely imbricated, and armed about the center with one or two erect spines; an oblong head, with a moderate convex snout and with thin osseous ridges, especially an inner V-shaped one on the crown, whose limbs diverge on each side of nape, and an outer sigmoid, one on each side, above the eyes, and continuous with one projecting from the nasal; the inner and outer ridges connected by a cross-bar on a line with the anterior margin of the orbit; rather small eyes, in the anterior half of the head, and the teeth small, acute, and in a band on the premaxillaries and dentaries (palate toothless), and with ventrals having one spine and five rays. Closely allied to *Melamphaës*." *Deep sea.* (*Στεφανοσ*, crown; *βήρυξ*, beryx.)

Stephanoberyx monæ Gill. Gulf stream, latitude 41°. (Gill. l. c. 258.)

[2] CAULOLEPIS Gill.

(Gill, Proc. U. S. Nat. Mus., 1883, 258; type *Caulolepis longidens* Gill.)

"Berycids with a laterally oval or broad pyriform contour; a compressed body, covered with small, pedunculated, leaf-like scales; an abruptly declivous forehead; small eyes; a pair of very long pointed teeth in front of upper jaw, closing in front of lower; a similar pair of still longer teeth in the lower, received in foveæ of the palate; on the sides of each jaw two long teeth, terminating in bulbous tips; a row of minute teeth on the posterior half of the maxillaries. Closely allied to *Anoplogaster*." *Deep sea.* (*Καυλος*, stem; *λεπις*, scale.)

Caulolepis longidens Gill. Deep sea: latitude 39°. (Gill, l. c. 258.)

[3] PLECTROMUS Gill.

(Gill, Proc. U. S. Nat. Mus., 1883, 257; type *Plectromus suborbitalis* Gill.)

"Berycids with an elongated form; moderate cycloid scales; an oblong head with a much decurved or truncate snout; rather small eyes, and teeth small, acute and in two rows in each jaw, of which those of the minor row, at least in the lower jaw, are largest, and palate toothless." Deep sea. (*Πλήκτρων*, spur; *ωμος*, shoulder); "two spines, one on each side of the nape, springing forward from the shoulder bones, give a strange appearance to the fish.")

Plectromus suborbitalis Gill. Gulf Stream, latitude 39°. (Gill, l. c., 257.)

Plectromus crassiceps Bean. Proc. U. S. Nat. Mus., 1885, 73. Gulf Stream.

271.—POROMITRA[1] Goode & Bean.

832. **Poromitra capito** Goode & Bean. B.

272.—HOPLOSTETHUS Cuv. & Val. (238)

833. **Hoplostethus mediterraneus** Cuv. & Val. B. Eu. (719)

Family XCV.—HOLOCENTRIDÆ.[2]

273.—HOLOCENTRUM Bloch. (239)

834. **Holocentrum ascensione**[3] Osbeck. W. (720)
835. **Holocentrum suborbitale**[4] Gill. P.

274.—MYRIPRISTIS[5] Cuv.

836. **Myripristis occidentalis** Gill. P.
837. **Myripristis pœcilopus** Gill. P.

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[1] POROMITRA Goode & Bean.

(Goode & Bean, Bull. Mus. Comp. Zoöl, 1882, 215; type, *Poromitra capito* G. & B.).

Body short, compressed, scopeliform, covered with thin cycloid scales. Head very large (in young specimens nearly as long as trunk), its sides scaly. No barbel. Mouth very large, the lower jaw projecting. Margin of upper jaw composed of a long maxillary and a short premaxillary. Teeth very small, cardiform, on premaxillaries and lower jaw only. Opercula complete. Dorsal fin in middle of body, its origin not far behind ventrals, its spinous and soft portions about equal in length; anal much shorter than dorsal; the last rays of dorsal nearly above its middle. Pseudobranchiæ present. Gill openings very wide. Deep seas. (*Πορος*, pore: *μιτρα*, stomacher.)

Poromitra capito Goode & Bean.

Eye large, as long as snout; maxillary 3½ in head. Scales as large as pupil, with concentric striæ. Insertion of dorsal midway between tip of snout and base of caudal; base of anal half that of dorsal; pectoral inserted low, its length twice its distance from the snout; ventrals minute, in advance of pectorals. Caudal (mutilated in the known specimens). Head 2½ (in young). D. VII or VIII, 9; A. 9; V. 7 or 8; P. 12. Gulf Stream in lat. 34°. (*Goode & Bean.*)

(Goode & Bean, l. c., 214, 1882).

[2] The genera *Holocentrum* and *Myripristis*, shore fishes with long spinous dorsal, should probably be regarded as forming a family distinct from the *Berycidæ*, which are deep-sea fishes with a single dorsal, provided with but few spines, or even with none.

[3] This species, called in the text *Holocentrum pentacanthum*, should apparently stand as *Holocentrum ascensione* (Osbeck). In life, an oblique white bar descends backward from the eye; this disappears entirely in spirits. To the synonymy, add: (*Perca ascensionis* Osbeck, Iter Chin., 1771, 388; *Perca ascensionis* Gmelin, Syst. Nat., 1788, 1318; *Amphiprion matejuelo* Bloch & Schneider, Ichthyol., 1801, 206; *Holocentrum matejuelo* Poey, Memorias Cuba, II, 155, 1860.)

[4] *Holocentrum suborbitale* Gill, Proc. Ac. Nat. Sci. Phila., 1863, 86. Mazatlan to Panama. Abundant in rock-pools.

[5] MYRIPRISTIS Cuv.

(Cuvier, Règne Animal; type *Myripristis jacobus* Cuv. & Val.)

This genus is very closely related to *Holocentrum*, differing externally, chiefly in the absence of the large spine at the angle of the preopercle. The air-bladder is divided into two parts by a transverse constriction, and the pyloric cœca are rather

Family XCVI.—APHREDODERIDÆ. (83)

275.—APHREDODERUS Le Sueur. (240)

838. Aphredoderus sayanus Gilliams. (721)

Family XCVII.—ELASSOMIDÆ. (83*b*)

276.—ELASSOMA Jordan (722)

839. Elassoma zonatum Jordan. Vs. (722)
840. Elassoma evergladei[1] Jordan. Vse.

Family XCVIII.—CENTRARCHIDÆ. (84)

277.—CENTRARCHUS Cuv. & Val. (242)

841. Centrarchus macropterus Lacépède. Vs. (723)

278.—POMOXYS Rafinesque. (243)

842. Pomoxys annularis Rafinesque. V. (724)
843. Pomoxys sparoides Lacépède. V. (725)

279.—ARCHOPLITES Gill. (244)

844. Archoplites interruptus Girard. T. (726)

280.—AMBLOPLITES Rafinesque. (245)

845. Ambloplites rupestris Rafinesque. V. (727)

281.—CHÆNOBRYTTUS Gill. (246)

846. Chænobryttus gulosus Cuv. & Val. V. (729)
846b. *Chænobryttus gulosus antistius* McKay. Vn. (728)

282.—ACANTHARCHUS Gill. (247)

847. Acantharchus pomotis Baird. Ve. (736)

283.—ENNEACANTHUS Gill.

848. Enneacanthus eriarchus Jordan. Vn. (731)
849. Enneacanthus obesus Baird. Ve. (732)
850. Enneacanthus gloriosus Holbrook. Vse. (733)
851. Enneacanthus simulans Cope. Ve. (734)
851b. *Enneacanthus simulans pinniger* Gill & Jordan. Vse.

284.—MESOGONISTIUS Gill.

852. Mesogonistius chætodon Baird. Ve. (735)

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few (9). Species numerous in the tropical seas; gay-colored inhabitants of reefs and rock-pools.

Myripristis occidentalis Gill, Proc. Ac. Nat. Sci. Phila., 1863, 87 = *Rhamphoberyx leucopus* Gill, l. c., 88. Gulf of California to Panama.

Myripristis pœcilopus Gill. *Rhamphoberyx pœcilopus* Gill, l. c., 87; see Jordan & Gilbert. Proc. U. S. Nat. Mus., 1882, 364. Cape San Lucas; perhaps identical with the preceding.

[1] *Elassoma evergladei* Jordan, Proc. U. S. Nat. Mus., 1884, 323. Indian, Saint John's and Suwannee Rivers, Florida.

285.—LEPOMIS Rafinesque. (250)

§ *Apomotis* Rafinesque.

853. **Lepomis cyanellus** Rafinesque. V. (736)
854. **Lepomis symmetricus** Forbes. Vs. (737)
855. **Lepomis phenax** Cope & Jordan. Ve. (738)

§ *Lepomis.*

856. **Lepomis ischyrus** Jordan & Nelson. Vnw. (739)
857. **Lepomis macrochirus** Rafinesque. Vw. (740)
858. **Lepomis mystacalis** Cope. Vse. (741)
859. **Lepomis elongatus** Holbrook. Vse. (742)
860. **Lepomis murinus** Girard. Vsw. (743)
861. **Lepomis punctatus** Cuv. & Val. Vse. (744)
862. **Lepomis miniatus** Jordan. Vs. (745)
863. **Lepomis auritus** Linnæus. Ve. (746)
864. **Lepomis megalotis**[1] Rafinesque. Vw. (747, 749)
865. **Lepomis garmani** Forbes. Vw.
866. **Lepomis marginatus** Holbrook. Vse. (748)
867. **Lepomis aquilensis**[2] Baird & Girard. Vsw.
868. **Lepomis humilis** Girard. Vsw. (750)
869. **Lepomis pallidus** Mitchill. V. (751)

§ *Xystroplites* Jordan.

870. **Lepomis heros** Baird & Girard. Vsw. (752)
871. **Lepomis euryorus** McKay. Vn. (753)
872. **Lepomis albulus** Girard. Vsw. (754)

§ *Eupomotis* Gill & Jordan.

873. **Lepomis holbrooki** Cuv. & Val. Vse. (755)
674. **Lepomis notatus** Agassiz. Vs. (756)
875. **Lepomis gibbosus** Linnæus.[3] Vne. (757)

286.—MICROPTERUS Lacépède. (251)

876. **Micropterus salmoides** Lacépède. V. (759)
877. **Micropterus dolomiei** Lacépède. V. (760.)

Family XCIX.—PERCIDÆ. (85)

287.—AMMOCRYPTA Jordan. (252)

878. **Ammocrypta beani** Jordan. Vs. (761)
879. **Ammocrypta clara**[4] Jordan & Meek. Vw.
880. **Ammocrypta pellucida** Baird. Vw. (762)
881. **Ammocrypta vivax** Hay. Vsw. (762 *b*.)

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[1] *Lepomis bombifrons* is omitted, as being probably based on a form of *L. megalotis.*

[2] *Lepomis aquilensis* (*Pomotis aquilensis* Baird & Girard, Proc. Ac. Nat. Sci. Phila. 1854, 24), placed in the Synopsis as a synonym of *L. pallidus*, is a valid species. It is closely related to *L. megalotis*, but has much higher spines, and a long and very narrow opercular flap; a dusky patch on base of last rays of dorsal.

[3] *Lepomis lirus* McKay=*Pomotis pallidus* Agassiz is here omitted. Agassiz's very poor description applies well enough to *Chænobryttus gulosus.*

[4] *Ammocrypta clara* Jordan & Meek, Proc. U. S. Nat. Mus., 1884. Des Moines R., Iowa, and Red R., Arkansas.

288.—CRYSTALLARIA[1] Jordan & Gilbert.

882. **Crystallaria asprella** Jordan. Vs. (763)

289.—IOA Jordan & Brayton. (253)

883. **Ioa vitrea** Cope. Vse. (764)
884. **Ioa vigilis** Hay. Vs. (764 *b*.)

290.—BOLEOSOMA De Kay. (254, 255)

885. **Boleosoma olmstedi** Storer. Vne. (765)
885 b. *Boleosoma olmstedi atromaculatum* Girard. (Ve.)
885 c. *Boleosoma olmstedi effulgens* Girard. (Vse.) (767)
885 d. *Boleosoma olmstedi maculatum*[2] Agassiz. Vw. (766)
885 e. *Boleosoma olmstedi ozarcanum*[3] Jordan & Gilbert. Vsw.
885 f. *Boleosoma olmstedi mesæum* Cope. Vw.
885 g. *Boleosoma olmstedi æsopus* Cope. Ve. (760)
886. **Boleosoma vexillare** Jordan. Ve. (768)
887. **Boleosoma susanæ**[4] Jordan & Swain. Vs.
888. **Boleosoma camurum** Forbes. Vw. (770, 771)

291.—ULOCENTRA[5] Jordan. (256)

889. **Ulocentra phlox** Cope. Vsw. (772)
890. **Ulocentra stigmæa** Jordan. Vs. (773)
891. **Ulocentra simotera** Cope. Vs. (774, 775)
892. **Ulocentra histrio**[6] Jordan & Gilbert. Vsw.
893. **Ulocentra blennius**[7] Gilbert & Swain. Vs.

292.—DIPLESION Rafinesque. (257)

894. **Diplesion blennioides** Rafinesque. Vw. (776)

293.—COTTOGASTER Putnam. (258)

895. **Cottogaster copelandi** Jordan Vw. (777)
896. **Cottogaster putnami** Jordan & Gilbert. Vw. (778)

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[1] CRYSTALLARIA Jordan & Gilbert.

(Genus nova; type *Pleurolepis asprellus* Jordan.)

This genus differs from *Ammocrypta* chiefly in having the premaxillaries non-protractile. The vertical fins are much more developed than in the latter genus, there being 14 dorsal spines, and 12 soft rays in the anal fin. The squamation is much more complete than in *Ammocrypta*, but the body is similarly hyaline. (*Κρυόταλλος*, crystal.)

[2] I adopt the name *maculatum* for this species or subspecies, the identification of Rafinesque's *Etheostoma nigra* with it being very doubtful. *Pœcilichthys beani* Jordan, Proc. U. S. Nat. Mus., 1884, is identical with *B. maculatum*.

[3] *Boleosoma olmstedi ozarcanum* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. Ozark region.

[4] *Boleosoma susanæ* Jordan & Swain, Proc. U. S. Nat. Mus., 1883, 248. Cumberland R., Kentucky.

[5] *Ulocentra atripinnis* Jordan is the adult of *Diplesion simoterum*.

[6] *Etheostoma histrio* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. Streams of Arkansas.

[7] *Etheostoma blennius* Gilbert & Swain, Proc. U. S. Nat. Mus., 1884. Streams of Northern Alabama.

897. **Cottogaster uranidea**[1] Jordan & Gilbert. Vw.
898. **Cottogaster shumardi** Girard. Vsw. (770)

294.—PERCINA Haldeman. (260)

899. **Percina caprodes** Rafinesque. V. (789)
899 b. *Percina caprodes zebra*[2] Agassiz. Vn.

295.—HADROPTERUS Agassiz. (261, 262)

§ *Alvordius* Girard.

900. **Hadropterus macrocephalus** Cope. Vne. (781)
901. **Hadropterus phoxocephalus** Nelson. Vw. (782)
902. **Hadropterus aspro** Cope & Jordan. Vw. (783)
903. **Hadropterus ouachitæ**[3] Jordan & Gilbert. Vsw.
904. **Hadropterus peltatus**[4] Stauffer. Ve. (784, 785, 786)

§ *Ericosma* Jordan.

905. **Hadropterus evides** Jordan & Copeland. Vw. (787)
906. **Hadropterus fasciatus** Girard. Vsw. (788)

§ *Hadropterus*.

907. **Hadropterus nigrofasciatus** Agassiz. Vs. (790)
908. **Hadropterus aurantiacus** Cope. Vs. (789)
909. **Hadropterus squamatus**[5] Gilbert & Swain. Vs.
910. **Hadropterus cymatotænia**[6] Gilbert & Meek. Vw.
911. **Hadropterus nianguæ**[7] Gilbert & Meek. Vw.
912. **Hadropterus variatus** Kirtland. Vw. (801)

§ *Serraria* Gilbert.

913. **Hadropterus scierus**[8] Swain. Vsw.

§ ——— ?

914. **Hadropterus ? tessellatus** Storer. Vs. (796)
915. **Hadropterus ? cinereus** Storer. Vs. (797)

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[1] *Cottogaster uranidea* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. Washita River, Arkansas.

[2] *Pileoma zebra* Agassiz, Lake Superior, = *Percina manitou* Jordan.

[3] *Hadropterus ouachitæ* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. Saline River, Arkansas.

[4] *Hadropterus maculatus* Girard = *Etheostoma peltatum* Stauffer = *Etheostoma nevisense* Cope = *Alvordius crassus* Jordan & Brayton = *Alvordius variatus* Auct. (not *Alvordius maculatus* Girard, nor *Etheostoma variatum* Kirtland).

[5] *Hadropterus squamatus* Gilbert & Swain, Proc. U. S. Nat. Mus., 1885. Tennessee Basin.

[6] *Hadropterus cymatotænia* Gilbert & Meek, Proc. U. S. Nat. Mus., 1885. Ozark region of Missouri.

[7] *Hadropterus nianguæ* Gilbert, & Meek Proc. U. S. Nat. Mus., 1885. Niangua River, Southern Missouri.

[8] *Hadropterus scierus* Swain. Proc. U. S. Nat. Mus., 1883, 352. Southern Indiana and southwestward; very abundant in streams of Arkansas and Texas. This species is made the type of a genus, *Serraria*, by Gilbert (Proc. U. S. Nat. Mus., 1884), distinguished from *Hadropterus* by the serrulate preopercle.

296.—ETHEOSTOMA Rafinesque. (263, 264, 265, 266)

§ *Rhothœca*[1] Jordan.

916. **Etheostoma zonale** Cope. Vw. (798)
916 b. *Etheostoma zonale arcansanum*[2] Jordan & Gilbert. Vsw.
917. **Etheostoma lynceum**[3] Hay. Vs. (799)
918. **Etheostoma thalassinum** Jordan & Brayton. Vse. (800)
919. **Etheostoma inscriptum** Jordan & Brayton. Vse. (802)

§ *Nothonotus* Agassiz. (263)

920. **Etheostoma camurum**[4] Cope. Ve. (791, 795)
921. **Etheostoma maculatum**[5] Kirtland. Ve. (792, 793)
922. **Etheostoma rufolineatum** Cope. Vs. (794)

§ *Etheostoma.*

923. **Etheostoma flabellare** Rafinesque. V. (804)
923 b. *Etheostoma flabellare*[6] *cumberlandicum* Jordan & Swain. Vs.
923 c. *Etheostoma flabellare lineolatum* Agassiz. Vnw. (803)
924. **Etheostoma artesiæ** Hay. Vs. (809)
925. **Etheostoma squamiceps** Jordan. S. (805)

§ *Pœcilichthys* Agassiz.

926. **Etheostoma virgatum** Jordan. Ve. (806)
927. **Etheostoma sagitta**[7] Jordan & Swain. Ve.
928. **Etheostoma saxatile** Hay. Vs. (807)
929. **Etheostoma rupestre**[8] Gilbert & Swain. Vs.
930. **Etheostoma luteovinctum**[9] Gilbert & Swain. Vs.
931. **Etheostoma parvipinne**[10] Gilbert & Swain. Vs.
932. **Etheostoma boreale**[11] Jordan. Vne.
933. **Etheostoma punctulatum**[12] Agassiz. Vw.

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[1] *Rhothœca* Jordan subgenus nova; type *Pœcilichthys zonalis* Cope; substitute for *Nanostoma* Putnam; preoccupied by *Nannostomus* Günther, a genus of *Characinidæ* (ῥοθος, a current; οἰχεω, to inhabit.) I here regard *Pœcilichthys, Nothonotus, and Rhothœca* as subgenera under *Etheostoma.*

[2] *Etheostoma zonale arcansanum* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. Arkansas and southward.

[3] *Etheostoma lynceum* Hay, nom. sp. nov. for *Nanostoma elegans* Hay; not *Boleichthys elegans* Girard.

[4] *Pœcilichthys camurus* Cope = *Pœcilichthys vulneratus* Cope.

[5] *Etheostoma maculatum* Kirtland = *Pœcilichthys sanguifluus* Cope.

[6] *Etheostoma cumberlandicum* Jordan & Swain, Proc. U. S. Nat. Mus., 1883, 251. Cumberland River.

[7] *Pœcilichthys sagitta* Jordan & Swain, Proc. U. S. Nat. Mus., 1883, 250. Cumberland River.

[8] *Etheostoma rupestre* Gilbert & Swain, Proc. U. S. Nat. Mus., 1885. Tennessee Basin.

[9] *Etheostoma luteovinctum* Gilbert & Swain, Proc. U. S. Nat. Mus., 1885. Northern Alabama.

[10] *Etheostoma parvipinne* Gilbert & Swain, Proc. U. S. Nat. Mus., 1885. Northern Alabama.

[11] *Pœcilichthys borealis* Jordan, Proc. U. S. Nat. Mus., 1884. Montreal.

[12] This is not the species described as *Pœcilichthys punctulatus* in the Synopsis. For description, see Gilbert & Meek, Proc. U. S. Nat. Mus., 1885. Osage River.

934. **Etheostoma whipplei**[1] Girard. Vsw. (808)
935. **Etheostoma lepidum** Baird & Girard. Vsw. (810)
936. **Etheostoma cœruleum** Storer. Vc. (811)
936 b. *Etheostoma cœruleum spectabile* Agassiz. Vw. (812)
937. **Etheostoma jessiæ**[2] Jordan & Brayton. Vw. (814)
938. **Etheostoma iowæ** Jordan & Meek. Vnw.

§ ——.

939. **Etheostoma tuscumbia**[3] Gilbert & Swain. Vs.

§ *Boleichthys* Girard.

940. **Etheostoma quiescens**[4] Jordan. Vse.
941. **Etheostoma fusiforme**[5] Girard. V. (815, 816, 817, 818, 819, 822)
941 b. *Etheostoma fusiforme eos* Jordan & Copeland. Vnw. (819)
942. **Etheostoma exile**[6] Girard. Vnw. (820, 821)

297.—ALVARIUS Girard. (267)

943. **Alvarius lateralis** Girard. Vsw. (823)
944. **Alvarius prœliaris** Hay. Vs. (824)
945. **Alvarius punctulatus** Putnam. Vn. (825)
946. **Alvarius fonticola**[7] Jordan & Gilbert. Vsw.

298.—PERCA Linnæus. (268)

947. **Perca lutea** Rafinesque. Vne. (826)

299.—STIZOSTEDION Rafinesque. (269)

948. **Stizostedion vitreum** Mitchill. V. (827)
949. **Stizostedion canadense** Smith. Vne. (828)
949 b. *Stizostedion canadense griseum* De Kay. Vn.
949 c. *Stizostedion canadense boreum* Girard. Vnw.

Family C.—CENTROPOMIDÆ.[8]

300.—CENTROPOMUS Lacépède. (270.)

950. **Centropomus undecimalis** Bloch. W. P. (879)

[1] This is *P. punctulatus* of the Synopsis, not of Agassiz. It is readily distinguished from the preceding by its slenderer form, larger scales, and less speckled coloration. In life it is spotted with bright red. See Gilbert, l. c.

[2] *Pœcilichthys jessiæ* Jordan & Brayton=*Pœcilichthys asprigenis* Forbes=*Pœcilichthys swaini* Jordan, Proc. U. S. Nat. Mus., 1884, 479. The lateral line in this species is sometimes complete.

[3] *Etheostoma tuscumbia* Gilbert & Swain, Proc. U. S. Nat. Mus., 1885. Tuscumbia Spring, Alabama.

[4] *Pœcilichthys quiescens* Jordan, Proc. U. S. Nat. Mus., 1884, 478. Suwannee River, Georgia.

[5] *Boleosoma fusiformis* Girard=*Boleosoma barratti* Holbrook=*Hololepis crochrons* Cope =*Boleosoma gracile* Girard=*Pœcilichthys butlerianus* Hay=*Pœcilichthys palustris* Gilbert, Proc. U. S. Nat. Mus., 1884, 209. *Pœcilichthys eos* seems also to represent a slight variety of this widely diffused species.

[6] *Boleichthys warreni* is doubtless identical with *Etheostoma exile*. The types of the former are lost.

[7] *Microperca fonticola* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1885. San Marcos Spring, Texas. *Alvarius* and *Microperca* are probably identical.

[8] The characters of the family of *Centropomidæ* are given in detail by Prof. Gill, Proc. U. S. Nat. Mus., 1882, 484.

951. **Centropomus nigrescens**[1] Günther. P.
952. **Centropomus pedimacula**[2] Poey. P. W.
953. **Centropomus robalito**[3] Jordan & Gilbert. P.

Family CI.—SERRANIDÆ. (86)

301.—ROCCUS Mitchill. (271)

§ *Roccus.*

954. **Roccus septentrionalis**[4] Bloch & Schneider. N. S. Ana. (830)
955. **Roccus chrysops** Rafinesque. Vw. (831)

§ *Morone* (Mitchell) Gill.

956. **Roccus interruptus** Gill. Vsw. (832)
957. **Roccus americanus** Gmelin. N. Ana. (833)

302.—SERRANUS Cuvier. (274)

§ *Centropristis* Cuvier.

958. **Serranus atrarius** Linnæus. S. (836)
959. **Serranus furvus** Walbaum.[5] N. (836 *b.*)
960. **Serranus philadelphicus**[6] Linnæus. S. (837)

§ *Diplectrum* Holbrook.

961. **Serranus formosus** Linnæus. S. W. (838)
962. **Serranus radialis**[7] Quoy & Gaimard. P. W.

§ *Prionodes* Jenyns.

963. **Serranus subligarius** Cope. W. (839)
964. **Serranus phœbe**[8] Poey. W.

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[1] *Centropomus nigrescens* Günther, Proc. Zoöl. Soc. London, 1864, 144; Günther, Fishes Centr. Amer., 1869, 407. Mazatlan to Panama.

[2] *Centropomus pedimacula* Poey, Memorias Cuba, II, 1860, 122=*Centropomus medius* Günther, Fish. Centr. Amer., 1869, 406. Both coasts of tropical America, north to Mazatlan.

[3] *Centropomus robalito* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 462. Mazatlan.

[4] This species should stand as above, instead of *Roccus lineatus*. The original *Sciæna lineata* of Bloch was probably one of the European species. To the synonymy add *Perca saxatilis* and *Perca septentrionalis* Bloch & Schneider, Syst. Nat., 1801, 89, 90. *Perca saxatilis* is preoccupied.

[5] *Perca furva* Walbaum, Artedi Piscium, 1279=*Coryphæna nigrescens* Bloch & Schneider, 1801.

[6] *Perca philadelphica* Linnæus, Syst. Nat. X, 291, 1758=ed. XII, 1766, 484=*Perca trifurca* Linnæus, Syst. Nat., ed. XII, 489, 1766.

[7] *Serranus radialis* Quoy & Gaimard, Voyage Freycinet, 316=*Centropristis radialis* Günther, I, 83=*Centropristis macropoma* Günther, Fish. Centr. Amer., 1869, 409. Coast of Brazil and west coast of tropical America, north to Gulf of California.

[8] *Serranus phœbe* Poey.

Light brownish, paler below; a sharply defined white bar extending upward from before vent about to middle of side, its width rather more than diameter of pupil; before this a broad dusky shade extending downward from back; a vaguely defined quadrate paler area below middle of dorsal and another on back of tail; head and fins without sharp markings. Body oblong, the back little elevated, the head large and not sharp

965. **Serranus calopteryx**[1] Jordan & Gilbert. P.

§ *Paralabrax* Girard.

966. **Serranus clathratus** Girard. C. (840)
967. **Serranus maculofasciatus** Steindachner. C. P. (841)
968. **Serranus nebulifer** Girard. C. (842)

303.—HYPOPLECTRUS Gill. (274 *b.*)

969. **Hypoplectrus nigricans** Poey. W. (843)
970. **Hypoplectrus gemma**[2] Goode & Bean. W.

304.—ANTHIAS[3] Bloch.

971. **Anthias multifasciatus** Gill. P.
972. **Anthias vivanus**[4] Jordan. W.

305.—PARANTHIAS Guichenot. (273 *b.*)

973. **Paranthias furcifer** Cuv. & Val. W. P. (835 *b.*)

306.—POLYPRION Cuvier.

974. **Polyprion americanus**[5] Bloch & Schneider. Acc. B. Eu. (835)

307.—STEREOLEPIS Ayres.

975. **Stereolepis gigas** Ayres. C. (834)

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in profile, much less slender than in *S. subligarius*. Teeth moderate, those on sides of lower jaw and front of upper largest; mouth moderate, the maxillary reaching to center of pupil, 2½ in head; lower jaw projecting; snout 3⅗ in head; eye large, 3⅗ in head. Scales on cheeks large; preopercle moderately serrate, the teeth nearly uniform; gill-rakers rather short. Caudal moderately forked; dorsal spines rather strong, higher than the soft rays, the longest 2⅓ in head; second and third anal spines subequal; pectorals reaching front of anal, 1⅗ in head; head 2⅜; depth 3⅓; D X, 12, A. III, 7. Scales 5–48–14. L. 8 inches. West Indies, north to Pensacola, Florida.

(Poey, Memorias Cuba, I, 1851, 55; *Centropristis phœbe* Günther, I, 85, 1859; *Haliperca phœbe* Poey, Enum. Pisc. Cubens., 1875, 22.)

[1] *Prionodes fasciatus* Jenyns, Voyage of the Beagle, Fishes, 1842, 46 = *Serranus calopteryx* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 350. Mazatlan to Galapagos Islands. The name *fasciatus* is preoccupied in this genus.

[2] *Hypoplectrus gemma* Goode & Bean, Proc. U. S. Nat. Mus., 1882, 428. Garden Key, Florida.

[3] ANTHIAS Bloch.

(*Pronotogrammus* Gill.)

(Bloch, Ichthyologia, type *Labrus anthias* L. = *Anthias sacer* Bloch.)

This genus is closely allied to *Serranus*, differing technically chiefly in the direction of the lateral line, which runs very high and is concurrent with the back, becoming abruptly straight and horizontal below last rays of dorsal. The body is rather strongly compressed, the snout blunt, the mouth oblique, the maxillary broad and scaly, and some of the fins with produced or filamentous rays, and the caudal generally deeply forked. Species of rather small size, mostly inhabiting deep waters.

Anthias multifasciatus = *Pronotogrammus multifasciatus* Gill, Proc. Ac. Nat. Sci. Phila., 1883, 81. Cape San Lucas. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 360.

[4] *Anthias vivanus* Jordan, Proc. U. S. Nat. Mus., 1885. Pensacola.

[4] *Amphiprion americanus* Bloch & Schneider, Syst. Ichth., 1801, 25; not *Epinephelus oxygeneios* Bloch & Schneider, l. c. 301.

308.—PROMICROPS[1] Gill. (277)

976. **Promicrops itaiara** Lichtenstein. W. P. (853)

309.—MYCTEROPERCA[2] Gill. (275)

977. **Mycteroperca rosacea**[3] Streets. P.
978. **Mycteroperca falcata phenax**[4] Jordan & Swain. W.
979. **Mycteroperca microlepis** Goode & Bean. W. S. (846)
980. **Mycteroperca bonaci**[5] Poey. W.
980 b. *Mycteroperca bonaci xanthosticta* Jordan & Swain.
981. **Mycteroperca venenosa**[6] Linnæus. W. (846 *b*.)

310.—EPINEPHELUS Bloch. (276)

982. **Epinephelus nigritus** Holbrook. S. (850)
983. **Epinephelus moric** Cuv. & Val. S. W. (849)
984. **Epinephelus striatus** Bloch. W. (850 *b*.)
985. **Epinephelus sellicauda**[7] Gill. P.
986. **Epinephelus niveatus** Cuv. & Val. W. Acc. (851)
987. **Epinephelus drummond-hayi** Goode & Bean. S. W. (848)
988. **Epinephelus apua**[8] Bloch. W. (850 *c*.)
989. **Epinephelus ascensionis**[9] Osbeck. W. (847)
990. **Epinephelus analogus**[10] Gill. P.

311.—ALPHESTES[11] Bloch & Schneider.

991. **Alphestes multiguttatus** Günther. P.

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[1] *Serranus itaiara* Lichtenstein = *Promicrops guasa* Poey.

For an account of the American genera and species of *Epinephelus* and related forms see Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 358. This paper should supersede the very incomplete account given in the Synopsis.

[2] *Mycteroperca* Gill, 1863 = *Trisotropis* Gill, 1865.

[3] *Epinephelus rosaceus* Streets, Bull. U. S. Nat. Mus., VII, 1877, 51; *M. rosacea* Jordan & Swain, l. c., 361. Gulf of California.

[4] *Mycteroperca falcata phenax* Jordan & Swain, l. c. 363. Key West to Pensacola.

[5] *Serranus bonaci, brunneus, arara*, etc., Poey. See Jordan & Swain. l. c. 370. Key West, southward; Var. *xanthosticta* (l. c. 371) at Pensacola.

[6] *Perca venenosa* L. = *Serranus petrosus* Poey.

[7] *Epinephelus sellicauda* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 250; Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 385.

[8] Described in the Synopsis, page 919, under the erroneous name of *Epinephelus guttatus*. See Jordan & Swain, l. c. 389.

[9] Described in the Synopsis, page 539, under the name of *Epinephelus capreolus*. See Jordan & Swain, l. c. 391.

[10] *Epinephelus analogus* Gill, Proc. Ac. Nat. Sci. Phila., 1863. Jordan & Swain, l. c. 393.

[11] ALPHESTES Bloch & Schneider.

(*Prospinus* Poey.)

(Bloch & Schneider, Syst. Ichth., 1801, 236; type, *Epinephelus afer* Bloch.)

This genus includes small species, differing from *Epinephelus* chiefly in the presence of a strong antrorse spine on the lower side of the angle of the preopercle. The three known species are American. (*Ἀλφηστής*, enterprising or greedy; a name applied to some kind of fish which goes in pairs.) *Alphestes multiguttatus*=*Plectropoma multiguttatum* Günther, Proc. Zoöl. Soc. London, 1866, 600. See Jordan & Swain, l. c. 395. Mazatlan to Panama.

312.—ENNEACENTRUS[1] Gill. (276 *b.*)

§ *Petrometopon* Gill.

992. **Enneacentrus guttatus[2] coronatus** Cuv. & Val. W.

§ *Enneacentrus.*

993. **Enneacentrus tæniops** Cuv. & Val. W. Acc. (852 *b.*)
994. **Enneacentrus fulvus ruber[3]** Bloch. W.

313.—DERMATOLEPIS[4] Gill.

995. **Dermatolepis punctatus** Gill. P.

Family CII.—RHYPTICIDÆ.[5]

314.—RHYPTICUS Cuvier. (279)

§ *Rhypticus.*

996. **Rhypticus saponaceus[6]** Bloch. W.
997. **Rhypticus xanti[7]** Gill. P.

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[1] For a statement of the reasons why *Enneacentrus* is preferred to *Bodianus* as the name of this group, see Jordan & Swain, l. c. 397.

[2] *Enneacentrus guttatus* L.; var *coronatus* Cuv. & Val. Key West and southward. For a description of this species see Jordan & Swain, l. c. 398.

[3] The Linnæan name, *Labrus fulvus* (Syst. Nat., X, 1758, 287), has priority for this species. The yellow, red, and brown varieties may stand as *fulvus*, *ruber*, and *punctatus*, respectively. See Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 402.

Epinephelus fulvus punctatus Linnæus. W. (852*b*)

[4] DERMATOLEPIS Gill.

(*Lioperca* Gill.)

(Gill, Proc. Ac. Nat. Sci. Phila., 1861, 54; type, *Dermatolepis punctatus* Gill.)

Scales all cycloid; canine teeth very small or obsolete; body comparatively deep; head small; soft dorsal, unusually long, of 19 or 20 rays; spines low. Otherwise essentially as in *Epinephelus*. Two species known. (Δερμα, skin; λέπις, scale.)

Dermatolepis punctatus Gill, Proc. Ac. Nat. Sci. Phila., 1861, 54. Jordan & Swain, l. c. 407. Cape San Lucas and adjacent rocky islands.

[5] The genus *Rhypticus*, differing from all other *Serranidæ* in the absence of anal spines and in the reduced number (2 to 4) of the dorsal spines, may be regarded as the type of a distinct family.

[6] *Rhypticus saponaceus* Bloch & Schneider.

Soap-fish; Jabon; Jaboncillo. Olivaceous brown, without distinct markings, in spirits. Body oblong, the back little arched, the snout rather pointed in profile, mouth moderate, the maxillary extending to beyond the eye, $2\frac{1}{8}$ in head; eye about equal to snout, $3\frac{2}{3}$ in head. Opercle with three strong spines, the middle one largest; preopercle with two spines. Head $3\frac{1}{4}$; depth $3\frac{1}{4}$. D. III, 25; A. 17. West Indies, north to Pensacola, Florida.

(*Anthias saponaceus* Bloch & Schneider, Systema Ichth., 1801, 310; Cuv. & Val., III, 63; Günther, I, 172; *Eleutheractis coriaceus* Cope, Trans. Am. Phil. Soc., 1871, 467.)

[7] *Rhypticus xanti* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 250. Cape San Lucas, and southward.

§ *Promicropterus* Gill.

998. **Rhypticus bistrispinus**[1] Mitchill. S. (855, 857 ?)
999. **Rhypticus nigripinnis**[2] Gill. P. (856)

Family CIII.—PRIACANTHIDÆ. (87)

315.—PRIACANTHUS Cuvier.

1000. **Priacanthus catalufa**[3] Poey. W.

316.—PSEUDOPRIACANTHUS[4] Bleeker.

1001. **Pseudopriacanthus altus** Gill. B. (859)

Family CIV.—LOBOTIDÆ.[5]

317.—LOBOTES Cuvier. (285)

1002. **Lobotes surinamensis** Bloch. N. S. W. P. (876)

Family CV.—SPARIDÆ.

318.—XENICHTHYS Gill.

1003. **Xenichthys xanti**[6] Gill. P.

319.—XENISTIUS Jordan & Gilbert. (281)

1004. **Xenistius californiensis** Steindachner. C. (860)

320.—HOPLOPAGRUS[7] Gill.

1005. **Hoplopagrus güntheri** Gill. P.

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[1] *Bodianus bistrispinus* Mitchill, Amer. Monthly Magazine, IV, 1818, 247 (Straits of Bahama)=*Rhypticus maculatus* Holbrook=? *Rhypticus pituitosus* Goode & Bean (young). The specimen from Newport, R. I., recorded by Cope as *Promicropterus decoratus* seems to belong to this species.

[2] *Rhypticus nigripinnis* Gill, 1861. *Rhypticus maculatus* Gill, 1862=*Promicropterus decoratus* Gill, 1863. Cape San Lucas to Panama.

[3] The species called in the Synopsis *Priacanthus macrophthalmus* (p. 544) and *Priacanthus arenatus* (p. 971) should stand as *Priacanthus catalufa* Poey; *Catalufa, Big-eye, Bull's-eye.* Instead of the synonymy in the Synopsis, read—

(*Catalufa* Parra, Descr. Dif. Piezas Hist. Nat., 1787; *Priacanthus macrophthalmus* Cuv. & Val., III, 95 in part; not *Anthias macrophthalmus* Bloch, which is an East Indian species; *Priacanthus macrophthalmus* Günther, I, 215; *Priacanthus catalufa* Poey, Proc. Ac. Nat. Sci. Phila., 1863, 182; not *Priacanthus arenatus* C. & V.)

[4] *Pseudopriacanthus* Bleeker should be recognized as a genus distinct from *Priacanthus.*

[5] The genus *Lobotes* should be removed from the family of *Sparidæ* and placed in or near the *Serranidæ*, with which it agrees in many respects, differing in the absence of teeth on the vomer. It may stand as a separate family LOBOTIDÆ, which has been defined by Professor Gill, Proc. U. S. Nat. Mus., 1882, 560.

[6] *Xenichthys xanti* Gill, Proc. Ac. Nat. Sci. Phila., 1863, 83=*Xenichthys xenops* Jordan & Gilbert, Bull. U. S. Fish Com., 1882, 325. Cape San Lucas to Panama.

[7] HOPLOPAGRUS Gill.

(Gill, Proc. Ac. Nat. Sci. Phila., 1862, 253; type *Hoplopagrus güntheri* Gill.)

This genus resembles *Lutjanus* in most respects, differing strikingly in the structure of the anterior nostril and in the dentition. The anterior nostril is remote from the

321.—LUTJANUS[1] Bloch.

1006. **Lutjanus argentiventris**[2] Peters. P.
1007. **Lutjanus caxis**[3] Bloch & Schneider. W.
1008. **Lutjanus jocū**[4] Bloch & Schneider. W.
1009. **Lutjanus griseus**[5] Linnæus. S. W. 862, 862 *b*., 864)
1010. **Lutjanus novemfasciatus**[6] Gill. P.
1011. **Lutjanus guttatus**[7] Steindachner. P.
1012. **Lutjanus synagris** Linnæus. W. (864 *b*.)
1013. **Lutjanus vivanus**[8] Cuv. & Val. S. W. (862 *c*., 863)
1014. **Lutjanus analis**[9] Cuv. & Val. W.
1015. **Lutjanus colorado**[10] Jordan & Gilbert. P.
1016. **Lutjanus aratus**[11] Günther. P.
1017. **Lutjanus inermis**[12] Peters. P.

322.—OCYURUS Gill.

1018. **Ocyurus chrysurus**[13] Bloch. W. (861)

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posterior and is placed near the end of the snout; vomer with three large molar teeth; teeth in jaws coarse and blunt. Otherwise as in *Lutjanus*. One species known. (Ὅπλος, armed; πάγρος, *Pagrus*, Spanish "Pargo," English "Porgee," a general name for sparoid fishes.)

Hoplopagrus güntheri Gill, l. c. 253; Steindachner, Ichth. Beitr., VI, 1, 1878; Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 429. Cape San Lucas to Panama.

[1] For a full account of the American species of *Lutjanus* and related genera (*Hoplopagrus, Ocyurus, Rhomboplites, Tropidinius, Aprion, Etelis,* and *Verilus*), see Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 427. The characters of the genera are given by Gill, Proc. U. S. Nat. Mus., 1884, 351, and in the paper above quoted.

[2] *Mesoprion argentiventris* Peters, Berliner Monatsberichte, 1869, 704 = *Lutjanus argentiventris* Jordan & Swain, l. c. 434. Mazatlan to Panama.

[3] For synonymy and description of *Lutjanus caxis,* see Jordan & Swain, l. c. 435. West Indies, north to Key West.

[4] For synonymy and description of *Lutjanus jocu*, see Jordan & Swain, l. c., 437.

[5] *Labrus griseus* L. = *Anthias caballerote* Bloch & Schneider = *Lutjanus stearnsi* Goode & Bean = *Lutjanus caxis* Synopsis, p. 548; not *Sparus caxis* Bloch & Schneider. The common Gray or Mangrove Snapper of our southern coasts. See Jordan & Swain, l. c. 439.

[6] For synonymy of *Lutjanus novemfasciatus* see Jordan & Swain, l. c. 443. For description see Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 232 (*Lutjanus prieto* J. & G.). Cape San Lucas to Panama.

[7] For synonymy and description of *Lutjanus guttatus,* see Jordan & Swain, l. c. 447. Mazatlan to Panama.

[8] *Mesoprion vivanus* Cuv. & Val. = *Mesoprion campechanus* Poey = *Lutjanus blackfordi* Goode & Bean. Charleston and Pensacola to Aspinwall and the Lesser Antilles. For synonymy and description of *Lutjanus vivanus*, see Jordan & Swain, l. c. 453.

[9] For synonymy and description of *Lutjanus analis,* see Jordan & Swain, l. c. 455. West Indies, north to Key West.

[10] For synonymy and description of *Lutjanus colorado,* see Jordan & Gilbert, Proc, U. S. Nat. Mus. 1881, 338, and Jordan & Swain, l. c. 1884, 457. Mazatlan to Panama.

[11] For synonymy and description of *Lutjanus aratus,* see Jordan & Swain, l. c. 460. Mazatlan to Panama.

[12] For synonymy and description of *Lutjanus inermis,* see Jordan & Swain, l. c. 459. One specimen known, from Mazatlan.

[13] For synonymy and detailed description of *Ocyurus chrysurus*, see Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 461.

323.—RHOMBOPLITES Gill.

1019. Rhomboplites aurorubens[1] Cuv. & Val. W. S. (865)

324.—CONODON Cuv. & Val. (282 *b.*)

1020. Conodon nobilis Linnæus. W. (866)
1021. Conodon serrifer[2] Jordan & Gilbert. P.

325.—ORTHOPRISTIS[3] Girard.

§ *Microlepidotus* Gill.

1022. Orthopristis inornatus[4] Gill. P.

§ *Orthopristis.*

1023. Orthopristis brevipinnis[5] Steindachner. P.
1024. Orthopristis cantharinus[6] Jenyns. P.
1025. Orthopristis chalceus[7] Günther. P.
1026. Orthopristis chrysopterus[8] Linnæus. S. W. (867, 868)

326.—POMADASYS Lacépède. (283)

§ *Hæmulopsis* Steindachner.

1027. Pomadasys leuciscus[9] Günther. P.
1028. Pomadasys elongatus[10] Steindachner. P.
1029. Pomadasys nitidus[11] Steindachner. P.
1030. Pomadasys axillaris[12] Steindachner. P.

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[1] For synonymy and description of *Rhomboplites aurorubens*, see Jordan & Swain, l. c. 464.

[2] *Conodon serrifer* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 351. Boca Soledad, Lower California.

[3] It is probably better to regard *Conodon, Orthopristis,* and *Anisotremus* as generically distinct from *Pomadasys*. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 384, for an analysis of the characters of the Pacific coast species of this group.

[4] *Microlepidotus inornatus* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 256. Cape San Lucas (not *Pomadasys inornatus* Jordan & Gilbert, l. c. 388).

[5] *Pristipoma brevipinne* Steindachner, Ichthyol. Notizen, VIII, 1869, 10. Mazatlan to Panama. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 625.

[6] *Pristipoma cantharinum* Jenyns, Zoöl. Voy. Beagle, 49, 1842, and Günther, 1, 363, Günther's description agrees with a specimen from Guaymas, diagnosed by Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 274 as "*Pomadasys ? inornatus*," and on page 388, l. c., as *P. cantharinus*. This species is distinct from *O. chalceus*, and is probably the original *cantharinus* from the Galapagos Islands. I have, however, seen specimens of *O. chalceus* from the Galapagos.

[7] For synonymy and diagnosis of *Orthopristis chalceus* see Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 387. Mazatlan to Galapagos Islands.

[8] *Perca chrysoptera* Linn. Syst. Nat.=*Pristipoma fulvomaculatum* and *P. fasciatum* of Cuv. & Val. The Linnæan type, sent by Dr. Garden from Charleston, has been identified by Dr. Bean.

[9] For diagnosis see Jordan & Gilbert, l. c. 387. Mazatlan to Panama.

[10] *Pristipoma leuciscus* var. *elongatus*, Steindachner, Neue & Seltene Fische aus K. K. Museum, Wien, &c., 1879, taf. 9, f. 2. *Pomadasys elongatus* Jordan & Gilbert, Proc. U. S. Nat Mus., 1882, 352. Mazatlan to Panama.

[11] For diagnosis of *Pomadasys nitidus* see Jordan & Gilbert, l. c. 387. Mazatlan to Panama.

[12] For diagnosis of *Pomadasys axillaris* see Jordan & Gilbert, l. c. 387. Gulf of California to Panama.

§ *Pseudopristipoma* Sauvage.

1031. **Pomadasys panamensis**[1] Steindachner. P.

§ *Pomadasys.*

1032. **Pomadasys branicki**[2] Steindachner. P.
1033. **Pomadasys macracanthus**[3] Günther. P.

327.—ANISOTREMUS Gill.

1034. **Anisotremus dovii**[4] Günther. P.
1035. **Anisotremus cæsius**[5] Jordan & Gilbert. P.
1036. **Anisotremus interruptus**[6] Gill. P. (871 *b.*)
1037. **Anisotremus bilineatus** Cuv. & Val. W. (871)
1038. **Anisotremus davidsoni** Steindachner C. (869)
1039. **Anisotremus virginicus** Linnæus. W. (870)
1039 b. *Anisotremus virginicus*[7] *tæniatus* Gill. P.

328.—HÆMULON[8] Cuvier.

§ *Orthostœchus* Gill.

1040. **Hæmulon maculicauda**[9] Gill. P.

§ *Lythrulon* Jordan & Swain.

1041. **Hæmulon flaviguttatum**[10] Gill. P.

§ *Bathystoma* Scudder.

1042. **Hæmulon aurolineatum**[11] Cuv. & Val. W. (874 *b.*)
1043. **Hæmulon rimator**[12] Jordan & Swain. S. W. (873)

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[1] For diagnosis of *Pomadasys panamensis* see Jordan and Gilbert, l. c. 387. Mazatlan to Panama.

[2] For diagnosis of *Pomadasys branicki* see Jordan and Gilbert, l. c. 386. Mazatlan to Tumbez, Peru.

[3] For diagnosis of *Pomadasys macracanthus* see Jordan & Gilbert, l. c. 386. Mazatlan to Panama.

[4] For diagnosis of *Anisotremus dovii* see Jordan & Gilbert, l. c. 386. Mazatlan to Panama.

[5] *Pomadasys cæsius* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 383. Mazatlan.

[6] *Anisotremus modestus* Tschudi, accredited to Mazatlan (as *Pristipoma notatum*), by Peters, is here omitted, for reasons given in Proc. Ac. Nat. Sci. Phila., 1883, 286.

[7] *Anisotremus tæniatus* Gill. Proc. Ac. Nat. Sci. Phila., 1861, 107. Gulf of California to Panama. For characters of this subspecies see Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 372.

[8] The generic name *Diabasis* is preoccupied and must give place to *Hæmulon.* For a detailed account of the species of this genus see Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 281.

[9] For an account of *Hæmulon maculicauda* see Jordan & Swain, l. c. 315. Cape San Lucas to Panama.

[10] See Jordan & Swain, l. c. 314. Cape San Lucas to Panama.

[11] *Hæmulon aurolineatum* Cuv. & Val. = *Hæmulon jeniguano* Poey. See Jordan & Swain, l. c. 310.

[12] *Hæmulon rimator* Jordan & Swain, l. c., 308. = *Hæmulon chrysopterum* C. & V., not of L.

§ *Brachygenys* Scudder.

1044. Hæmulon tæniatum[1] Poey. W.

§ *Hæmulon.*

1045. Hæmulon flavolineatum[2] Desmarest. W.
1046. Hæmulon plumieri Lacépède. S. W. (872)
1047. Hæmulon sciurus[3] Shaw. W. (872 *b.*)
1848. Hæmulon steindachneri[4] Jordan & Gilbert. P.
1049. Hæmulon fremebundum[5] Goode & Bean. W. (874)
1050. Hæmulon scudderi[6] Gill. P.
1051. Hæmulon acutum[7] Poey. W. (873 *b.*)
1052. Hæmulon gibbosum[8] Walbaum. W. (873 *c.*)
1053. Hæmulon sexfasciatum[9] Gill. P.

329.—SPARUS Linnæus.

§ *Pagrus* Cuv. & Val.

1054. Sparus pagrus Linnæus. S. Eu. (878)

330.—CALAMUS Swainson. (285)

1055. Calamus proridens[10] Jordan & Gilbert. W. (876 *b.*)
1056. Calamus calamus[11] Cuv. & Val. W.
1057. Calamus bajonado[12] Bloch & Schneider. W.
1058. Calamus brachysomus[13] Lockington. P.

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[1] For description of *Hæmulon tæniatum* see Jordan & Swain, l. c. 307. West Indies, north to Key West.

[2] For description and synonymy of *Hæmulon flavolineatum* see Jordan & Swain, l. c. 305. West Indies north to Key West.

[3] *Sparus sciurus* Shaw=*Hæmulon elegans* Cuvier. See Jordan & Swain, l. c. 301.

[4] *Diabasis steindachneri* Jordan & Gilbert, Bull. U. S. Fish Com., 1881, 322. Mazatlan to Panama.

[5] For description of the adult form of *Hæmulon fremebundum* see Jordan & Swain, l. c. 297. This species has been recently described from Jamaica under the name of *Diabasis lateralis* (Vaillant & Bocourt, Miss. Sci. au Mexique, 1883.)

[6] For description of *Hæmulon scudderi* see Jordan & Swain, l. c. 296. Mazatlan to Panama.

[7] Described by Jordan & Swain, l. c. 294.

[8] For description of *Hæmulon gibbosum* see Jordan & Swain, l. c. 290. The oldest binomial name of this species in that of *Perca gibbosa* Walbaum, Artedi, Piscium, 1792, 348, based on *Perca marina gibbosa*, the Margate-fish, of Catesby.

[9] For description of *Hæmulon sexfasciatum* see Jordan & Swain, l. c. 288.

[10] *Calamus proridens* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 239=*Calamus pennatula* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 15 (not of Guichenot). West Indies, north to Key West. For synonymy and description of this and other species of *Calamus* see Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 15.

[11] For synonymy and description of *Calamus calamus* see Jordan & Gilbert, l. c. 16. West Indies, north to Key West.

[12] For synonymy and description of *Calamus bajonado* see Jordan & Gilbert, l. c. 20. West Indies, north to Key West.

[13] *Sparus brachysomus* Lockington, Proc. U. S. Nat. Mus., 1880, 284. Magdalena Bay, southward.

1059. **Calamus leucosteus**[1] Jordan & Gilbert. S. (876 *c.*)
1060. **Calamus penna**[2] Cuv. & Val. S. W. (877)
1061. **Calamus arctifrons** Goode & Bean. S. W. (876 *e.*)

331.—STENOTOMUS Gill.

1062. **Stenotomus caprinus** Bean. S. (881 *b.*)
1063. **Stenotomus chrysops**[3] Linnæus. N. S. (881)
1063 b. *Stenotomus chrysops aculeatus* Cuv. & Val. N. S. (880)

332.—DIPLODUS Rafinesque. (267)

§ *Lagodon* Holbrook.

1064. **Diplodus rhomboides** Linnæus. S. W. (882)
1065. **Diplodus unimaculatus**[4] Bloch. W. (1885 *b.*)

§ *Archosargus* Gill.

1066. **Diplodus probatocephalus** Walbaum. N. S. (883)

§ *Diplodus.*

1067. **Diplodus holbrooki** Bean. S. (884, 885)

333.—GIRELLA Gray. (288)

1068. **Girella nigricans** Ayres. C. (886)

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[1] *Calamus leucosteus* Jordan & Gilbert nom. sp. nov. "White Bone Porgy." Body formed much as in *Calamus penna*, short and deep, with steep anterior profile and high, arched back, the profile nearly straight from snout to above eyes, thence convex. Head deeper than long; the preorbital region very deep, its least depth 2¼ in head, half greater than interorbital width. Eye rather large, 2⅗ in head in adults; a strong blunt prominence before it. Mouth rather large, the maxillary 2⅖ in head. Outer teeth in both jaws moderately enlarged, canine-like, about ten in each jaw, none of them directed forwards. Highest dorsal spine 2⅛ in head. Pectorals very long, 2⅗ in length of body. Ventrals 1⅗ in head. Scales large, those on cheeks in five rows. Smutty-silvery sides with vague cross bars; dorsal and anal fins with dark blotches; ventrals dusky; no black axillary spot. Head 2⅓; depth 3¼. D. XII, 12; A. III, 10. Scales 7–51–14. Length about a foot. Charleston, S. C.

[2] *Pagellus penna* Cuv. & Val. = *Pagellus milneri* Goode & Bean. For synonymy and description of *Calamus penna* see Jordan & Gilbert, l. c. 21.

[3] According to Dr. Bean, the types of *Sparus chrysops* and *Sparus argyrops* Linnæus are both the common scup. The large or Southern scup, if really a distinct species or variety, should stand as *Stenotomus aculeatus* Cuv. & Val.

[4] *Diplodus unimaculatus* (Bloch). *Salema; Bream.*

This species has the teeth emarginate, as in *D. rhomboides*, and it likewise belongs to the subgenus *Lagodon*. It is distinguished from *D. rhomboides* by its deeper body, and by the longer second anal spine, which extends beyond the tip of the third spine when depressed. It has, further, 13 dorsal spines instead of 12, and its coloration is deeper and more golden. West Indies, north to Pensacola.

To the synonymy add:

(*Salema* Marcgrave, Hist. Brazil, p. 153; *Perca unimaculata* Bloch, taf. 308; *Sargus unimaculatus* Cuv. & Val., VI, 62, 1830; *Sargus unimaculatus* Günther, I, 446; *Sargus caribæus* Poey, Memorias Cuba, II, 1860, 198; *Diplodus unimaculatus* Jordan, Proc. U. S. Nat. Mus., 1884, 126.)

334.—KYPHOSUS Lacépède. (289)

1069. **Kyphosus sectatrix**[1] Linnæus. W. S. (887)
1070. **Kyphosus analogus**[2] Gill. P.

335.—CÆSIOSOMA[3] Kaup. (290)

1071. **Cæsiosoma californiense** Steindachner. S. (888)

Family CVI.—CIRRHITIDÆ.[4]

336.—CIRRHITES Lacépède.

1072. **Cirrhites rivulatus** Valenciennes. P.

Family CVII.—APOGONIDÆ.

337.—APOGON Lacépède. (291)

§ *Apogon.*

1073. **Apogon imberbis**[5] Linnæus. Eu. N. (Acc.) (889)
1074. **Apogon maculatus** Poey. W. (889 *b.*)
1075. **Apogon retrosella**[6] Gill. P.

§ *Apogonichthys* Bleeker.

1076. **Apogon alutus** Jordan & Gilbert. W. (889 *c.*)

§ *Glossamia* Gill.

1077. **Apogon pandionis** Goode & Bean. B. (890)

Family CVIII.—MULLIDÆ.

338.—MULLUS Linnæus. (292)

1078. **Mullus barbatus (L.) auratus** Jordan & Gilbert. S. N. Eu. (891)

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[1] *Perca sectatrix* L., Syst. Nat., Ed. XII, 486 = *Pimelepterus bosci* Cuv. & Val.

[2] *Pimelepterus analogus* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 245. Mazatlan to Panama.

[3] I now adopt the genus *Cæsiosoma* for *Scorpis californiensis.* This species differs much from the figure of *Scorpis georgianus,* to which it may not be really related. *Cæsiosoma* is certainly not a *Chætodont,* but a very near relative of *Kyphosus.* The propriety of placing *Girella, Kyphosus,* and *Cæsiosoma* among the *Sparidæ* is questionable. Gill has placed them together in his family *Pimelepteridæ.*

[4] See Günther, ii, 70, for the characters of the family of *Cirrhitidæ* and of the genus *Cirrhites.* Our species, *Cirrhites rivulatus* Valenciennes, Voyage Vénus Poiss., 399 = *Cirrhitichthys rivulatus* Günther, Fish. Centr. Amer., 1869, 421 = *Cirrhites betaurus* Gill, Proc. Ac. Nat. Sci. Phila., 1862, is found from Cape San Lucas to the Galapagos Islands.

[5] The specimen from Newport, R. I., recorded by Cope as *Apogon americanus,* belongs to the European species, *Apogon imberbis* L. It has been compared with the latter, at my request, by Mr. S. E. Meek.

[6] *Amia retrosella* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 251. Cape San Lucas.

339.—**UPENEUS** Cuvier. (293)

1079. Upeneus maculatus Bloch. W. (892)
1080. Upeneus martinicus[1] Cuv. & Val. W.
1081. Upeneus grandisquamis[2] Gill. P.
1082. Upeneus dentatus[3] Gill. P.

Family CIX.—SCIÆNIDÆ. (91)

340.—**APLODINOTUS** Rafinesque. (294)

1083. Aplodinotus grunniens Rafinesque. V. (893)

341.—**POGONIAS** Lacépède. (295)

1084. Pogonias chromis Linnæus. S. (894)

342.—**RONCADOR** Jordan & Gilbert. (296 *b.*)

1085. Roncador stearnsi Steindachner. C. (899)

343.—**SCIÆNA** Linnæus. (296)

§ *Stelliferus* Stark.

1086. Sciæna lanceolata Holbrook. S. (895)

§ *Bairdiella* Gill.

1087. Sciæna chrysura Lacépède. S. (896)
1088. Sciæna icistia[4] Jordan & Gilbert. P.

§ *Sciæna.*

1089. Sciæna jacobi Steindachner. C. (897)
1090. Sciæna sciera[5] Jordan & Gilbert. P.
1091. Sciæna ocellata Linnæus. S. (898)

344.—**JOHNIUS**[6] Bloch. (296 *c.*)

§ *Corvina* Cuvier.

1092. Johnius saturnus Girard. C. (900)

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[1] *Upeneus martinicus* Cuv. & Val.

Yellow Goat-fish: Salmonete amarilla. Red; sides with a broad longitudinal band of bright yellow; snout with yellow streaks; vertical fins and patches on sides of head bright yellow. Body moderately elongate; anterior profile gibbous before the eyes; eyes large, 3½ in head. Teeth bluntish, rather strong, in two or three series, the lower larger than the upper; no teeth on vomer. Interorbital space flat, 3⅗ in head. Barbels 1⅗ in head; longest dorsal spine 1⅓; anal small. Head 3½; depth 4, D. VII–9; A. 7. Scales 2½–37–7. L. 1 foot. West Indies, north to Key West.

(*Upeneus martinicus* and *U. balteatus* Cuvier & Valenciennes, III, 484, 1829; *Upeneus flavovittatus* Poey, Memorias Cuba, I, 224, 1856; *Mulloides flavovittatus* Günther, I, 403.)

[2] *Upeneus grandisquamis* Gill, Proc. Ac. Nat. Sci. Phila., 1863, 168 = *Upeneus tetraspilus* Günther, Fish. Centr. Amer., 1869, 420. Mazatlan to Panama.

[3] *Upeneus dentatus* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 256; Jordan & Gilbert. Proc. U. S. Nat. Mus., 1882, 363. Cape San Lucas.

[4] *Sciæna icistia* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 356. Mazatlan.

[5] *Sciæna sciera* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 480. Mazatlan to Panama.

[6] The name *Johnius* Bloch & Schneider should be used instead of *Corvina* (pp. 572, 932) for the section of *Sciæna* characterized by the absence of bony serræ on the preopercle. The intergradations among the species will perhaps prevent this group from being considered as a genus from *Sciæna*.

Johnius Bloch & Schneider, Syst. Ichth., 1801, p. 74; type (as restricted by Cuvier & Gill) *Johnius carutta* Bloch. (Named for John, a missionary in Tranquebar.)

345.—EQUES Bloch. (296 *d.*)

§ *Pareques* Gill.

1093. Eques acuminatus[1] Bloch & Schneider. W. (901 *b.*)

§ *Eques.*

1094. Eques lanceolatus Gmelin. W. (901 *b.*)

346.—LIOSTOMUS Lacépède. (297)

1095. Liostomus xanthurus Lacépède. S. (902)

347.—LARIMUS Cuvier & Valenciennes. (302)

1096. Larimus fasciatus Holbrook. S. (911)
1097. Larimus breviceps[2] Cuv. & Val. P. W.

348.—GENYONEMUS Gill. (298)

1098. Genyonemus lineatus Ayres. C. (903)

349.—MICROPOGON Cuv. & Val. (299)

1099. Micropogon undulatus Linnæus. N. S. (904)
1100. Micropogon ectenes[3] Jordan & Gilbert. P.

350.—UMBRINA Cuvier. (300)

1101. Umbrina roncador Jordan & Gilbert. C. (905)
1102. Umbrina xanti[4] Gill. P.
1103. Umbrina dorsalis[5] Gill. P.
1104. Umbrina broussoneti Cuv. & Val. W. (906)

351.—MENTICIRRUS Gill. (301)

1105. Menticirrus littoralis Holbrook. S. (908)
1106. Menticirrus elongatus[6] Günther. P.
1107. Menticirrus undulatus Girard. C. (910)
1108. Menticirrus saxatilis[7] Bloch & Schneider. N. S. (907)
1109. Menticirrus alburnus Linnæus. S. (909)
1110. Menticirrus panamensis[8] Steindachner. P.
1111. Menticirrus nasus[9] Günther. P.

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[1] The subgenus *Pareques* and its typical species *Sciæna acuminata* should be transferred to the genus *Eques*.

[2] *Larimus breviceps* Cuv. & Val., V, 146; Günther, I, 268. Both coasts of Tropical America, north to Mazatlan.

[3] *Micropogon ectenes* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 355; 1882, 282. Mazatlan.

[4] *Umbrina xanti* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 257 = *Umbrina analis* Günther, Fish. Centr. Amer., 1869, 426. For diagnosis, see Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 364.

[5] *Umbrina dorsalis* Gill, l. c. 1862, 257. See Jordan & Gilbert, l. c. 364.

[6] *Umbrina elongata* Günther, Proc. Zoöl. Soc. London, 1864, 148. For diagnosis see Jordan & Gilbert, l. c. 284. Mazatlan to Panama.

[7] The name *Johnius saxatilis* (Bloch & Schneider, Syst. Ichth., 1801, 75, based on a specimen from New York, now in the museum at Berlin) has priority for the species called in the Synopsis, *Menticirrus nebulosus*.

[8] *Umbrina panamensis* Steindachner, Ichth. Beitr., IV, 9, 1875. Mazatlan to Panama. See Jordan & Gilbert, l. c. 284.

[9] *Umbrina nasus* Günther, Fish. Centr. Amer., 1869, 426. Mazatlan to Panama. See Jordan & Gilbert, l. c. 284.

352.—CYNOSCION Gill. (303, 304)

§ *Atractoscion* Gill.

1112. Cynoscion nobile Ayres. C. (912)

§ *Cynoscion.*

1113. Cynoscion regale Bloch & Schneider. N. S. (915)
1114. Cynoscion thalassinum Holbrook. S. (916)
1115. Cynoscion nothum Holbrook. S. (914)
1116. Cynoscion othonopterum[1] Jordan & Gilbert. P.
1117. Cynoscion parvipinne Ayres. C. P. (913)
1118. Cynoscion xanthulum[2] Jordan & Gilbert. P.
1119. Cynoscion reticulatum[3] Günther. P.
1120. Cynoscion maculatum Mitchill. S. (917)

353.—SERIPHUS Ayres. (305)

1121. Seriphus politus Ayres. C. (918)

Family CX.—GERRIDÆ. (92)

354.—GERRES Cuvier. (306)

§ *Gerres.*

1122. Gerres plumieri Cuv. & Val. W. (919)
1123. Gerres lineatus[4] Humboldt. P.
1124. Gerres olisthostoma Goode & Bean. S. W. (919 *b.*)
1125. Gerres peruvianus[5] Cuv. & Val. P.

§ *Diapterus* Ranzani.

1126. Gerres cinereus Walbaum. P. W. (921 *b.*)
1127. Gerres californiensis Gill. P.
1128. Gerres gula[6] Cuv. & Val. S. W. (920, 921)
1129. Gerres gracilis[7] Gill. P. W. S. (922)
1130. Gerres jonesi Günther. W.
1131. Gerres lefroyi[8] Goode. W.

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[1] *Cynoscion othonopterum* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 274. Gulf of California.

[2] *Cynoscion xanthulum* Jordan & Gilbert, Proc. U. S. Nat. Mus.. 1881, 460. Mazatlan.

[3] *Otolithus reticulatus* Günther, Proc. Zoöl. Soc. London, 1864, 149. Mazatlan to Panama. For diagnosis of this and other species of Cynoscion see Jordan & Gilbert, Bull. U. S. Fish Comm., 1881, 319.

[4] For synonymy and description of *Gerres lineatus*, see Jordan & Gilbert, Proc. U. S. Mus., 1881, 330. Mazatlan to Panama.

[5] For synonymy and diagnosis of *Gerres peruvianus*, see Jordan & Gilbert, Bull. U. S. Fish Comm., 1881, 330. Mazatlan to Peru. For a detailed account of American species of *Gerres*, see Evermann & Meek, Proc. Ac. Nat. Sci. Phila., 1883, 116.

[6] *Gerres homonymus* seems to me indistinguishable from *Gerres gula.*

[7] *Diapterus gracilis* Gill. Proc. Ac. Nat. Sci. Phila., 1882, 246 = *Diapterus harengulus* Goode & Bean. Abundant on both coasts of Tropical America.

To its synonymy add:

(*Diapterus gracilis* Gill, Proc. Ac. Nat. Sci. Phila, 1862, 246; *Eucinostomus pseudogula* Poey, Enum. Pisc. Cubens., 124, 1875; Jordan & Gilbert, Bull. U. S. Fish Comm., 1881, 329; Evermann & Meek, Proc. Ac. Nat. Sci. Phila., 1882, 118. *Gerres aprion* Günther, IV, 255, 1862, not of C. & V.)

[8] *Gerres lefroyi* Goode. Bluish above the back, rather darker than in related species, with oblique dusky cross shades; faint dusky streaks along sides; lower parts

Family CXI.—EMBIOTOCIDÆ. (93)

355.—HYSTEROCARPUS Gibbons. (307)

1132. Hysterocarpus traski Gibbons. T. (923)

356.—ABEONA Girard. (308)

1133. Abeona minima Gibbons. C. (924)
1134. Abeona aurora Jordan & Gilbert. C. (925)

357.—BRACHYISTIUS Gill. (308 *b.*)

1135. Brachyistius frenatus Gill. C. (926)
1136. Brachyistius rosaceus Jordan & Gilbert. C. (927)

358.—MICROMETRUS Gibbons. (309)

1137. Micrometrus aggregatus Gibbons. C. (928)

359.—HOLCONOTUS Agassiz. (310)

§ *Hypocritichthys* Gill.

1138. Holconotus analis Alex. Agassiz. C. (929)

§ *Hyperprosopon* Gibbons.

1139. Holconotus argenteus Gibbons. C. (930)
1140. Holconotus agassizii Gill. C. (931)

§ *Holconotus.*

1141. Holconotus rhodoterus Agassiz. C. (933)

360.—AMPHISTICHUS Agassiz. (310 *b.*)

1142. Amphistichus argenteus Agassiz. C. (933)

361.—HYPSURUS Alex. Agassiz. (311)

1143. Hypsurus caryi Agassiz. C. (934)

362.—DITREMA Schlegel. (312)

§ *Tæniotoca* Alex. Agassiz.

1144. Ditrema laterale Agassiz. C. (935)

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brightly silvery; tip of spinous dorsal usually black, other fins pale; slenderer than any other of the American species; the snout rather sharp; the outlines of the body notangular; eye rather large, 3 in head, nearly equal to the flattish interorbital space; premaxillary groove linear, naked, formed as in *G. gracilis;* fins low; the longest dorsal spines, 2 in head; anal spines short; pectoral short, $1\frac{1}{4}$ in head; head, $3\frac{1}{6}$; depth, $3\frac{1}{6}$; D, IX, 10; A, II, 8; scales, 4—45—10; L., 4 inches. West Indies, north to Cedar Key, Florida. Well distinguished from all related species by the presence of but two anal spines. The only other species with two anal spines is *G. rhombeus* C. & V., an ally of *G. olisthostoma.*

(*Diapterus lefroyi* Goode, Am. Journ. Sci. Arts, 1874, 123; *Eucinostomus lefroyi* Goode, Bull. U. S. Nat. Mus. V., 1876, 39; *Eucinostomus productus* Poey, Ann. Lyc. N. Y., XI, 59, 1876; Evermann & Meek, Proc. Ac. Nat. Sci. Phila., 1883, 118.)

§ *Embiotoca* Agassiz.

1145. Ditrema jacksoni Agassiz. C. (936)

§ *Phanerodon* Girard.

1146. Ditrema atripes Jordan & Gilbert. C. (937)
1147. Ditrema furcatum Girard. C. (938)

363.—RHACOCHILUS Agassiz. (313)

1148. Rhacochilus toxotes Agassiz. C. (939)

364.—DAMALICHTHYS Girard. (314)

1149. Damalichthys argyrosomus Girard. C. (940)

Family CXII.—LABRIDÆ. (94)

365.—CTENOLABRUS Cuv. & Val. (315)

§ *Tautogolabrus* Günther.

1150. Ctenolabrus adspersus Walbaum. N. (941)

366.—HIATULA Lacépède. (316)

1151. Hiatula onitis Linnæus. N. (948)

367.—LACHNOLÆMUS Cuv. & Val. (317)

1152. Lachnolæmus maximus[1] Walbaum. W. (943)

368.—BODIANUS[2] Bloch. (318)

1153. Bodianus rufus Linnæus. W. (944)
1154. Bodianus diplotænia[3] Gill. P.
1155. Bodianus pectoralis[4] Gill. P.

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[1] The species commonly known as *Lachnolæmus falcatus* must stand as *Lachnolæmus maximus* Walbaum.

The *Labrus falcatus* of Linnæus is certainly not this species as supposed by Valenciennes, but is probably some species of *Trachynotus*. The oldest name, certainly, belonging to the *Lachnolæmus* is that of *Labrus maximus* Walbaum, Artedi Piscium, 1792, 261 = (*Lachnolæmus suillus* Cuvier, Règne Animal, Ed. II, 1829, 257, both names based on *Suillus*, the hog-fish of Catesby.)

[2] The genus called in the text *Harpe* must probably stand as

BODIANUS Bloch.

(Bloch, Ichthyologia, about 1780; type *Bodianus bodianus* Bloch = *Labrus rufus* L.)

The genus *Bodianus* Bloch is a medley of unrelated fishes. The group was, however, based especially on *Bodianus bodianus* Bloch, from the Portuguese name, of which (*Bodiano* or *Pudiano*) the name *Bodianus* was derived.

[3] *Harpe diplotænia* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 140; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 367. Cape San Lucas.

[4] *Harpe pectoralis* Gill, l. c. 141. Gulf of California southward. This is probably the male of *Bodianus diplotænia*.

369.—DECODON[1] Günther.

1156. **Decodon puellaris** Poey. W.

370.—TROCHOCOPUS Günther. (318*b.*)

§ *Pimelometopon* Gill.

1157. **Trochocopus pulcher** Ayres. C. (945)

371.—PLATYGLOSSUS Bleeker. (319)

1158. **Platyglossus radiatus**[2] Linnæus. W. (946)
1159. **Platyglossus bivittatus**[3] Bloch. S. W. (947; 948)
1160. **Platyglossus caudalis** Poey. W. (948 *b.*)

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[1] DECODON Günther.

(Günther, Cat. Fish. Brit. Mus., IV, 101, 1862; type *Cossyphus puellaris* Poey.)

Body moderately compressed, oblong, covered with large scales; head oblong; cheeks, opercles, and lower limb of preopercle scaly, the posterior limb being naked; base of dorsal and anal not scaly; lateral line continuous. Teeth essentially as in *Harpe*, those of the jaws in a single series; four canines in the front of each jaw; a posterior canine on each premaxillary. Dorsal with eleven spines; anal with three. A single species, intermediate between *Bodianus* and *Trochocopus*, having the large scales of the former and the naked fins of the latter. Apparently the genera in this group have been too much subdivided. (*Δεκας*, ten; *ὅδους*, tooth; there being ten canines.)

Decodon puellaris.

Rose-colored, with three large red blotches; head with several pearl-colored streaks (yellow in life); a transverse one between the nostrils; two oblique ones running from orbit towards subopercle, and a broad one from angle of mouth to angle of preopercle. Some yellow spots on sides of head. Each scale on sides with a yellow spot on its edge. Fins mostly red, the soft dorsal and anal with four rounded yellow spots; several spots on spinous dorsal and caudal (*Poey*). Eye rather large, as wide as interorbital space, shorter than snout. Maxillary reaching a little beyond eye. Edge of preopercle minutely denticulated, the angle rounded, projecting somewhat beyond the posterior edge; opercle with a membranaceous flap. Ventrals not reaching vent; caudal emarginate. Head 4 in total length; depth $4\frac{3}{5}$. D. XI, 10; A. III, 10. Scales $2\frac{1}{2}$–30–8. L. 10 inches. West Indies, north to Pensacola.

(*Cossyphus puellaris* Poey, Memorias Cuba, 1860, II, 210; Günther, IV, 101. Jordan, Proc. U. S. Nat. Mus., 1884.)

[2] *Platyglossus radiatus. Pudding-wife; Doncella; Blue-fish.*

This species (*Platyglossus radiatus* of the text; and *cyanostigma* of the addenda) is the original *Labrus radiatus* L., Syst. Nat., Ed. X, 288, 1758, based on *Turdus oculo radiato*, the Pudding-wife, of Catesby. It reaches a much larger size than our other species. The ground color in the males is blue, in the females chiefly of a bronze-olive. Both are most brilliantly colored. Lower pharyngeals T-shaped, but little broader than long.

[3] *Platyglossus bivittatus. Slippery Dick.*

This is the *Sparus radiatus* of Linnæus, Syst. Nat., Ed. XII, 472, 1766, based on a specimen sent from Charleston by Dr. Garden. It varies considerably with age and surroundings. The names *grandisquamis, humeralis*, and *florealis* represent different stages of growth. Lower pharyngeal T-shaped, more than twice as broad as long.

1161. Platyglossus maculipinna[1] Müller & Troschel. W.
1162. Platyglossus semicinctus Ayres. C. (949)
1163. Platyglossus dispilus[2] Günther. P.

372.—PSEUDOJULIS Bleeker. (320)

§ *Pseudojulis.*

1164. Pseudojulis notospilus[3] Günther. P.

§ *Oxyjulis.* Gill.

1165. Pseudojulis modestus Girard. C. (950)

373.—THALASSOMA[4] Swainson.

1166. Thalassoma lucasanum Gill. P.

374.—DORATONOTUS[5] Günther.

1167. Doratonotus thalassinus Jordan & Gilbert. W.

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[1] *Platyglossus maculipinna* Müller & Troschel.

Dorsal fin with a black (blue) spot between the fifth and seventh spines and with a band along the middle of the soft portion; a small black spot posteriorly in the axil of the dorsal; a broad dark band runs from the head to the caudal fin, below the lateral line; sometimes a dark spot below the band on the middle of the body; a blue band from the snout through the eye to the operculum, and another above it from the snout to the eye; both bands are united, forming a V. Three bluish bands across the nape and three white ones on the cheek. Base of the pectoral with a small black spot. Caudal rounded. D. IX, 11; A. III, 11. Scales 2–28–9 (*Günther*), West Indies; a young specimen taken by us at Beaufort, N. C., in 1877.

(*Julis maculipinna* Müller & Troschel, Hist. Barbadoes, 674; Günther, IV, 165. "*Pusa*"? *radiata* Jor. & Gill., Proc. U. S. Nat. Mus. 1878, 374.)

[2] *Platyglossus dispilus* Günther, Proc. Zoöl. Soc. London, 1864, 25, and Fish. Centr. Amer., 1869, 447. Mazatlan to Panama.

[3] *Pseudojulis notospilus* Günther ll. cc. 26, 447. Mazatlan to Panama.

[4] THALASSOMA Swainson.

(*Julis* Günther, not of Cuvier, whose type *Labrus julis* L. is a species of *Coris*; not of Swainson, who also restricted *Julis* to the species of *Coris*.)

(Swainson, Classn. Anim. II, 1839, 224; type *Julis purpureus* Rüppell.)

This genus differs from *Platyglossus* in the possession of but eight spines in the dorsal, and in having no posterior canine tooth. The numerous species are gaily colored, like those of *Platyglossus*. They are found chiefly in the Western Pacific. (*Θάλασσα*, the sea; *σῶμα*, body, from the sea-green color of *T. purpureum.*)

Thalassoma lucasanum = *Julis lucasana* Gill., Proc. Ac. Nat. Sci. Phila., 1862, 142; *Julis lucasana* Günther, IV, 184. Gulf of California.

[5] DORATONOTUS Günther.

(Günther, Cat. Fishes Brit. Mus. IV, 124, 1862; type *Doratonotus megalepis* Günther.)

Body compressed; head not compressed to an edge anteriorly; its profile in front straight or concave; preorbital not very deep; mouth rather wide; teeth in a single series, two large canines in front in each jaw; a posterior canine; cheeks and opercles scaly; gill membranes united, free from the isthmus; scales large; lateral line interrupted behind, beginning again lower down; dorsal fin with nine strong pungent spines; some of the anterior elevated, the median spines short, so that the outline of the fin is concave; caudal rounded. Colors brilliant. Size small. Two species, each known from a single specimen. (*Δόρυ* (*δορατος*), spear; *νῶτος*, back.)

Doratonotus thalassinus Jordan & Gilbert, Proc., U. S. Nat. Mus., 1884, 28. Key West.

375.—XYRICHTHYS Cuvier. (321)

§ *Xyrichthys.*

1168. **Xyrichthys psittacus**[1] L. S.W. (951)
1169. **Xyrichthys mundiceps**[2] Gill. P.

§ *Iniistius* Gill.

1170. **Xyrichthys mundicorpus**[3] Gill. P.

§ *Dimalacocentrus* Gill.

1171. **Xyrichthys rosipes**[4] Jordan & Gilbert. W.

376.—CRYPTOTOMUS[5] Cope. (322)

1172. **Cryptotomus ustus** Cuv. & Val. W. (953)
1173. **Cryptotomus beryllinus**[6] Jordan & Swain. W.

377.—SPARISOMA[7] Swainson.

1174. **Sparisoma radians** Cuv. & Val. W. (954 *d.*)

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[1] *Coryphæna psittacus* L., Syst. Nat., XII, 448, 1766=*Coryphæna lineata* Gmelin = *Xyrichthys vermiculatus* Poey. The type of *Coryphæna psittacus* was sent from Charleston by Dr. Garden, and it has been identified as a *Xyrichthys* by Dr. Bean, who has examined it in London. Possibly another species of this type (*Xyrichthys venustus* Poey = *X. lineatus* C. & V.) occurs with the preceding on our coasts.

[2] *Xyrichthys mundiceps* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 143; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 367. Cape San Lucas.

[3] *Iniistius mundicorpus* Gill, l. c., 1862, 145; *Novacula mundicorpus* Jordan & Gilbert, l. c., 367. Cape San Lucas. The subgenus, *Iniistius* (Gill, Proc. Ac. Nat. Sci. Phila., 1862, 145; type *Xyrichthys pavo* Cuv. & Val.) is distinguished from *Xyrichthys* by the prolongation and separation from the fin of the first two dorsal spines.

[4] *Xyrichthys rosipes* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 27. Key West. The subgenus *Dimalococentrus* Gill (Proc. Ac. Nat. Sci. Phila., 1863, 223; type *Novaculichthys callosoma* Bleeker), is distinguished from *Xyrichthys* by the rounded (not trenchant) anterior edge of the head, and by the partial separation of the first two dorsal spines from the rest of the fin.

[5] *Cryptotomus* Cope (Trans. Am. Phil. Soc., 1871, 462; type *Cr. roseus* Cope) = *Calliodon* Cuv.; not of Bloch & Schneider, which is *Scarus* Forskål. For a detailed account of our genera and species of *Scaroid* fishes, see Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 81.

[6] *Cryptotomus beryllinus* Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 101. Key West and Havana.

[7] SCARUS Forskål.

The two groups *Scarus* (= *Hemistoma* Swainson, and *Pseudoscarus* Bleeker) and *Sparisoma* (= *Scarus* Bleeker) are really very distinct genera, each represented by several species among the Florida Keys. They may be thus defined:

SCARUS Forskål.

(*Calliodon* Gronow; *Hemistoma* Swainson; *Pseudoscarus* Bleeker.)

(Forskål, Descr. Anim. Orientali Observ., 1775, 25; type *Scarus psittacus* Forskål, &c.)

Lower pharyngeal spoon-shaped, much longer than broad, transversely concave; teeth fully coalesced, divided in each jaw by a distinct median suture; skull broad above; gill membranes forming a fold across the narrow isthmus; dorsal spines flex-

1175. **Sparisoma xystrodon**[1] Jordan & Swain. W.
1176. **Sparisoma cyanolene**[2] Jordan & Swain. W.
1177. **Sparisoma flavescens**[3] Bloch & Schneider. W. (954 *c.*)

373.—**SCARUS** Forskål. (323)

1178. **Scarus croicensis** Bloch. W. (954 *b.*)
1179. **Scarus cœruleus**[4] Bloch W.
1180. **Scarus guacamaia** Cuvier. W. (954)
1181. **Scarus perrico**[5] Jordan & Gilbert. P.

Family CXIII.—CICHLIDÆ. (95)

379.—**HEROS** Heckel. (324)

1182. **Heros cyanoguttatus** Baird & Girard. Vsw. (955)
1183. **Heros pavonaceus** Garman. Vsw. (955 *b.*)

Family CXIV.—POMACENTRIDÆ. (96)

380.—**POMACENTRUS** Lacépède.

§ *Pomacentrus.*

1184. **Pomacentrus obscuratus**[6] Poey. W.
1185. **Pomacentrus leucostictus** Müller & Troschel. W. (956)
1186. **Pomacentrus caudalis**[7] Poey. W.

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ible, lateral line interrupted, its pores nearly simple; scales about head comparatively numerous, lower jaw included; upper pharyngeal teeth in two rows. Species mostly of large size, brightly colored; sexes similar.

SPARISOMA Swainson.
(*Scarus* Bleeker.)

(Swainson, Nat. Hist. Class'n Fishes, &c., 1839, II, 227; type *Sparus abildgaardii* Bloch.)

Lower pharyngeal much broader than long, its surface slightly concave; teeth less perfectly coalescent than in *Scarus*; the median suture not very distinct; skull narrow; gill membranes broadly united to the isthmus; dorsal spines pungent; lateral line continuous, its pores very much branched; scales about head few and large, those on cheeks in one row; lower jaw projecting; upper pharyngeal teeth in three rows. Species mostly of small size. (*Sparus; σῶμα*, body.)

[1] *Sparisoma xystrodon* Jordan & Swain, l. c. 99. Havana and Key West.

[2] *Sparisoma cyanolene* Jordan & Swain, l. c. 98. Key West.

[3] For synonymy and description of *Sparisoma flavescens* (*Scarus squalidus* Poey), see Jordan & Swain, l. c. 92. Key West, southward.

[4] For synonymy and description of *Scarus cœruleus*, see Jordan & Swain, l. c. 85.

[5] *Scarus perrico* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 357. Mazatlan to Panama.

[6] *Pomacentrus obscuratus* Poey, Enumeratio Piscium Cubensium, 1875, 101; Jordan, Proc. U. S. Nat. Mus., 1884, 133. Key West to Cuba.

[7] *Pomacentrus caudalis* Poey, Synopsis Piscium Cubensium, 328, 1868.

Upper parts dusky, the greater part of each scale light grayish blue; lower parts bright yellow, with some blue spots on the scales; top and sides of head similarly marked with bluish spots on the scales. A jet-black, ink-like spot ocellated with blue on the back of the tail. Dorsal fin colored like the back; the posterior rays abruptly yellow; caudal fin bright yellow; lower fins chiefly yellow. Form oblong, ovate; the anterior profile moderately convex. Preorbital and preopercle well serrated. Teeth moderate, entire. Soft parts of dorsal and anal rather high. Head 3½; depth 2⅙. D. XII,14; A. II, 13. Scales 4–29–9. Cuba; lately obtained at Pensacola, by Silas Stearns.

1187. Pomacentrus rectifrænum[1] Gill. P.
1188. Pomacentrus flavilatus[2] Gill. P.

§ *Hypsypops* Gill.

1189. Pomacentrus quadrigutta[3] Gill. P.
1190. Pomacentrus rubicundus[4] Girard. C. (957)

381.—GLYPHIDODON Lacépède. (325 *b.*)

1191. Glyphidodon declivifrons Gill. W. P. (958)
1192. Glyphidodon saxatilis Linnæus. W. (959)
1192b. *Glyphidodon saxatilis troscheli*[5] Gill. P.

382.—CHROMIS Cuvier. (326)

1193. Chromis punctipinnis Cooper. C. (960)
1194. Chromis atrilobatus[6] Gill. P.
1195. Chromis insolatus Cuv. & Val. W. (961)
1196. Chromis enchrysurus Jordan & Gilbert. W. (961 *b.*)

Family CXV.—EPHIPPIDÆ. (97)

383.—CHÆTODIPTERUS Lacépède. (327)

1197. Chætodipterus faber Broussonet. N. S. W. (962)
1198. Chætodipterus zonatus[7] Girard. P.

Family CXVI.—CHÆTODONTIDÆ. (98)

384.—CHÆTODON Linnæus. (328)

1199. Chætodon maculocinctus Gill. (Acc.) (963)
1200. Chætodon ocellatus[8] Bloch. W. (963 *b.*)
1201. Chætodon capistratus Linnæus. W. (963 *c.*)
1202. Chætodon humeralis[9] Günther. P.
1203. Chætodon nigrirostris[10] Gill. P.

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[1] *Pomacentrus rectifrænum* Gill, Proc. Ac. Nat. Sci., Phila. 1862, 148; 1863, 244 = *Pomacentrus analigutta* Gill, in Günther, IV, 27. Gulf of California to Panama.

[2] *Pomacentrus flavilatus* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 148; 1863, 214 = *Pomatoprion bairdi* Gill, l. c., 1863, 217. Cape San Lucas. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 365.

[3] *Hypsypops dorsalis* Gill, Proc. Ac. Nat. Sci. Phila. 1862, 147 = *Pomacentrus quadrigutta* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 149; the name *dorsalis* is preoccupied in *Pomacentrus*. Cape San Lucas.

[4] For description of the young of *Pomacentrus rubicundus*, see Rosa Smith, Proc. U. S. Nat. Mus., 1882, 652.

[5] *Glyphidodon troscheli* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 150. Cape San Lucas to Panama; perhaps not at all different from *G. saxatilis*.

[6] *Chromis atrilobatus* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 149. Cape San Lucas to Panama.

[7] *Ephippus zonatus* Girard, U. S. Pac. R. R. Ex pl., 1858, 110. San Diego to Panama. Pacific coast specimens of *Chætodipterus* differ from the ordinary *C. faber* in the less development of the third dorsal spine, which is little longer or higher than the others. The dark bands are usually more obscure in *C. zonatus*. In other respects the two forms agree very closely.

[8] *Chætodon ocellatus* Bloch, Ichth. tab. 211 = *Chætodon bimaculatus* Bloch, tab. 219. See Poey, Enum. Pisc. Cubens., 1875, 62.

[9] *Chætodon humeralis* Günther, II, 19, 1860. Mazatlan to Panama.

[10] *Sarothrodus nigrirostris* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 243. Cape San Lucas.

385.—HOLACANTHUS Lacépède.

1204. **Holacanthus strigatus**[1] Gill. P.
1205. **Holacanthus ciliaris** Linnæus. W. (964)

386.—POMACANTHUS Lacépède. (329)

§ *Pomacanthodes* Gill.

1206. **Pomacanthus zonipectus**[2] Gill. P.

§ *Pomacanthus.*

1207. **Pomacanthus aureus**[3] Bloch. W.

Family CXVII.—ACANTHURIDÆ. (99)

387.—TEUTHIS[4] Linnæus. (330)

1208. **Teuthis hepatus** Linnæus. S. W. (966)
1209. **Teuthis tractus** Poey. W. P. (966 *c.*)
1210. **Teuthis cœruleus** Bloch. W. (967)

388.—PRIONURUS[5] Lacépède.

1211. **Prionurus punctatus** Gill. P.

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[1] *Holacanthus strigatus* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 243. Cape San Lucas to Panama. *Holacanthus tricolor* (Synopsis, p. 941) should be omitted. It has not yet been taken at the Florida Keys, although doubtless occurring there.

[2] *Pomacanthodes zonipectus* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 244 (adult) = *Pomacanthus crescentalis* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 358 (Young). Gulf of California to Panama.

[3] *Pomacanthus aureus* (Bloch), *Black Angel, Chirivita.* The description of *Pomacanthus arcuatus*, on page 616 of the Synopsis, was taken from a specimen of this species, with the exception of the following phrases, which should be suppressed: "Young with yellowish vertical bands"; the bands in the young of *P. aureus* are whitish. "Lat. l. 80–100"; this should read, "lat. l. 65." The additional characters given on page 973 are taken from the true *P. arcuatus*, and should be suppressed, as should also the synonymy on page 616. The true *arcuatus* is a West Indian species, not yet known from our coast; it is darker and more uniform in color than *P. aureus*, the cross-bands in the young are better defined and are yellow; the scales are smaller (lat. l. 85 to 90); and the dorsal spines are almost invariably 10 instead of 9. *P. aureus* is common in the West Indies and north to the Florida keys.

(*Chætodon aureus* Bloch, Ichthyol.; tab. 193, f. 1.; Cuvier & Val., VII, 202, 1831; *Pomacanthus balteatus* and *arcuatus* Cuv. & Val., VII. 208, 211; *Chætodon aureus* Poey, Syn. Pisc., Cubens., 1875, 60; *Chætodon aureus* Bleeker, Archives Neerlaudaises, IX, 1876, 183; Lütken, Spolia Atlantica, 1880, 571.)

[4] The genus *Teuthis* of Linnæus, Systema Naturæ, is based on *Teuthis hepatus* L. This species, founded on *Hepatus* of Gronow, is the common species known as *Acanthurus chirurgus*, with which *A. phlebotomus* Cuv. & Val. (*nigricans* of the Synopsis) seems to be identical. The generic name *Acanthurus* must give place to *Teuthis*, and this species should stand as *Teuthis hepatus*. See Gill, Proc. Ac. Nat. Mus., 1884, 275, and Meek and Hoffman, Proc. Ac. Nat. Sci. Phila., 1884. In the latter paper is given a detailed account of the three American species of *Teuthis*.

[5] PRIONURUS Lacépède.

(Lacépède, Annales Museum, Paris, IV, 205; type *Prionurus microlepidotus* Lac.)

This genus differs from *Teuthis* chiefly in the armature of the tail, which consists of a series of 3 to 6 bony keeled laminæ on each side. Size small. Species not very numerous, in the tropical seas. (*Πριων*, saw; *ὀυρα*, tail.)

Prionurus punctatus Gill, Proc. Ac. Nat. Sci. Phila., 1862, 242. Cape San Lucas.

Family CXVIII.—TRACHYPTERIDÆ. (100)

389.—TRACHYPTERUS Gouan. (331)

1212. Trachypterus altivelis Kner. B. C. (968)

Family CXIX.—BATHYMASTERIDÆ.[1]

390.—BATHYMASTER Cope. (334)

1213. Bathymaster signatus Cope. A. (971)

Family CXX.—MALACANTHIDÆ. (102)

391.—LOPHOLATILUS Goode & Bean. (335)

1214. Lopholatilus chamæleonticeps Goode & Bean. B. (972)

392.—CAULOLATILUS Gill. (336)

1215. Caulolatilus princeps Jenyns. C. P. (973)
1216. Caulolatilus microps[2] Goode & Bean. W. (974)

Family CXXI.—GOBIIDÆ. (104)

393.—GOBIOMORUS Lacépède. (339)

1217. Gobiomorus dormitator Lacépède. W. Vsw. (978)
1218. Gobiomorus lateralis Gill. [3] P.

394.—EROTELIS Poey.

1219. Erotelis smaragdus[4] Cuv. & Val. W.

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[1] I have here dismembered the unnatural group of *Icosteidæ* as given in the Synopsis, referring *Icosteus* and *Icichthys*, in accordance with the views of Dr. Steindachner (Ichth. Beitr., XI, 4, 1881, and XII, 22, 1882), to the Scombroid series, in the neighborhood of the *Bramidæ*. Steindachner considers *Schedophilus* the nearest ally of *Icosteus* (= *Schedophilopsis spinosus* Steindachner l. c.), and this may be correct.

The genus *Bathymaster* is perhaps the type of a separate family, allied to *Malacanthus*, *Latilus*, &c., or perhaps to *Opisthognathus*. For the present, I unite the *Latilidæ* with the *Malacanthidæ*, leaving *Bathymaster* in a group by itself. This arrangement is, however, merely provisional, until the anatomy of the different forms is made known.

[2] *Caulolatilus microps* Goode & Bean.

The identity of our Atlantic species of *Caulolatilus* with either the Cuban *cyanops* or the Brazilian *chrysops* is as yet unproven, though not improbable. The scales in our species are smaller than they are said to be in the others. There is little difference between *C. microps* and *C. princeps* except in color. The scales of the body have each a small brownish spot at base in *C. microps*.

[3] *Philypnus lateralis* Gill, Proc. Ac. Nat. Sci. Phila., 1860, 123; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 380. Streams of Northwestern Mexico.

[4] *Eleotris smaragdus* Cuv. & Val. *Esmeralda negra*.

Dusky olive, the fins mostly bluish, the dorsal with brown lines; some dark markings about eye, and on base of pectoral above. Body very long and slender, compressed behind, the form much as in *Gobionellus oceanicus*. Head depressed, flattish above, the eyes mostly superior, not half the width of the interorbital area, which has a knob near its middle. Mouth very oblique, the lower jaw much projecting, 395.—**ELEOTRIS** (Gronow) Bloch & Schneider. (340, 341 *b.*)

1220. **Eleotris pisonis** Gmelin. W. (981)
1221. **Eleotris amblyopsis** Cope. S. W. (981 *b.*)
1222. **Eleotris æquidens**[1] Jordan & Gilbert. P.

396.—**DORMITATOR** Gill. (341)

1223. **Dormitator maculatus** Bloch. W. (980, 981)
1224. **Dormitator latifrons**[2] Richardson. P.

397.—**GOBIUS** Linnæus.

§ *Euctenogobius* Gill.

1225. **Gobius lyricus** Girard. S. (983)
1226. **Gobius encæomus** Jordan & Gilbert. S. (983 *b.*)

§ *Rhinogobius* Gill.

1227. **Gobius banana**[3] Cuv. & Val. P. W.

§ *Gobius.*

1228. **Gobius soporator** Cuv. & Val. S. W. P. (984, 982, 985)

§ *Coryphopterus* Gill.

1229. **Gobius sagittula**[4] Günther. P.
1230. **Gobius boleosoma** Jordan & Gilbert. S. (987 *b.*)
1231. **Gobius stigmaturus** Goode & Bean. S. (987 *c.*)
1232. **Gobius würdemanni**[5] Girard. S. (987)
1233. **Gobius nicholsi** Bean. A. (987 *d.*)
1234. **Gobius glaucofrænum** Gill. A. (988)

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the maxillary about reaching front of eyes; teeth rather small, in bands. Fins rather high; dorsal spines slender, lower than the highest soft rays, which are $1\frac{1}{5}$ in head. Caudal lanceolate, $\frac{1}{5}$ longer than head. Ventrals moderate, 2 in head. Scales very small cycloid. Head $5\frac{1}{2}$; depth 10 to 12 D. VI–I, 10. A, I, 9. Lat. l. about 100. L. 8 inches. West Indies, north to Key West, not ascending the fresh waters.

(Cuv. & Val., XII, 231, 1837; *Erotelis valenciennesi* Poey, Mem. Cuba, II, 273, 1860. Günther, III, 123.)

This species is the type of Poey's genus *Erotelis* (name an anagram of *Eleotris*), distinguished from *Eleotris* by the very slender form, similar to that of *Gobionellus.*

[1] *Culius æquidens* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 461. Fresh waters of Western Mexico and Lower California.

[2] *Eleotris latifrons* Richardson, Voyage Sulphur, Fishes, 57 ≐ *Dormitator microphthalmus* Gill. Streams of the Pacific coast, north to Lower California. There are some tangible differences between the specimens of *Dormitator* found on the west coast of Mexico and that found in the Atlantic waters. For an excellent account of the genera and species of *Eleotridinæ*, see Eigenman and Fordise, Proc. Ac. Nat. Sci. Phila., 1885.

[3] *Gobius banana* Cuv. & Val., XII, 103; Günther, III, 59; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 379. Tropical America, north to Lower California, in fresh water.

[4] *Euctenogobius sagittula* Günther, III, 555. *Gobius sagittula* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 380. Lower California to Panama.

[5] For description of *Gobius würdemanni* see Jordan, Proc. U. S. Nat. Mus., 1884, 321.

398.—GOBIONELLUS Girard. (345)

1235. Gobionellus oceanicus Pallas. S. W. (989)
1236. Gobionellus stigmaticus Poey. W. (989 *b.*)

399.—GILLICHTHYS Cooper. (346)

1237. Gillichthys mirabilis Cooper. C. (990)

400.—LEPIDOGOBIUS Gill. (347)

§ *Lepidogobius* Gill.

1238. Lepidogobius lepidus Girard. C. (991)

§ *Eucyclogobius* Gill.

1239. Lepidogobius newberryi Girard. C. (992)
1240. Lepidogobius gulosus Girard. S. (992 *b*; 986)
1241. Lepidogobius thalassinus Jordan & Gilbert. S. (992 *b.*)

401.—GOBIOSOMA[1] Girard. (348)

1242. Gobiosoma ceuthœcum Jordan & Gilbert. W.
1243. Gobiosoma bosci Lacépède. N. S. (993; 994)
1244. Gobiosoma histrio[2] Jordan. P.
1245. Gobiosoma zosterurum[3] Jordan and Gilbert. P.
1246. Gobiosoma longipinne[4] Steindachner. P.
1247. Gobiosoma ios Jordan & Gilbert. C. (994*b.*)

402.—TYPHLOGOBIUS Steindachner. (349)

1248. Typhlogobius californiensis Steindachner. C. (995)

403.—TYNTLASTES Günther. (350)

1249. Tyntlastes sagitta Günther. P. (996)

404.—IOGLOSSUS Bean. (350 *b.*)

1250. Ioglossus calliurus Bean. S. (996 *b.*)

Family CXXII.—CHIRIDÆ. (105)

405.—PLEUROGRAMMUS Gill. (351 *a.*)

1251. Pleurogrammus monopterygius Pallas. A. (997)

406.—HEXAGRAMMUS Steller. (351*b.*)

1252. Hexagrammus ordinatus Cope. A. (998.)
1253. Hexagrammus asper Steller. A. (999)

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[1] *Gobiosoma ceuthœcum* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 29. Key West; found in the cavity of a sponge.

[2] *Gobiosoma histrio* Jordan, Proc. U. S. Nat. Mus., 1884, 260. Guaymas.

[3] *Gobiosoma zosterurum* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 361. Mazatlan.

[4] *Gobiosoma longipinne* Steindachner, Ichth. Beitr., VIII, 1879, 24. Las Animas, Gulf of California.

1254. Hexagrammus scaber Bean. A. (999 *b.*)
1255. Hexagrammus superciliosus Pallas. A. C. (1000)
1256. Hexagrammus decagrammus Pallas. A. C. (1001)

407.—OPHIODON Girard. (352)

1257. Ophiodon elongatus Girard. C. A. (1002)

408.—ZANIOLEPIS Girard. (353)

1258. Zaniolepis latipinnis Girard. C. (1003)

409.—OXYLEBIUS Gill. (354)

1259. Oxylebius pictus Gill. C. (1004)

410.—MYRIOLEPIS Lockington. (355)

1260. Myriolepis zonifer Lockington. C. (1005)

411.—ANOPLOPOMA Ayres. (356)

1261. Anoplopoma fimbria Pallas. C. A. (1006)

Family CXXIII.—SCORPÆNIDÆ. (106)

412.—SEBASTES Cuvier. (357)

1262. Sebastes marinus Linnæus. G. N. Eu. (1007)

413.—SEBASTODES Gill. (358)

1263. Sebastodes paucispinis Ayres. C. (1008)

414.—SEBASTICHTHYS Gill.

§ *Sebastosomus* Gill.

1264. Sebastichthys flavidus Ayres. C. (1009)
1265. Sebastichthys melanops Girard. C. (1010)
1266. Sebastichthys ciliatus Tilesius. A. (1011)
1267. Sebastichthys mystinus Jordan & Gilbert. C. (1012)
1268. Sebastichthys entomelas Jordan & Gilbert. C. (1013)
1269. Sebastichthys ovalis Ayres. C. (1014)
1270. Sebastichthys proriger Jordan & Gilbert. C. (1015)
1271. Sebastichthys brevispinis[1] Bean. A.
1272. Sebastichthys atrovireus Jordan & Gilbert. C. (1016)
1273. Sebastichthys pinniger Gill. C. (1017)

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[1] *Sebastichthys brevispinis* (Bean). Closely allied to *S. proriger*, but larger in size and more uniform in color; second anal spine shorter than third; peritoneum white. Coast of Alaska. (Bean.)

(*Sebastichthys proriger* var. *brevispinis* Bean., Proc., U. S. Nat. Mus., 1883. *Sebastodes proriger*, Alaskan specimens, Jor. & Gilb., Syn. Fish. N. A., 1883, 950.)

The statement in the Synopsis, p. 950, that *S. proriger* has been confounded by Tilesius and Pallas with *S. ciliatus* is erroneous. The specimens called by them *ciliatus* and *variabilis* include *ciliatus* and *matzubaræ*. The true *proriger* is not yet known from Alaska.

1274. **Sebastichthys miniatus** Jordan & Gilbert. C. (1018)
1275. **Sebastichthys matzubaræ**[1] Hilgendorf. A.

§ *Sebastomus* Gill.

1276. **Sebastichthys ruber** Ayres. C. (1019)
1277. **Sebastichthys umbrosus** Jordan & Gilbert. C. (1019*b*.)
1278. **Sebastichthys constellatus** Jordan & Gilbert. C. (1020)
1279. **Sebastichthys rosaceus** Girard. C. (1021)
1280. **Sebastichthys rhodochloris** Jordan & Gilbert. C. (1022)
1281. **Sebastichthys chlorostictus** Jordan & Gilbert. C. (1023)
1282. **Sebastichthys elongatus** Ayres. C. (1024)
1283. **Sebastichthys rubrovinctus** Jordan & Gilbert. C. (1025)

§ *Sebastichthys.*

1284. **Sebastichthys auriculatus** Girard. C. (1026)
1285. **Sebastichthys rastrelliger** Jordan & Gilbert. C. (1027)
1286. **Sebastichthys caurinus** Richardson. A. (1028)
1286 b. *Sebastichthys caurinus vexillaris* Jordan & Gilbert. C. (1028 *b*.)
1287. **Sebastichthys maliger** Jordan & Gilbert. C. (1029)
1288. **Sebastichthys carnatus** Jordan & Gilbert. C. (1030)
1288 b. *Sebastichthys carnatus chrysomelas* Jordan & Gilbert. C. (1031)
1289. **Sebastichthys nebulosus** Ayres. C. (1032)
1290. **Sebastichthys serriceps** Jordan & Gilbert. C. (1033)
1291. **Sebastichthys nigrocinctus** Ayres. C. (1034)

415.—SEBASTOPSIS[2] Gill.

1292. **Sebastopsis xyris** Jordan & Gilbert. P.

416.—SEBASTOPLUS[3] Gill.

1293. **Sebastoplus dactylopterus** De la Roche. B. Eu. (1035)

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[1] *Sebastichthys matzubaræ* (Hilgendorf). Dark red; three dark shades across cheeks. Allied to *Sebastichthys miniatus.* Spines of head low, developed about as in *S. miniatus* and *S. pinniger.* Preocular, supraocular, postocular, tympanic, occipital, and nuchal spines distinct; a pair of small coronal spines present, as also a small spine before and one just below eye. Maxillary reaching to posterior border of eye $1\frac{1}{5}$ in head. Both jaws covered with rough, ctenoid scales. Interorbital space flattish, scaled, its breath a little less than that of eye. Preopercular spine short, simple. Preorbital spines simple. Lower jaw scarcely projecting. Second anal spine scarcely longer than third. Longest dorsal spine $2\frac{3}{4}$ in head, a little less than the longest short rays. Pectoral $4\frac{1}{2}$ in body.

Color chiefly red; three dark shades across cheek. D. XIII, 14. A. III, 7. Yeso; Aleutian Islands. The above description from a specimen in the Berlin Museum, brought by Pallas from the Aleutian Islands.

(*Perca variabilis* Pallas, Zoogr. Rosso. Asiat., III, 241, 1811, in part; the larger specimen, No. 8145, Berl. Mus.; *Sebastes matzubaræ* Hilgendorf, Sitzber. Gesellschaft Naturforschender Freunde, Berlin, 1880, 170; Jordan, Proc. Ac. Nat. Sci. Phila., 1883, 291.)

[2] SEBASTOPSIS Gill.

(Gill, Proc. Ac. Nat. Sci. Phila., 1862, 278; type *Sebastes polylepis* Bleeker.

This genus differs from *Sebastichthys* in the absence of palatine teeth. The known species are small in size and not very numerous. (*Sebastes*; ὄψιϭ, appearance.)

Sebastopsis xyris Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 369. Cape San Lucas.

[3] SEBASTOPLUS Gill.

(Gill, Proc. Ac. Nat. Sci. Phila., 1863, 207; type *Sebastes kuhli* Lowe.)

This genus includes species which have the general characters of *Sebastichthys*, with the vertebræ and dorsal spines in smaller number, as in *Scorpæna.*

The species are red in color and mostly inhabit deep water. (*Sebastes*; ὅπλος, armed.)

417.—SCORPÆNA Linnæus. (359)

1294. Scorpæna guttata Girard. C. (1036)
1295. Scorpæna plumieri Bloch. W. P. (1037)
1296. Scorpæna grandicornis[1] Cuv. & Val. W.
1297. Scorpæna brasiliensis[2] Cuv. & Val. W. S. (1038 *b.*)
1298. Scorpæna occipitalis[3] Poey. W. (1038 *c.*)

418.—SETARCHES Johnson. (360)

1299. Setarches parmatus Goode. B. (1039)

Family CXXIV.—COTTIDÆ. (107)

419.—HEMITRIPTERUS Cuvier.

1300. Hemitripterus americanus Gmelin. G. N. (1040)
1300 b. *Hemitripterus americanus cavifrons*[4] Lockington. A. (1041)

420.—ASCELICHTHYS Jordan & Gilbert. (362)

1301. Ascelichthys rhodorus Jordan & Gilbert. A. (1042)

421.—PSYCHROLUTES Günther. (363)

1302. Psychrolutes paradoxus Günther. A. (1043)

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[1] *Scorpæna grandicornis* Cuv. & Val.

Gray, with brown shades and faint cross-bars; sides with numerous bright yellow spots in life; axil dark gray, with round white dots, each surrounded by a dark ring. Pectoral largely blackish above; a black blotch at base below; the fin largely tinged with yellow, especially on the inner side. Supraocular filament blackish, with gray fringes. Soft dorsal largely blackish toward the tip; spinous dorsal chiefly dusky; ventrals tipped with blackish; anal with three black bands; caudal with two; a faint band at its base. Body rather stout; deeper than in *S. plumieri* and much less variegated in color. Sides and head with dermal flaps; a slight depression below eye; occipital pit very deep; spines of head sharp. A few scales on opercle. Breast with rudimentary scales. Supraocular flap very large, wide and fringed, more than half length of head, reaching to beyond front of dorsal. Maxillary reaching posterior margin of eye, 2⅛ in head. Dorsal spines higher than in related species, the highest equal to second spine of anal and about half head. Head, 2½; depth, 2½. D. XII, 9. A. III, 5. Lat. l, 26 (pores.)

West Indies, north to Key West.

(Cuv. & Val., IV, 1829, 309; Günther, II, 115; Poey, Syn. Pisc. Cubens. 303.)

The species of *Scorpæna* found in our waters may be readily distinguished by the color of the axillary region as follows:

Guttata: pale, usually unspotted; one or two dark spots behind it.
Plumieri: jet black, with a few large white spots.
Brasiliensis: pale, with several round blackish spots.
Occipitalis: pale, with dark specks, and a black spot above.
Grandicornis: dusky gray, with numerous white stellate spots.

[2] *Scorpæna brasiliensis* Cuv. & Val., V, 105; Günther, II, 312 = *Scorpæna stearnsi* Goode & Bean. South Carolina to Brazil.

[3] *Scorpæna occipitalis* Poey, (Memorias Cuba, II, 171), is probably identical with *Scorpæna calcarata* Goode & Bean.

[4] According to Dr. Bean, *Hemitripterus cavifrons* is not distinct from *H. americanus*.

422.—COTTUNCULUS Collett. (364)

1303. **Cottunculus microps** Collett. B. Eu. (1044)
1304. **Cottunculus torvus**[1] Goode. B. (1045).

423.—ARTEDIUS Girard.

1305. **Artedius lateralis** Girard. C. (1046)
1306. **Artedius notospilotus** Girard. C. (1047)
1307. **Artedius fenestralis**[2] Jordan & Gilbert. A. (365)

424.—ICELUS Kröyer.

1308. **Icelus bicornis**[3] Reinhardt. (1048, 1053, 1083)

425.—ICELINUS[4] Jordan.

1309. **Icelinus quadriseriatus** Lockington. C. (1049)

426.—CHITONOTUS Lockington.

1310. **Chitonotus megacephalus** Lockington. C. (1050)
1311. **Chitonotus pugetensis** Steindachner. A. (1051)

427.—ARTEDIELLUS[5] Jordan.

1312. **Artediellus uncinatus** Reinhardt. G. B. (1052)

428.—URANIDEA De Kay. (366)

Tauridea Jordan & Rice.

1313. **Uranidea ricei** Nelson. Vn. (1054)

Cottopsis Girard.

1314. **Uranidea aspera** Richardson. T. (1055)
1315. **Uranidea semiscabra** Cope. R. (1056)
1316. **Uranidea rhothea** Rosa Smith. T. (1056 *b*.)

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[1] *Cottunculus torvus* is described in full by Goode, Bull. Mus. Comp. Zoöl., XIX, 212. Mr. Goode counts D. VII, 14; A. 13.

[2] *Artedius fenestralis* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 577. Puget Sound.

[3] According to Lütken (Vidensk. Meddels. naturh. Foren. Kjøb., 1876, 92), *Cottus bicornis* Reinhardt is identical with *Icelus hamatus* Kröyer. It is thought by Lütken that *Cottus polaris* Sabine is probably also the same fish, but if so, the description of Sabine is very erroneous. Nos. 1053 and 1083 may therefore be erased, and the species *Icelus hamatus* in the Synopsis may stand as *Icelus bicornis*.

[4] *Icelinus*, genus or subgenus nova for *Artedius quadriseriatus* Lockington, characterized by the peculiar squamation, preopercular armature, and form of the body as described in the Synopsis, p. 691. (Name a diminutive of *Icelus*.)

[5] ARTEDIELLUS Jordan.

(Genus nova; type *Cottus uncinatus* Reinhardt.)

This genus or subgenus differs from *Icelus* proper, apparently its nearest ally, in having the skin naked and smooth. *Centridermichthys* Richardson, an Asiatic genus to which this and other American species have been sometimes referred, has the skin prickly, and a large slit behind the fourth gill, the gill membranes being fully united to the isthmus. (A diminutive of *Artedius*.)

§ *Potamocottus* Gill.

1317. **Uranidea gulosa** Girard. T. (1057)
1318. **Uranidea punctulata** Gill. R. (1058)
1319. **Uranidea bendirei** Bean. R. (1059)
1320. **Uranidea richardsoni** Agassiz. V. (1060)
1320 b. *Uranidea richardsoni bairdi* Girard. Vne.
1320 c. *Uranidea richardsoni kumlieni* Hoy. Vn.
1320 d. *Uranidea richardsoni wilsoni* Girard. Vn.
1320 e. *Uranidea richardsoni alvordi* Girard. Vn.
1320 f. *Uranidea richardsoni meridionalis* Girard. Ve.
1320 g. *Uranidea richardsoni zophera* Jordan. Vs.
1320 h. *Uranidea richardsoni carolinæ* Gill. Vs.
1320 i. *Uranidea richardsoni wheeleri* Cope. R.

§ *Uranidea.*

1321. **Uranidea cognata** Richardson. Vn. (1062)
1322. **Uranidea minuta** Pallas. Y. (1063)
1323. **Uranidea spilota**[1] Cope. Vn. (1062 *b.*)
1324. **Uranidea pollicaris** Jordan & Gilbert. Vn. (1062 *c.*)
1325. **Uranidea marginata** Bean. R. (1064)
1326. **Uranidea viscosa** Haldeman. Ve. (1065)
1327. **Uranidea gracilis** Heckel. Ve. (1066)
1328. **Uranidea gobioides** Girard. Ve. (1067)
1329. **Uranidea boleoides** Girard. Ve. (1068)
1330. **Uranidea franklini** Agassiz. Vn. (1069)
1331. **Uranidea formosa** Girard. Vn. (1069 *b.*)
1332. **Uranidea hoyi** Putnam. Vn. (1070)

429.—**COTTUS** Linnæus. (367)

1333. **Cottus octodecimspinosus**[2] Mitchill. N. (1072)
1334. **Cottus æneus** Mitchill. N. (1073)
1335. **Cottus scorpioides** Fabricius. G. (1074)
1336. **Cottus scorpius** L. G. Eu. (1075)
1336 b. *Cottus scorpius grönlandicus* Cuv. & Val. N. G. (1075 *b.*)
1337. **Cottus polyacanthocephalus**[3] Pallas. A. (1076, 1081)
1338. **Cottus labradoricus** Girard. G. (1077)
1339. **Cottus tæniopterus** Kner. A. (1078)
1340. **Cottus quadricornis** L. G. Eu. (1079)
1341. **Cottus humilis** Bean. A. (1080)
1342. **Cottus axillaris** Gill. A. (1082)
1343. **Cottus platycephalus**[4] Pallas. A. (1084)
1344. **Cottus verrucosus** Bean. A. (1085)
1345. **Cottus niger** Bean. A. (1086)
1346. **Cottus quadrifilis** Gill. A. (1087)

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[1] I have re-examined the type of *Uranidea spilota*. It has now no evident teeth on the palatines and the ventral rays are I, 3. The skin is smooth, and the preopercular spine, although prominent and directed upward, is not hooked. The spots on the body are less sharply defined than in *U. ricei*.

[2] *Cottus bubalis* should be omitted. It is a European species, and it has not yet been found in Greenland, according to Dr. Lütken.

[3] *Cottus jaok* should be omitted. The type, lately examined by Dr. Bean in Berlin, is identical with *Cottus polyacanthocephalus*.

[4] *Cottus platycephalus* Pallas, the type of which has been lately re-examined by Dr. Bean and the writer, is a valid species of *Cottus*. It has no palatine teeth.

430.—GYMNACANTHUS Swainson. (368)

1347. **Gymnacanthus tricuspis**[1] Reinhardt. G.
1348. **Gymnacanthus pistilliger** Pallas. A. (1088)
1349. **Gymnacanthus galeatus** Bean. A. (1089)

431.—TRIGLOPSIS Girard. (369)

1350. **Triglopsis thompsoni** Girard. Vn. (1090)

432.—ENOPHRYS Swainson. (370)

1351. **Enophrys bison** Girard. C. A. (1091)
1352. **Enophrys diceraus**[2] Pallas. A. (1092, 1093)

433.—LIOCOTTUS Girard. (371)

1353. **Liocottus hirundo** Girard. C. (1094)

434.—TRIGLOPS Reinhardt. (372)

1354. **Triglops pingeli** Reinhardt. G. Eu. A. (1095)

435.—PRIONISTIUS[3] Bean.

1355. **Prionistius macellus** Bean. A.

436.—LEPTOCOTTUS Girard. (373)

1356. **Leptocottus armatus** Girard. C. (1096)

437.—HEMILEPIDOTUS Cuvier. (374)

1357. **Hemilepidotus spinosus** Ayres. C. (1097)
1358. **Hemilepidotus jordani** Bean. A. (1098)
1359. **Hemilepidotus hemilepidotus** Tilesius. A. (1099)

438.—MELLETES Bean. (375)

1360. **Melletes papilio** Bean. A. (1100)

439.—SCORPÆNICHTHYS Girard. (376)

1361. **Scorpænichthys marmoratus** Ayres. C. (1101)

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[1] Mr. Dresel observes (Proc. U. S. Nat. Mus., 1884, 251): Dr. T. H. Bean "inclines to the belief that the Greenland form of *Gymnacanthus* (*tricuspis*) does not occur in the Pacific. It is best, therefore, to retain Reinhardt's name, *tricuspis*, for the Atlantic species." A description of *G. tricuspis* is given by Mr. Dresel, l. c. The description in the Synopsis is also from an Atlantic specimen.

[2] *Enophrys claviger* is the young of *E. diceraus*, according to Dr. Bean, who has examined the types of both species.

[3] PRIONISTIUS Bean.

(Bean, Proc. U. S. Nat. Mus., 1883, 355; type *Prionistius macellus* Bean.)

Allied to *Triglops*, differing in the following respects: the much slenderer form; the absence of a series of bony tubercles along the bases of the dorsal fins, the elongation of the exserted pectoral rays so that the lower portion of the fin is considerably longer than the upper, the presence of serrations on all the dorsal spines and on the first soft ray, and the emargination of the caudal fin. Alaska. (*Πριον*, saw; *ἱστιον*, sail; dorsal fin.)

Prionistius macellus Bean, l. c. Coast of British Columbia.

440.—OLIGOCOTTUS Girard. (377)

§ *Clinocottus* Gill.

1362. Oligocottus analis Girard. C. (1102)

§ *Oligocottus.*

1363. Oligocottus maculosus Girard. C. (1103)

§ *Blennicottus* Gill.

1364. Oligocottus globiceps Girard. C. (1104)

441.—BLEPSIAS Cuvier. (378)

1365. Blepsias cirrhosus Pallas. A. (1105)
1366. Blepsias bilobus Cuv. & Val. A. (1106)

442.—NAUTICHTHYS Girard. (379)

1367. Nautichthys oculofasciatus Girard. A. (1107)

443.—RHAMPHOCOTTUS Günther. (380)

1368. Rhamphocottus richardsoni Günther. A. (1108)

Family CXXV—AGONIDÆ (108 *a.*)

444.—ASPIDOPHOROIDES Lacépède. (381)

1369. Aspidophoroides monopterygius Bloch. N. G. (1109)
1370. Aspidophoroides inermis Günther. A. (1110)
1371. Aspidophoroides olriki[1] Lütken. G.
1372. Aspidophoroides güntheri Bean. A.

445.—SIPHAGONUS Steindachner. (382)

1373. Siphagonus barbatus Steindachner. G. (1111)

446.—BRACHYOPSIS[2] Gill. (383)

1374. Brachyopsis rostratus Tilesius. A. (1112)

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[1] *Aspidophoroides olriki* Lütken.

Body short and thick, much less elongate than in the other species of this genus; head broad, the interorbital space concave, as is the median line of the back; lower jaw included; snout with a short spine above; no barbels; shields without spines; breast with about ten conical striate shields. Fins very much larger than in the other species of *Aspidophoroides*, the dorsal fin about as high as long, but little larger than anal. Ventrals small, $2\frac{2}{3}$ in head; pectorals about as long as head. Head $4\frac{2}{5}$; depth 6. D. 6 or 7. A. 6 or 7. V. 1, 2. P. 13. C. 10. L. 4 inches. Greenland, from the stomachs of flounders.

(Lütken, Nordiske Ulkefiske, Vidensk. Meddels. naturh. Foren., Kjöbenhavn, 1876, 385.)

[2] The name *Brachyopsis* should be retained for this genus, instead of *Leptagonus*. "*Leptagonus*" *decagonus*, lately examined by me in Copenhagen, has the gill membranes attached to the isthmus and forming a narrow fold across it. It should, therefore, be referred to *Podothecus*, although in some respects approaching *Agonus*, rendering a reunion of these genera probably necessary.

1375. **Brachyopsis verrucosus** Lockington. C. (1113)
1376. **Brachyopsis xyosternus** Jordan & Gilbert. C. (1114)

447.—BOTHRAGONUS Gill. (385)

1377. **Bothragonus swani** Steindachner. A. (1117)

448.—ODONTOPYXIS Lockington. (386)

1378. **Odontopyxis trispinosus** Lockington. C. (1118)

449.—PODOTHECUS Gill. (387)

§ *Leptagonus* Gill.

1379. **Podothecus decagonus** Bloch & Schneider. G. (1115)

§ *Podothecus.*

1380. **Podothecus vulsus** Jordan & Gilbert. C. (1119)
1381. **Podothecus acipenserinus** Tilesius. A. (1120)

Family CXXVI.—TRIGLIDÆ. (108 *b*.)

450.—PERISTEDION Lacépède. (388)

1382. **Peristedium miniatum.** Goode. B. (1121)
1383. **Peristedium imberbe**[1] Poey. W. B.

451.—PRIONOTUS Lacépède. (390)

§ *Ornichthys* Swainson.

1384. **Prionotus scitulus**[2] Jordan & Gilbert. (1123)
1385. **Prionotus palmipes** Mitchill. N. (1124)
1386. **Prionotus alatus**[3] Goode & Bean. B.

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[1] *Peristedion imberbe* Poey.

Only a very few specimens of this fish are known; all in bad condition, having been taken from the stomachs of deep-water fishes at Havana and Pensacola. Barbels very small, scarcely visible—this character distinguishing the species from the others known in America.

(*Peristedion imberbe* Poey, Memorias, II, 389, 1860. *Peristedion micronemus* Poey, Ann. Lyc. Nat. Hist., IX, 321; Jordan, Proc. U. S. Nat. Mus., 1884.)

[2] I am unable to find any positive evidence of the occurrence of the West Indian *Prionotus punctatus* on the coasts of the United States, all the specimens so named being apparently either *P. scitulus* or *P. palmipes*. *Prionotus punctatus* may therefore be omitted.

[3] *Prionotus alatus* Goode & Bean.

Brownish, with about four faint darker cross-bands; vertical fins uniform, the caudal with a black tip and two paler shades before it; dorsal with the usual black spots; pectorals blotched and clouded. Body rather stout, covered with small, rough scales. Maxillary 3 in head; preopercular, opercular, and humeral spines strong, the latter extending farthest back. Palatine teeth few and feeble. Gill-rakers 1+6, besides some rudiments, the longest 3 in eye. Second dorsal spine longest, half head; first spine strongly serrated in front. Caudal subtruncate. Ninth ray of pectoral longest, reaching base of caudal. Pectoral appendages slender. Head 2½; depth 4, D. X—12. A. 11. P. 13+3. Scales 109; 50 tubes in lat. l. Deep water off Charleston, S. C. (*Goode & Bean.*)

(Goode & Bean, Bull. Mus. Comp. Zoöl., XIX, 1883, 210.)

§ *Prionotus.*

1387. Prionotus ophryas[1] Jordan & Swain. W.
1388. Prionotus stearnsi[2] Jordan & Swain. W.
1389. Prionotus tribulus Cuv. & Val. S. (1125)
1390. Prionotus evolans[3] Linnæus. S. (1126)
1391. Prionotus strigatus[4] Mitchill. N. (1126 *b.*)
1392. Prionotus stephanophrys Lockington. C. B. (1127)

452.—CEPHALACANTHUS Lacépède. (391)

1393. Cephalacanthus volitans Linnæus. N. S. W. (1128)

Family CXXVII.—LIPARIDÆ. (109.)

453.—MONOMITRA[5] Goode. (392)

1394. Monomitra liparina Goode. B. (1129)

454.—CAREPROCTUS Kröyer. (393)

1395. Careproctus gelatinosus Pallas. A. (1130 *b.*)
1396. Careproctus reinhardti Kröyer. G. (1130 *b.*)

455.—LIPARIS Linnæus. (394)

§ *Actinochir* Gill.

1397. Liparis major Walbaum. G. (1131)

§ *Liparis.*

1398. Liparis pulchella Ayres. C. (1132)
1399. Liparis gibba Bean. A (1133)
1400. Liparis tunicata Reinhardt. G. (1135)
1401. Liparis liparis Linnæus. G. N. Eu. (1136)
1401 b. *Liparis liparis arctica* Gill. (1134)
1402. Liparis ranula Goode & Bean. N. B. (1137)
1403. Liparis montaguei Donovan. N. Eu. (1138)
1404. Liparis calliodon Pallas. A. (1139)
1405. Liparis cyclopus Günther. A. (1140)

§ *Neoliparis* Steindachner.

1406. Liparis mucosa Ayres. C. B. (1141)

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[1] *Prionotus ophryas* Jordan & Swain. Proc. U. S. Nat. Mus., 1885. Deep water off Pensacola.

[2] *Prionotus stearnsi* Jordan & Swain, l. c. Deep water off Pensacola, lately discovered by Mr. Silas Stearns.

[3] This species should probably retain the name of *Prionotus evolans*, as adopted in the Synopsis, instead of that of *Prionotus sarritor*, since given it by us (p. 974, Proc. U. S. Nat. Mus., 1882, 615). The type of *Trigla evolans* L., recently examined by Dr. Bean, appears to belong to this species.

[4] *Prionotus strigatus* Cuv. & Val. Described in the Synopsis (p. 736) as *Prionotus evolans lineatus*. Mitchill's name *lineatus*, as stated on page 974, was not given as that of a new species, but through a mistaken identification with the European *Trigla lineata* Bloch.

[5] MONOMITRA Goode.

(Goode, Proc. U. S. Nat. Mus., 1883, 109; type *Amitra liparina* Goode; name a substitute for *Amitra*, preoccupied as *Amitrus*. (*Μονος*, lacking; *μιτρα*, stomacher.)

Family CXXVIII.—CYCLOPTERIDÆ. (110)

456.—CYCLOPTERICHTHYS Steindachner. (395)

1407. Cyclopterichthys ventricosus Pallas. A. (1142)
1408. Cyclopterichthys stelleri Pallas. A. (1143)

457.—EUMICROTREMUS Gill. (395 *b.*)

1409. Eumicrotremus spinosus Müller. A. (1144)

458.—CYCLOPTERUS Linnæus. (396)

1410. Cyclopterus lumpus Linnæus. N. G. Eu. (1145)

Family CXXIX.—GOBIESOCIDÆ. (111)

459.—GOBIESOX Lacépède. (397)

1411. Gobiesox mæandricus Girard. C. (1146)
1412. Gobiesox strumosus Cope. S. (1147)
1413. Gobiesox virgatulus Jordan & Gilbert. S. W. (1147 *b.*)
1414. Gobiesox rhessodon Rosa Smith. P. (1148)
1415. Gobiesox adustus[1] Jordan & Gilbert. P.
1416. Gobiesox zebra[2] Jordan & Gilbert. P.
1417. Gobiesox erythrops[3] Jordan & Gilbert. P.
1418. Gobiesox eos[4] Jordan & Gilbert. P.

Family CXXX.—BATRACHIDÆ. (112)

460.—BATRACHUS Bloch & Schneider. (398)

1419. Batrachus tau Linnæus. N. S. W. (1149)
1419 b. *Batrachus tau pardus* Goode & Bean. S. (1149 *b.*)

461.—PORICHTHYS Girard. (399)

1420. Porichthys margaritatus[5] Richardson. C. (1150)
1421. Porichthys porosissimus[6] Cuv. & Val. W. (1150 *b.*)

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[1] *Gobiesox adustus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 360. Mazatlan, southward.

[2] *Gobiesox zebra* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 359. Mazatlan.

[3] *Gobiesox erythrops* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 360. Mazatlan; Tres Marias.

[4] *Gobiesox eos* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 360. Mazatlan.

[5] *Porichthys margaritatus* (Richardson.)

The Pacific species, found from Vancouver's Island to Panama, most abundant northward. The description on page 751 belongs here, and the names *margaritatus* and *notatus*, as also all Pacific coast references to *P. porosissimus.*

[6] *Porichthys porosissimus* (Cuv. & Val.)

The Atlantic species, found from Surinam to Galveston, Pensacola, and Charleston, distinguished from *P. margaritatus* by the strong, unequal palatine teeth, as described on page 958. The names *porosissimus* and *plectrodon* belong to this species, the only one of its genus yet known from the Atlantic.

Family CXXXI.—TRICHODONTIDÆ. (102 b.)

462.—TRICHODON Steller. (337)

1422. **Trichodon trichodon** Tilesius. A. (975)
1423. **Trichodon japonicus**[1] Steindachner. A.

Family CXXXII.—LEPTOSCOPIDÆ. (113)

463.—DACTYLOSCOPUS Gill. (400)

1424. **Dactyloscopus mundus**[2] Gill. P.
1425. **Dactyloscopus pectoralis**[3] Gill. P.
1426. **Dactyloscopus tridigitatus** Gill. W. (1151)

464.—MYXODAGNUS[4] Gill.

1427. **Myxodagnus opercularis** Gill. P.

Family CXXXIII.—URANOSCOPIDÆ. (103)

465.—UPSILONPHORUS[5] Gill. (338)

1428. **Upsilonphorus y-græcum** Cuv. & Val. S. (976)
1429. **Upsilonphorus guttatus** Abbott. N. S. (977)

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[1] *Trichodon japonicus* Steindachner.

Form of body and coloration of *T. trichodon*. First dorsal high, triangular, formed of ten slender spines, and separated by a long interval from the second dorsal. Preopercle with five sharp spines; the two spines on the preorbital very small. Pectoral well developed, all its rays simple, the lower a little thickened; the fin considerably longer than the head and reaching past the last spine of the dorsal. Anal fin with its rays gradually longer posteriorly. Dentition as in *T. trichodon*, the mouth rather more oblique than in the latter. Head 3⅘: depth 3⅘. D. X–13; A. 31; P. 25; L. 4¼ inches. Strietok, in the sea of Japan, and Sitka, Alaska (*Steindachner*).

(Steindachner, Ichth., Beitr., X, 4, 1881.)

[2] *Dactylagnus mundus* Gill, Proc. Ac. Nat. Sci. Phila., 1862, 505. Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 628. Cape San Lucas to Panama.

We find very small pseudobranchiæ present in living examples of *Dactyloscopus tridigitatus*. Probably none of the family are wholly destitute of these organs.

[3] *Dactyloscopus pectoralis* Gill, Proc. Ac. Nat. Sci. Phila., 1861, 267. Cape San Lucas.

[4] MYXODAGNUS Gill.

(Gill, Proc. Ac. Nat. Sci. Phila., 1861, 269, 270; type *Myxodagnus opercularis* Gill.)

This genus differs from *Dactyloscopus* in the form of the head, which is elongate-conoid, the lower jaw obtusely pointed and provided with a short flap in front. The pseudobranchiæ are well developed and the dorsal fin commences far behind the nape. One species known. (*Myxodes*, a genus of blennies; αγνος, an old name of *Uranoscopus scaber*.) *Myxodagnus opercularis* Gill, l. c., 270. Cape San Lucas.

[5] Instead of genus *Astroscopus* as given in the Synopsis (p. 627) read:

UPSILONPHORUS Gill.

(Gill, Proc. U. S. Nat. Mus., 1861, 113; type *Uranoscopus y-græcum* Cuv. & Val.)

The definition of *Astroscopus* in the text applies entirely to this genus. (*Υψιλον*, ῡ; φορεω, to bear.)

The species of this genus should stand as:

Upsilonphorus y-græcum (C. & V.) Gill.

The comparison made on page 941 between *A. y-græcum* and *A. anoplus* should be suppressed, as the specimens there called *anoplus* were the young of *y-græcum*, and the differences noted are the changes produced by age.

Upsilonphorus guttatus (Abbott) Gill.

This is the species called *Astroscopus anoplus* by Bean (Proc. U. S. Nat. Mus., 1879, 60) and by us in the text on page 629. The original *anoplus* is, however, very different.

466.—ASTROSCOPUS[1] Brevoort.

1430. Astroscopus anoplus Cuv. & Val. S.

Family CXXXIV.—OPISTHOGNATHIDÆ. (103 *b.*)

467.—GNATHYPOPS Gill. (338 *b.*)

1431. Gnathypops rhomaleus[2] Jordan & Gilbert. P.
1432. Gnathypops mystacinus[3] Jordan. W.
1433. Gnathypops maxillosus Poey. W.

468.—OPISTHOGNATHUS Cuv. & Val. (339 *b.*)

1434. Opisthognathus scaphiura Goode & Bean. W. (977 *c.*)
1435. Opisthognathus lonchura Jordan & Gilbert. W. (977 *d.*)
1436. Opisthognathus punctata[4] Peters. P.

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[1] ASTROSCOPUS Brevoort.

(*Agnus* Günther.)

(Brevoort MSS.; Gill, Proc. Ac. Nat. Sci., Phila., 1860, 20; type *Uranoscopus anoplos.* C. & V.)

This genus is distinguished from *Upsilonphorus* chiefly by the armature of the head, which is entirely covered above by a rugose coat of mail as in *Uranoscopus.* In other respects it agrees with *Upsilonphorus,* which should, perhaps, be regarded as a subgeneric section of *Astroscopus.* One species known.

Astroscopus anoplus (Cuv. & Val.).

Jet black above and on lower jaw and spinous dorsal; belly and other fins whitish; top of head with no naked areas except at base of premaxillary; cheeks covered with smooth skin except the narrow suborbital and a long slender preorbital strip lying along the maxillary. A transverse depression behind the eyes; occipital ridges prominent, bluntish. Humeral spine obsolete; preopercle with two blunt processes, the lower turned downwards and forwards. Scales minute, obsolete below; no intralabial filament. Head as broad as deep; head 2½; depth 3¼. D. IV–14; A. 13. New York to Key West. No specimens known more than 2½ inches in length.

Uranoscopus anoplos C. & V., VIII, 493, 1831. *Agnus anoplus* Günther, II, 229 (not *Astroscopus anoplus* of most recent authors).

[2] *Opisthognathus rhomaleus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 276. Gulf of California.

[3] *Gnathypops mystacinus* Jordan, Proc. U. S. Nat. Mus., 1884.

[4] *Opisthognathus punctatus* Peters, Berliner Monatsberichte, 1869; Jordan, Proc. Ac. Nat. Sci. Phila., 1883, 290. Mazatlan.

Head everywhere finely speckled with black, the body more coarsely and irregularly spotted. Pectoral finely and closely speckled, its edge plain. Ventral fin dusky, similarly marked. Dorsal without large black blotch, finely spotted, the spots behind gradually forming the boundaries of white ocelli, the base of the fins having rings of white around black spots, the upper part with dark rings around pale spots. Caudal with pale spots, its edge, like that of the dorsal, somewhat dusky, not black. Anal with a broad, blackish edge, and with dark spots, those near the base of the fin largest. Lining membrane of maxillary with the usual bands of white and inky black.

Scales very small, about 125 in lateral line. Dorsal spines continuous with the soft rays. D. 28; A. 18. No vomerine teeth. Maxillary very long, extending slightly beyond head.

Only the type of this species is yet known.

Family CXXXV.—CHIASMODONTIDÆ. (120 *b.*)

469.—CHIASMODON Johnson. (446)

1437. **Chiasmodon niger** Johnson. B. (1250)

Family CXXXVI.—BLENNIIDÆ. (114)

470.—OPHIOBLENNIUS Gill. (401)

1438. **Ophioblennius webbi** Valenciennes. W. P. (1152)

471.—CHASMODES Cuv. & Val. (402)

1439. **Chasmodes bosquianus** Lacépède. S. (1153)
1440. **Chasmodes quadrifasciatus** Wood. S. (1154)
1441. **Chasmodes saburræ** Jordan & Gilbert. S. (1154 *b.*)

472.—HYPSOBLENNIUS[1] Gill. (403)

1442. **Hypsoblennius brevipinnis**[2] Günther. P.
1443. **Hypsoblennius gentilis** Girard. C. P. (1155 *b.*)
1444. **Hypsoblennius gilberti** Jordan. C. (1155)
1445. **Hypsoblennius punctatus**[3] Wood. S. (1156, 1156 *b.*)
1446. **Hypsoblennius ionthas** Jordan & Gilbert. S. (1156 *c.*)
1447. **Hypsoblennius scrutator** Jordan & Gilbert. S. (1156 *d.*)

473.—HYPLEUROCHILUS Gill. (404)

1448. **Hypleurochilus multifilis** Girard. S. (1157)
1449. **Hypleurochilus geminatus** Wood. S. (1158)

474.—BLENNIUS Linnæus. (405)

§ *Blennius.*

1450. **Blennius stearnsi**[4] Jordan & Gilbert. W. (1159 *b.*)
1451. **Blennius favosus** Goode & Bean. W. (1159 *c.*)
1452. **Blennius asterias** Goode & Bean. W. (1159 *d.*)

§ *Pholis* Cuv. & Val.

1453. **Blennius carolinus** Cuv. & Val. S. (1160)

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[1] The generic name *Hypsoblennius* Gill (Cat. Fish. East Coast U. S., 1861; *H. hentzi*) introduced without definition or explanation is equivalent to *Isesthes* Jordan & Gilbert. If it be thought best to adopt such *nomina nuda*, *Hypsoblennius* has precedence over *Isesthes*.

[2] *Blennius brevipinnis* Günther, Cat. Fishes, III, 226. Mazatlan, southward. This species is a genuine *Isesthes*, as is also the *Blennius striatus* of Steindachner, from Panama.

[3] *Isesthes hentzi* should be erased. It is identical with *Isesthes punctatus*, as given on page 758 of the Synopsis.

[4] *Blennius fucorum* should be erased. It is a tropical species introduced into our faunal lists by DeKay, on information which was probably erroneous.

475.—RUPISCARTES Swainson.[1]

1454. **Rupiscartes chiostictus**[2] Jordan & Gilbert. P.
1455. **Rupiscartes atlanticus**[3] Cuv. & Val. P. W.

476.—EMBLEMARIA[4] Jordan & Gilbert.

1456. **Emblemaria nivipes** Jordan & Gilbert. W. P.

477.—NEOCLINUS Girard. (406)

1457. **Neoclinus satiricus** Girard. C. (406)
1458. **Neoclinus blanchardi** Girard. C. (1162)

478.—LABROSOMUS Swainson.

1459. **Labrosomus nuchipinnis** Quoy & Gaimard. W. (1163)
1459b. *Labrosomus nuchipinnis xanti*[5] Gill. P.
1460. **Labrosomus zonifer**[6] Jordan & Gilbert. P.

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[1] RUPISCARTES Swainson.

(Swainson, Class'n Anim., 1839, II, 275; type *Salarias alticus* C. & V.)

As here understood, this genus differs from *Blennius*, in having the teeth in the jaws slender and movable. From the genus *Salarias* Cuv. (type *S. quadripinnis* Cuv.), which has the same dentition, and to which genus its species have been usually referred, it differs in the presence of posterior canines. Species numerous, in tide pools of the tropics. (Latin, *rupis*, rock; *σκάρτης*, a leaper; "it is said to jump on the sea-rocks like a lizard"; *Swainson.*)

[2] *Salarias chiostictus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 363. Mazatlan.

[3] *Salarias atlanticus* Cuv. & Val., XI, 321; Günther, III, 242. Tropical America, on both coasts, north to Cape San Lucas.

[4] EMBLEMARIA Jordan & Gilbert.

(Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 627; type *Emblemaria nivipes* Jordan & Gilbert.)

Body moderately elongate, not compressed, naked. Ventrals jugular, I, 2. Dorsal fin continuous, beginning at the nape, not confluent with the caudal. Spines and soft rays similar, both much elevated. Head cuboid, formed much as in *Opisthognathus.* Lower jaw very acute at symphysis. A single series of strong, blunt, conical teeth on each jaw and on vomer and palatines. Teeth of vomer and palatines larger, forming a uniform curve. No cirri. Gill openings very wide, the membranes broadly united below, free from the isthmus. One species known. (*Emblema*, a banner (emblem); from the elevated fins.)

Emblemaria nivipes Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 627.

Originally described from the Pearl Islands (Panama). A specimen which we cannot distinguish from this species was obtained at Pensacola by Mr. Silas Stearns. See Proc. U. S. Nat. Mus., 1884.

[5] *Labrosomus xanti* Gill. Proc. Ac. Nat. Sci. Phila., 1860, 107; *Clinus xanti* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 368. Gulf of California, southward. The genus *Labrosomus*, as here understood, differs from *Clinus* chiefly in the absence of the upturned spine-like process on the inner edge of the shoulder girdle, characteristic of the latter genus and *Heterostichus.* This process is found on *Clinus acuminatus*, the type of the genus *Clinus.*

[6] *Clinus zonifer* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 361. Mazatlan.

479.—TRIPTERYGION[1] Risso.

1461. Tripterygion carminale[2] Jordan & Gilbert. P.

480.—CLINUS Cuv. & Val. (407)

§ *Gibbonsia* Cooper.

1462. Clinus evides Jordan & Gilbert. C. (1164)

481.—HETEROSTICHUS Girard. (408)

1463. Heterostichus rostratus Girard. C. (1165)

482.—CREMNOBATES Günther. (409)

1464. Cremnobates altivelis[3] Lockington. P.
1465. Cremnobates marmoratus Steindachner. W. (1166*b*.)
1466. Cremnobates fasciatus[4] Steindachner. W.
1467. Cremnobates affinis[5] Steindachner. W.

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[1] TRIPTERYGION Risso.

(Risso, Europe Méridion. 1826, III, 241; type *Blennius tripteronotus* Risso.) This genus is allied to *Clinus*, differing chiefly in the division of the dorsal fin into three nearly or quite separate fins, the anterior of 3 to 6 spines, the median one of many spines and the last of many soft rays. Warm seas in tide-pools. (*Τρεῖς*, three; *πτερύγιον*, fin.)

[2] *Tripterygium carminale* Jordan & Gilbert, Proc. U. Nat. Mus., 1881, 362. Mazatlan to Panama.

[3] *Cremnobates altivelis* Lockington, Proc. Ac. Nat. Sci. Phila., 1881. Gulf of California.

[4] *Cremnobates fasciatus* Steindachner.

Light pinkish-brown, much mottled, and with 6 or 8 darker bars; sides of head marbled with whitish, its cirri pale; 3 black spots behind and below eye; dorsal pale, with 9 blackish blotches extending from the bands on the sides; in the next the last of these is a large blue-black spot ocellated with orange; anal with 5 dark blotches and no ocellus; a dark band across base of caudal; caudal otherwise pale yellowish with dark dots. Pectorals whitish, barred with black; its base with a whitish area; with a brown center, below which is a small black spot. Ventrals barred. Body rather slender, a little deeper than as in *C. integripinnis*, the snout less acute than in *C. marmoratus*. First dorsal spine rather higher than second, and lower than the spines of posterior part of fin; membrane of third spine joining second dorsal at a point above its base, the two parts of the fin therefore separated only by an emargination. Tentacle above eye slender, small; cirri on side of occiput bluish. Head 4; depth 4½. D. III, 24, 1. A. II, 18. Lat. l. 37. L. 2 inches. Florida Straits; north to Key West.

(Steindachner, Ichth. Beitr, V, 1876, 176). For a comparison of our species of *Cremnobates*, see Jordan, Proc. U. S. Nat. Mus., 1884, 142.)

[5] *Cremnobates affinis* Steindachner.

Dark brown, paler than in *C. nox*, but darker and more uniform than in *C. fasciatus;* lower side of head pearly gray, thickly speckled with darker; sides with 5 very faint darker cross-bands; dorsal and anal dusky, the latter with a pale edge; between the 18th and 22d dorsal spines a large dark spot ocellated with yellowish; caudal yellowish white, with darker cross-streaks; a blackish band at its base; pectoral dusky at base, its posterior half yellowish, with darker cross-streaks; ventral similar. A wedge-shaped whitish band extending backward from eye to opercle. Form of *C. integripinnis;* maxillary reaching to below posterior margin of eye; a fringed tentacle above eye and one on each side of occiput. First dorsal low, its longest (second) ray

1468. **Cremnobates integripinnis** Rosa Smith. C. P. (1166)
1469. **Cremnobates nox**[1] Jordan & Gilbert. W.

483.—CHIROLOPHUS Swainson. (410)

1470. **Chirolophus polyactocephalus**[2] Pallas. A. (1167)

484.—MURÆNOIDES[3] Lacépède. (411)

1471. **Muræenoides gunnellus** Linnæus. N. G. Eu. (1168)
1472. **Muræenoides fasciatus** Bloch & Schneider. G. (1169)
1473. **Muræenoides ornatus** Girard. A. (1170)
1474. **Muræenoides maxillaris** Bean. A. (1171)
1475. **Muræenoides dolichogaster** Pallas. H. (1172)

485.—APODICHTHYS Girard. (412)

1476. **Apodichthys flavidus** Girard. C. (1174)
1477. **Apodichthys fucorum** Jordan & Gilbert. C. (1175)
1478. **Apodichthys univittatus**[4] Lockington. P.

486.—ANOPLARCHUS Gill. (413)

1479. **Anoplarchus atropurpureus**[5] Kittlitz. C. A. (1176)

487.—XIPHISTER Jordan. (414)

1480. **Xiphister chirus** Jordan & Gilbert. C. (1178)
1481. **Xiphister mucosus**[6] Girard. C. (1179)
1482. **Xiphister rupestris** Jordan & Gilbert. C. (1180)

488.—CEBEDICHTHYS Ayres. (415)

1483. **Cebedichthys violaceus** Girard. C. (1181)

489.—EUMESOGRAMMUS Gill. (416)

1484. **Eumesogrammus præcisus** Kröyer. G. (1182)
1485. **Eumesogrammus subbifurcatus** Storer. N. (1183)

490.—STICHÆUS Reinhardt. (417)

1486. **Stichæus punctatus** Fabricius. G. (1184)

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shorter than the highest of second dorsal; membrane of third spine joining the fourth spine just above its base. Last ray of second dorsal joined by membrane to base of caudal. Head 4; depth 4⅝, D. III, 27, I. A. II, 19. V. 1, 2. Lat. l. 33 to 35. Key West; St. Thomas.

(Steindachner, Ichthyologische Beiträge, V, 178, 1876. Jordan, l. c., 142.)

[1] *Cremnobates nox* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 30. Key West.

[2] *Blennius polyactocephalus* Pallas, lately rediscovered by Mr. Nelson in Alaska, proves to be, as supposed in the Synopsis, a genuine species of *Chirolophus*.

[3] I here omit *Muræenoides* (*Asternopteryx*) *gunelliformis*. It is not certain that the single known specimen is a *Muræenoides* or that it is from American waters.

[4] *Apodichthys univittatus* Lockington, Proc. Ac. Nat. Sci. Phila., 1881, 118. Gulf of California.

[5] *Anoplarchus alectrolophus* should not have been inserted. It is an Asiatic species, not found within our limits.

[6] The type of *Xiphidium cruoreum* Cope, examined by Mr. Meek, is identical with *X. mucosus*.

491.—**NOTOGRAMMUS** Bean. (418)

1487. **Notogrammus rothrocki** Bean. A. (1185)

492.—**LEPTOCLINUS** Gill.

1488. **Leptoclinus maculatus** Fries. G. (1186)

493.—**LUMPENUS** Reinhardt. (419)

1489. **Lumpenus medius** Reinhardt. G. (1187)
1490. **Lumpenus anguillaris** Pallas. A. (1188)
1491. **Lumpenus lumpenus** Müller. G. (1189)

494.—**LEPTOBLENNIUS** Gill. (420)

1492. **Leptoblennius nubilus** Richardson. G. (1190)
1493. **Leptoblennius serpentinus** Storer. N. (1191)
1494. **Leptoblennius lampetræformis** Walbaum. G. (1192)

495.—**PHOLIDICHTHYS** [1] Bleeker.

1495. **Pholidichthys anguilliformis** Lockington. P.

Family CXXXVII.—CRYPTACANTHODIDÆ.[2]

496.—**DELOLEPIS** Bean. (421)

1496. **Delolepis virgatus** Bean. A. (1193)

497.—**CRYPTACANTHODES** Storer. (422)

1497. **Cryptacanthodes maculatus** Storer. N. (1194)

Family CXXXVIII.—ANARRHICHADIDÆ.[2]

498.—**ANARRHICHAS** Linnæus. (423)

1498. **Anarrhichas lupus** Linnæus. N. Eu. (1195)
1499. **Anarrhichas minor** Olafsen. G. Eu. (1196)
1500. **Anarrhichas latifrons** Steenstrup & Halgrimsson. G. Eu. (1197)
1501. **Anarrhichas lepturus** Bean. A. (1198)

499.—**ANARRHICHTHYS** Ayres. (424)

1502. **Anarrhichthys ocellatus** Ayres. C. (1199)

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[1] PHOLIDICHTHYS Bleeker.

(Bleeker, Boeroe, 406; type *Pholidichthys leucotænia* Bleeker.)

Body elongate, tapering, naked; snout obtuse; no cirri. Teeth unequal, on jaws only. Dorsal, anal, and caudal fins distinct, but connected by membrane, the dorsal formed of flexible spines. Ventrals inserted scarcely before the pectorals, of two rays. Two species known, of the tropical parts of the Pacific. (Φολίς, Pholis; ἰχθύς, fish.)

Pholidichthys anguilliformis Lockington, Proc. Ac. Nat. Sci. Phila., 1881, 118. Dredged off Amortiguado Bay, Gulf of California.

[2] There seems to be no doubt that the families of *Cryptacanthodidæ* and *Anarrhichadidæ* at least, should be detached from the *Blenniidæ*. Whether the latter group should be further subdivided or not, I am not certain. In the northern types (*Xiphisterinæ*, *Stichæinæ*) the vertebræ are much more numerous than in the tropical *Clininæ* and *Blenniinæ*.

Family CXXXIX.—LYCODIDÆ. (115)

500.—ZOARCES Cuvier. (425)

1503. Zoarces anguillaris Peck. N. G. (1200)

501.—LYCODOPSIS Collett. (426)

1504. Lycodopsis pacificus Collett. C. A. (1201)
1505. Lycodopsis paucidens Lockington. C. (1202)

502.—LYCODONUS[1] Goode & Bean.

1506. Lycodonus mirabilis Goode & Bean. B.

503.—LYCENCHELYS[2] Gill.

1507. Lycenchelys paxillus Goode & Bean. B. (1203)
1508. Lycenchelys paxilloides[3] Goode & Bean. B.
1509. Lycenchelys verrilli Goode & Bean. B.

504.—LYCODES Reinhardt. (427)

1510. Lycodes vahli Reinhardt. B. G. (1205)
1511. Lycodes esmarki Collett. B. G. Eu. (1206)
1512. Lycodes reticulatus Reinhardt. B. G. (1207)
1513. Lycodes seminudus Reinhardt. B. G. (1208)
1514. Lycodes nebulosus Reinhardt. G. (1209)
1515. Lycodes coccineus Bean. A. (1210)

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[1] LYCODONUS Goode & Bean.

(Goode & Bean, Bull. Mus. Comp., Zoöl., XIX, 1883, 208; type *Lycodonus mirabilis* Goode & Bean.)

Body elongate, formed as in *Lycenchelys*. Scales small, circular, imbedded in the skin; lateral line very short, obsolete posteriorly. Jaws without fringes, lower jaw included. Fin rays all articulated, each ray of dorsal and anal supported laterally by a pair of sculptured scutes. Caudal distinct, not fully connate with dorsal and anal. Ventrals present. Gill opening narrow. Teeth as in *Lycodes*. Deep water (*Lycodes; Onos*).

Lycodonus mirabilis Goode & Bean.

Form of *Lycenchelys verrilli*, very slender; head, nape, and fins scaleless; maxillary reaching front of pupil. Dorsal inserted slightly behind base of pectorals. Length of pectorals 3 times snout. Eye 2½ in head, 3½ times interorbital width. Head 7; depth 18. D. 80 +. A. 70 +. Gulf Stream, lat. 40°.

(Goode & Bean, Bull. Mus. Comp. Zoöl., XIX, 1883, 208.)

[2] LYCENCHELYS Gill.

(Gill, Proc. Ac. Nat. Sci., Phila., 1884, 180; type *Lycodes muræna* Collett.)

This name *Lycenchelys* may be used for Collett's second group, which have the body elongate; height of the body contained from 12 to 24 times in the total length (*Gill*). (*Λύκος*, wolf; ἔγχελυς, eel.)

[3] *Lycenchelys paxilloides* Goode & Bean.

Light brown, the head somewhat darker. Form of *L. paxillus*, but with a smaller mouth and less prominent cheeks. Dorsal beginning over tip of pectoral; ventral little longer than pupil. Scales very small, present everywhere except on head and pectorals, nearly covering vertical fins. Eye 3½ in head, equal to snout, which is 4 times interorbital width. Head 8, depth 16. D. (with half caudal) 118. A. 110. P. 16. V. 3. Gulf Stream, lat. 40°, in deep water (*Goode & Bean*).

(*Lycodes paxillus* Goode & Bean, Bull. Mus. Comp. Zoöl., XIX, 1883, 207.)

505.—LYCODALEPIS Bleeker. (428)

1516. Lycodalepis mucosus Richardson. G. (1211)
1517. Lycodalepis turneri Bean. A. (1212)
1518. Lycodalepis polaris Sabine. G. (1213)

506.—GYMNELIS Reinhardt. (429)

1519. Gymnelis viridis[1] Fabricius. G. A. (1214, 1215?)

507.—LYCOCARA[2] Gill. (430)

1520. Lycocara parrii Ross. G. (1216)

508.—MELANOSTIGMA[3] Günther.

1521. Melanostigma gelatinosum Günther. B.

Family CXL.—CERDALIDÆ.[4]

509.—MICRODESMUS.[5] Günther.

1522. Microdesmus dipus Günther. P.

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[1] I here omit *Gymnelis stigma*. It is probably based on an inaccurate description of *Gymnelis viridis*. If, however, really possessing scales, it may belong to the Antarctic genus *Maynea* (Cunningham), which differs from *Lycodes* chiefly in the absence of ventrals.

[5] LYCOCARA Gill.

(Gill, Proc. Ac. Nat. Sci. Phila., 1884, 180; type *Ophidium parrii* Ross.)

This name is a substitute for *Uronectes*, which is preoccupied. (*Λυκος*, wolf; *κάρα*, head.)

[3] MELANOSTIGMA Günther.

(Günther, Proc. Zoöl. Soc. Lond., 1881, 21; type *Melanostigma gelatinosum* Günther.)

Allied to *Gymnelis;* "technically distinguished by the much more elongate teeth, which in the jaws, as well as on the vomer and palatines, stand in single series." Gill openings much smaller than in related forms, reduced to a small foramen above the base of the pectoral. Skin loose and movable, as in *Liparis*, enveloping the vertical fins; pectorals very small; ventrals, none. Body tapering very rapidly backward; the tail very slender. Deep sea. (*Μελας*, black; *στιγμα*, spot.)

Melanostigma gelatinosum Günther.

Purplish above; sides grayish, marbled with darker, the end of the tail almost black. Head large, deep, compressed; the snout blunt. Eye large, 3½ in head, longer than snout. Cleft of mouth oblique, the maxillary reaching a little past front of pupil, the lower jaw not projecting. Inside of mouth, gill openings and vent black. Dorsal beginning above middle of pectoral, low in front, becoming higher than the part of the body below it posteriorly. Head 6½. Deep waters of the Atlantic; Martha's Vineyard; Straits of Magellan.

(Günther, Proc. Zoöl. Soc. London, 1881, 21; Goode & Bean, Bull. Comp. Zoöl., XIX, 1883, 209.)

[4] I suggest the provisional name *Cerdalidæ* for two closely related genera, *Cerdale* Jordan & Gilbert, and *Microdesmus* Günther, which seem to be allied to the *Lycodidæ*, differing in the small, slit-like gill openings and in the non-isocercal tail. The three known species are scantily represented in collections, and until their osteology is examined we cannot be sure as to their relation to the *Lycodidæ*, *Congrogadidæ*, and *Brotulidæ*.

[5] MICRODESMUS Günther.

Günther, Proc. Zool. Soc., London, 1864, 26; type *Microdesmus dipus* Günther.)

Body anguilliform, covered with rudimentary scales. Head small, with short snout and small mouth; lower jaw projecting. Teeth minute, in jaws only. Gill opening reduced to a very narrow, somewhat oblique slit, in front of lower part of pectorals. Vertical fins well developed, the dorsal and anal joined to the caudal by a thin mem-

Family CXLI.—CONGROGADIDÆ. (116)

510.—SCYTALISCUS[1] Jordan & Gilbert. (431)

1523. Scytaliscus cerdale Jordan & Gilbert. A. (1217)

Family CXLII.—FIERASFERIDÆ. (117)

511.—FIERASFER Cuvier. (432)

1524. Fierasfer dubius[2] Putnam. P. W. (1218)

Family CXLIII.—OPHIDIIDÆ. (118)

512.—OPHIDION Linnæus. (433)

1525. Ophidion marginatum[3] Dekay. S. W. (1219, 1220)
1526. Ophidion holbrooki Putnam. W. (1221)
1527. Ophidion beani[4] Jordan. W. (1221 *b.*)

513.—OTOPHIDIUM[5] Gill. (433 *b.*)

1528. Otophidium taylori Girard. C. (1222)
1529. Otophidium omostigma Jordan & Gilbert. W. (1223 *b.*)

514.—LEPTOPHIDIUM Gill.

1530. Leptophidium profundorum Gill. W. B. (1223)

Family CXLIV.—BROTULIDÆ.[6] (119)

515.—BYTHITES Reinhardt. (434)

1531.—Bythites fuscus Reinhardt. G. (1224)

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brane. Tail not isocercal. Rays of dorsal all articulate; all but a few of the last simple. Ventral fins very small, reduced to a single ray. Pectorals moderate. Vent normal. Pacific coast of tropical America. (Μικρος, small; δεσμος, a band.)

Microdesmus dipus Günther, l. c.

Gulf of California to Panama. The two remaining species of this family, *Microdesmus retropinnis* and *Cerdale ionthas*, both from Panama, are described by Jordan & Gilbert, Bull. U. S. Fish Comm., 1881, 331.

[1] SCYTALISCUS Jordan & Gilbert.

Proc. U. S. Nat. Mus., 1883, 111; name a substitute for *Scytalina*, preoccupied in *Coleoptera* as *Scytalina* Erichson. It is doubtful whether this genus is really an ally of *Congrogadus*.

[2] *Fierasfer dubius* Putnam = *Fierasfer arenicola* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 363. Mazatlan. See Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 629.

[3] *Ophidium josephi* Girard and *Ophidium graëllsi* Poey (not of Jor. & Gilb.) seem to be identical with *O. marginatum*.

[4] The species described in the Synopsis as *Ophidium graëllsi* should stand as *Ophidion beani* Jordan & Gilbert. See Proc. U. S. Nat. Mus., 1883, 143.

[5] OTOPHIDIUM Gill, gen. nov.

Type *Genypterus omostigma* Jordan & Gilbert. This genus differs from *Ophidium* in the presence of a sharp concealed spine on the opercle. The typical species has been wrongly referred to *Genypterus*.

[6] The Brotuline genera (*Bythites* and *Dinematichthys*) have been erroneously placed in the Synoposis among the *Gadidæ*. For the characters of the *Brotulidæ* see Gill, Proc. Ac. Nat. Sci. Phila., 1863, 252; 1864, 200, and 1884, 169, 175. These fishes are certainly much nearer the *Ophidiidæ*, or even the *Lycodidæ*, than the *Gadidæ*.

516.—DINEMATICHTHYS Bleeker. (435)

§ *Brosmophycis* Gill.

1532. Dinematichthys marginatus Ayres. C. (1225)
1533. Dinematichthys ventralis[1] Gill. P.

517.—BARATHRODEMUS[2] Goode & Bean.

1534. Barathrodemus manatinus Goode & Bean. B.

518.—DICROLENE[3] Goode & Bean. B.

1535. Dicrolene intronigra Goode & Bean. B.

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[1] *Brosmophycis ventralis* Gill, Proc. Ac. Nat. Sci. Phila., 1863, 253. Cape San Lucas, southward.

[2] BARATHRODEMUS Goode & Bean.

(Goode & Bean, Bull. Mus. Comp. Zoöl., XIX, 1883, 200; type *Barathrodemus manatinus* G. & B.)

Body brotuliform, much compressed; head compressed; mouth moderate. Head unarmed, except for a short flattened spine at upper angle of opercle. Snout long, projecting far beyond premaxillaries, its tip much swollen; jaws subequal in front. Teeth minute, in villiform bands on jaws, vomer and palatines. No barbels. Anterior nostrils on the outer angles of the dilated snout, circular, each surrounded by a cluster of mucous tubes. Posterior nostrils above front of eye. Gill openings wide, the membranes not united. Gill-rakers rather few. Body and head covered with small, thin, scarcely imbricated scales. Dorsal and anal long. Caudal fin separate, long, and slender. Ventrals close together, far in front of pectorals, each reduced to a single bifid ray. Deep-sea fishes. (*βάραθρον*, a gulf or deep abyss; *δῆμος*, people.)

Barathrodemus manatinus Goode & Bean.

Grayish brown; abdomen black. Snout longer than eye, its form resembling that of the manatee. Maxillary reaching to opposite front of eye, its length 2½ in head. Eye 5¼ in head. Insertion of dorsal above that of pectoral. Ventrals inserted nearly below middle of opercle, their length half head. Head 6; depth 7½. D. 106; A. 86; C + 5 +; Lat. l. 175. Gulf Stream, latitude 33°. (*Goode & Bean.*)

(Goode & Bean, Bull. Mus. Comp. Zoöl., XIX, 1883, 200.)

[3] DICROLENE Goode & Bean.

(Goode & Bean, Bull. Mus. Comp. Zoöl., 1883, 202, XIX; type *Dicrolene introniger* G. & B.)

Body brotuliform, moderately compressed; head somewhat compressed, the mouth large; tip of maxillary much dilated. Eye large, placed high. Head with supraorbital spines; several strong spines on the preopercle and one long spine at upper angle of opercle. Snout short, not projecting; jaws subequal. Teeth in narrow, villiform bands on jaws, head of vomer, and on palatines. No barbel. Gill membranes separate. Caudal fin small, separate. Dorsal and anal fins long. Pectoral with several of its lower rays separate and very much produced. Ventrals close together, under front of operculum, each composed of a single bifid ray. Head and body covered with small scales. Lateral line incomplete. Stomach siphonal; pyloric cæca rudimentary; intestine short. Deep water. (*Δίκροος*, forked; *ὠλένη*, arm.)

Dicrolene introniger Goode & Bean.

Opercular spine with its exposed portion half as long as eye, which is as wide as interorbital space, and 4 in head. Mouth large, the maxillary extending beyond eye, its length considerably more than half head; width of expanded tip of maxillary ⅘ eye. Bones of head with large muciferous cavities. Length of caudal half distance from

519.—BASSOZETUS Gill.[1]

1536. **Bassozetus normalis** Gill. B.

Family CXLV.—GADIDÆ. (120)

520.—RHINONEMUS Gill.

1537. **Rhinonemus cimbrius** Linnæus. N. En. (1226)

521.—ONOS[2] Risso. (436)

1538. **Onos reinhardti** Kröyer. G. (1227)
1539. **Onos ensis** Reinhardt. G. (1228)
1540. **Onos rufus**[3] Gill. B.
1541. **Onos septentrionalis**[4] Collett. G. En.

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snout to front of dorsal. Eight lower rays of pectorals free, much prolonged, the longest and most anterior being nearly one-third length of body and more than three times length of the nearest of the normal rays, which are, however, about equal to the least of the free rays; normal rays of pectorals 4 in body. Head 5; depth 6. D. 100; A. *ca.* 85, C. 7; P. 19 + 7; Lat. l. *ca.* 115. Gulf Stream, latitude 34°. (*Goode & Bean.*)

(Goode & Bean, l. c. 202.)

[1] BASSOZETUS Gill.

(Gill, Proc. U. S. Nat., Mus., 1883, 259; type *Bassozetus normalis* Gill.)

"Dinematichthyine brotulids with a slender body; a narrow differentiated caudal fin; anus about a third of the total length from the snout; small eyes, and unarmed head and shoulders." Deep sea. (*βάθθων*, deep; *ζήτων*, seeker.)

Bassozetus normalis Gill. Deep water; latitude 39°.

(Gill, l. c. 259.)

The descriptions, generic and specific in this paper, "Diagnoses of new Genera and Species of Deep-sea Fish-like vertebrates," are among the most brief and unsatisfactory in our ichthyological literature. This paper, by a most able and competent ichthyologist, from the brief and superficial character of its descriptions, is likely to cause great confusion in the study of the Bassalian fauna of the Atlantic, unless soon followed by accurate and sufficient descriptions.

[2] "The *Lotinæ*, and apparently the *Oninæ*, have doubled or paired frontals. * * * It seems probable that they may be segregated in a peculiar family." Gill, Proc. Ac. Nat. Sci. Phila., 1884, 172.

[3] *Onos rufus* Gill.

Color in life almost uniform salmon or brick-red; barbels three; enlarged dorsal ray not shorter than head; some enlarged brown-colored teeth developed in the exterior row. Closely allied to *O. ensis*, but apparently different in color. Deep sea, latitude 40°. (*Gill.*)

(Gill, Proc. U. S. Nat. Mus., 1883, 259.)

[4] *Onos septentrionalis* Collett.

Three barbels, two at the nostrils, one at the chin, besides a row of about eight shorter rudimentary barbels along the edge of the upper lip; eye small, half length of snout; cleft of mouth extending far beyond eye, its length nearly equal to that of postorbital part of head; teeth rather small, unequal; outer teeth of upper jaw and some of the inner teeth of lower enlarged; first ray of first dorsal short, about as long as snout; vent midway between tip of snout and last anal ray; lateral line with about 20 large pores, grayish brown, paler below; cavity of mouth white. D. 50; A. 42; P. 16. Coast of Norway; one specimen known from Greenland. (*Collett.*)

(*Motella septentrionalis* Collett, Ann. Mag. Nat. Hist., 15, 82, 1874; *Onos septentrionalis* Collett, Norske Nord-Havs Exped., 1880, 139.)

522.—LOTA Cuvier. (441)

1542. Lota lota maculosa Le Sueur. Vv. Eu. (1236)

523.—PHYCIS Bloch & Schneider. (437)

1543. Phycis regius Walbaum. N. S. (1229)
1544. Phycis floridanus[1] Bean & Dresel. S.
1545. Phycis earlli Bean. S. (1230)
1546. Phycis chuss Walbaum. N. (1231)
1547. Phycis tenuis Mitchill. N. (1232)
1548. Phycis chesteri Goode & Bean. B. (1233)

524.—LÆMONEMA[2] Günther.

1549. Læmonema barbatula Goode & Bean. B.

525.—ANTIMORA[3] Günther. (438)

1550. Antimora viola Goode & Bean. B. (1233 *b.*)

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[1] PHYCIS FLORIDANUS Bean & Dresel.

In general appearance it resembles *P. regius*, differing from this in its smaller scales and more numerous dorsal rays. The greatest height is one-fifth of the total length to caudal base, and equals four-fifths of the length of head. Head 4 times in length to caudal base; eye slightly less than snout, 5 times in length of head; maxilla slightly less than mandible, one-half length of head. First dorsal not produced; ventral about five-fourths length of head; pectoral equal to head in length. Dorsal 13, 57; Anal, 49. Scales between first dorsal and lateral line in nine or ten rows; about 120 scales in the lateral line; L. 7¼ inches. Pensacola. (*Bean & Dresel.*)

(Bean & Dresel, Proc. Biol. Soc. Wash., 1884, 100.)

[2] LÆMONEMA Günther.

(Günther, IV, 356, 1862; type *Phycis yarrelli* Lowe.)

This genus is scarcely distinct from *Phycis*, differing chiefly in the character of the first dorsal, which is composed of five rays only, the anterior ray being filamentous. Deep water. (*Λαιμος*, throat; *νῆμα*, thread.)

Læmonema barbatula Goode & Bean.

Color of species of *Phycis*; dorsal and anal with narrow black margins. Eye 3 in head; upper jaw a little more than 2; barbel half as long as eye; vent under 6th ray of spinous dorsal; first ray of first dorsal elongate, about 3 times length of caudal, about reaching 24th ray of second dorsal. Distance from snout to front of anal twice length of head; ventrals as long as pectorals, not reaching vent; scales small, very thin, deciduous. D. 5–63. A. 59. P. 19. V. 2. Scales 13–140, 31. L. 7 inches. Gulf Stream, latitude 32°, in deep water. (*Goode & Bean.*)

(*Læmonema barbatula* Goode & Bean, Bull. Mus. Comp. Zoöl., XIX, 204.)

[3] *Haloporphyrus viola* belongs to the subgenus *Antimora* (Günther, Ann. Mag. Nat. Hist., 1878, 2; type *Haloporphyrus rostratus* Günther). This group differs from *Haloporphyrus* "in the form of the snout, the backward position of the vent, the imperfect division of the anal, in which latter respect it approaches *Mora*." In *Haloporphyrus* the snout is subconical, obtusely rounded; in *Antimora* it forms a flat, triangular lamina, sharply keeled at the sides, resembling the snout of *Macrurus*. The diagnosis of *Haloporphyrus* given in the Synopsis (p. 800) applies to *Antimora* and not to *Haloporphyrus*.

In the very brief description of *Haloporphyrus rostratus* Günther, l. c. (from the mid-Atlantic east of Rio de la Plata), there is nothing by which our species can be distinguished from it. It is probable that the two will prove identical. *A. rostrata* has five months' priority in date over *A. viola*.

526.—PHYSICULUS[1] Kaup. (439)

1551. Physiculus fulvus Bean. B.

527.—LOTELLA[2] Kaup.

1552. Lotella maxillaris Bean. B.

528.—MOLVA Nilsson. (440)

1553. Molva molva Linnæus. G. Eu. (1235)

529.—BROSMIUS Cuvier.

1554. Brosmius brosme Müller. N. G. Eu. (1237)

530.—MELANOGRAMMUS[3] Gill.

1555. Melanogrammus æglefinus Linnæus. N. G. Eu. (1238)

531.—GADUS Linnæus. (443)

1556. Gadus callarias Linnæus. N. G. A. Eu. (1239)
1557. Gadus ogac [4] Richardson. G.

532.—PLEUROGADUS[5] Bean.

1558. Pleurogadus navaga Kölreuter. A. (1240)

533.—MICROGADUS Gill.

1559. Microgadus proximus Girard. C. (1241)
1560. Microgadus tomcod Walbaum. N. (1242)

534.—POLLACHIUS Nilsson.

§ *Pollachius.*

1561. Pollachius virens Linnæus. N. Eu. (1243)
1562. Pollachius chalcogrammus Pallas. A. (1244)

§ *Boreogadus* Günther.

1563. Pollachius saida Lepechin. G. A. Eu. (1245)

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[1] *Physiculus dalwigkii* was included in the Synopsis on the basis of an erroneous identification. It should be omitted. A species of *Physiculus* has, however, been recently found. *Physiculus fulvus* Bean, Proc. U. S. Nat. Mus., 1884, 240. Gulf Stream, latitude 40,° in 76 fathoms.

[2] LOTELLA Kaup.

(Kaup, Wiegmann's Archiv, 1858, 88; type *Lotella schlegeli* Kaup.)

This genus differs from *Physiculus* chiefly in the presence in both jaws of an outer row of large teeth. Deep sea. (Name, a diminutive of *Lota.*)

Lotella maxillaris Bean, Proc. U. S. Nat. Mus., 1884, 241. Gulf Stream, latitude 40°.

[3] It seems best to regard the different sections of *Gadus*, as given in the Synopsis, as distinct genera. *Melanogrammus*, especially, is well distinguished by the swollen form of the bones of the shoulder girdle.

[4] For description of *Gadus ogac*, which is regarded by Mr. Dresel as a valid species, see Dresel, Proc. U. S. Nat. Mus., 1884, 246.

(*Gadus ogac* Richardson, Fauna Bor.-Amer., III, 1836, 246. Greenland.

[5] *Pleurogadus* Bean, nom. gen. nov. to be substituted for *Tilesia*, preoccupied. Type *Gadus navaga* Kölreuter = *Gadus gracilis* Tilesius. (*Bean.*)

535.—HYPSICOMETES Goode. B. (444)

1564. **Hypsicometes gobioides** Goode. B. (1246)

536.—MERLUCIUS Rafinesque. (445)

1565. **Merlucius bilinearis** Mitchill. N. (1247)
1566. **Merlucius merlucius** Linnæus. G. Eu. (1248)
1567. **Merlucius productus** Ayres. C. (1249)

Family CXLVI.—MACRURIDÆ. (121)

537.—MACRURUS Bloch. (447)

1568. **Macrurus berglax**[1] Lacépède. G. Eu. B. (1251)
1569. **Macrurus acrolepis**[2] Bean. A.
1570. **Macrurus carminatus** Goode. B. (1252)
1571. **Macrurus bairdii** Goode & Bean. B. (1253)
1572. **Macrurus asper**[3] Goode & Bean. B.

538.—CORYPHÆNOIDES Gunner (448)

1573. **Coryphænoides rupestris** Gunner. G. B. (1254)
1574. **Coryphænoides carapinus**[4] Goode & Bean. B.

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[1] *Macrurus berglax* Lacépède = *Macrurus fabricii* Sundevall. To the synonymy add: (*Macrurus berglax* Lacépède, Hist. Nat. Poiss., based on *Macrurus rupestris* Bloch, not of Gunner; the synonymy confused with that of *Coryphænoides rupestris*, which is called "Berglax" ("Rock-Salmon") by Ström.

[2] *Macrurus acrolepis* Bean.

Form of *M. berglax*; width of head ⅘ its height; interorbital width ⅘ eye, which is equal to length of snout, and nearly 4 in head; snout moderate, pointed; maxillary a little more than ⅓ head; second ray of dorsal serrated; distance of anal from snout 2½ in body; pectoral nearly half head; ventral 8 in total length. Head, 4⅘. Depth, 7. D. II, 11, III +. A. 94 +; 7 rows of scales between lateral line and front of dorsal. L. 2½ feet. Straits of Juan de Fuca. A specimen obtained from the stomach of a seal by Mr. J. G. Swan. (*Bean.*)

(Bean, Proc. U. S. Nat. Mus., 1883, 362.)

[3] *Macrurus asper* Goode & Bean.

Dark reddish brown, the spinules with a metallic luster; stouter than in *M. bairdii;* scales small, strong, their free portions covered with vitreous spines in about 7 rows, the middle row not forming a keel, though projecting backward most strongly; interorbital with a little more than length of eye, 4½ in head; snout triangular, depressed; upper ridge prominent anteriorly, ending in advance of concavity of interorbital space; lateral ridges prominent, continued behind the eye; barbel shorter than eye; cleft of mouth reaching to below posterior margin of orbit; second spine of dorsal nearly two-thirds head, not reaching front of soft dorsal when depressed; anal three times as high as second dorsal; vent at a distance from ventral much greater than length of ventral. D. II, 8–105. A. 110. P. 20. V. 10. Scales 7–150–18. Gulf Stream, south of New England.

(Goode & Bean, Bull. Mus. Comp. Zoöl., Vol. X, No. 5, 1883, 196.)

[4] *Coryphænoides carapinus* Goode & Bean.

Scales oval, membranous, without armature, rather large, 22 to 24 in a transverse series. Second ray of dorsal compressed and serrate, as long as head; soft dorsal inserted on a lump-like elevation of the back. Vent nearly below end of first dorsal. Snout acute, projecting beyond the mouth a distance equal to diameter of eye, which is about 4 in head. Bones of head very soft and flexible; surface of head very irreg-

539.—CHALINURA[1] Goode & Bean.

1575. Chalinura simula Goode & Bean. B.

ORDER AA.—HETEROSOMATA. (U)

Family CXLVII.—PLEURONECTIDÆ. (122)

540.—BOTHUS Rafinesque. (449)

1576. Bothus maculatus Mitchill. N. (1255)

541.—PLATOPHRYS[2] Swainson.

1577. Platophrys leopardinus[3] Günther. P.

1578. Platophrys nebularis[4] Jordan & Gilbert. S.

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ular; a very prominent subocular ridge; a prominent ridge from tip of snout to middle of interorbital space; a curved ridge from front of eye above to a point on side of snout just behind its tip. Maxillary extending to opposite posterior margin of pupil, its length half head without snout. Interorbital space equal to length of upper jaw. Head 6. D. 11, 8–100. A. 117. V. 10. Gulf Stream, lat. 40°, in deep water. (*Goode & Bean.*)

(Goode & Bean, Bull. Mus. Comp. Zoöl., Vol. X, No. 5, 197, 1883.)

[1] CHALINURA Goode & Bean.

(Goode & Bean, Bull. Mus. Comp. Zoöl., Vol. X, No. 5, 1883, 198; type, *Chalinura simula.*)

Scales cycloid, fluted longitudinally, with slightly radiating striæ. Snout long, broad, truncate, not much produced. Mouth lateral, subterminal, very large. Head without prominent ridges except the subocular ones and those upon the snout. Suborbital ridge not reaching angle of preopercle. Teeth in the upper jaw in a villiform band, those of the outer series much enlarged, those of the lower jaw uniserial, large. No teeth on vomer or palatines; small pseudobranchiæ present. Gill-rakers spiny, strong, depressible, in double series on anterior arch. Gill membranes apparently free from the isthmus. Ventrals below the pectorals; chin with a barbel. Vertical fins as in *Coryphænoides.* Deep-sea fishes. (*Χᾰλῖνός*, rein; *ὀυρά*, tail.)

Chalinura simula Goode & Bean.

Form of *Coryphænoides.* Snout broad, obtuse, scarcely projecting beyond the mouth; its width at the tip nearly equal to its own length or to the interorbital width. Eye 5 in head, as long as snout; preopercle emarginate behind. Second spine of dorsal serrate; ventral prolonged in a filament which reaches 18th ray of anal. Head 5¼; depth 6⅔. D. II, 9–113. A. 118. P. 20. V. 9. Gulf Stream, about latitude 40°. (*Goode & Bean.*)

(Goode & Bean, l. c., 1883, 199.)

[2] PLATOPHRYS Swainson.

(*Rhomboidichthys* Bleeker).

(Swainson, Nat. Hist. Class'n Fishes, etc., 1839, II, 302; type *Rhombus ocellatus* Agassiz.)

Eyes and color on the left side. Body ovate, strongly compressed; mouth of the large type, but comparatively small; the maxillary one-third or less of the length of the head; teeth small, subequal, in one or two series; no teeth on vomer or palatines. Interorbital space broad and concave, usually broadest in adult males. Gill-rakers moderate. Dorsal fin beginning in front of eye; all its rays simple; ventral of colored side on ridge of abdomen; caudal convex behind; pectoral of left side usually with one or more filamentous rays, longest in the male. Scales very small (in American species); lateral line with a strong arch in front. Coloration usually variegated. Species numerous in warm seas. (*Πλατυς*, broad; *ωφρυς*, eyebrow.)

[3] *Rhomboidichthys leopardinus* Günther, IV, 34; *Parophrys leopardinus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 260. Guaymas.

[4] *Platophrys nebularis* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 31. Key West; (Jordan); Long Island (Bean).

542.—CITHARICHTHYS Bleeker.

§ *Aramaca*[1] Jordan & Goss.

1579. **Citharichthys ocellatus** Pocy. W. (1256 *b.*)
1580. **Citharichthys pætulus** Goode & Bean. W. (1256)

§ *Hemirhombus* Bleeker.

1581. **Citharichthys ovalis**[2] Günther. P.

§ *Citharichthys.*

1582. **Citharichthys panamensis**[3] Steindachner. P.
1583. **Citharichthys sordidus** Girard. C. (1257)
1584. **Citharichthys stigmæus** Jordan & Gilbert. C. (1257 *b.*)
1585. **Citharichthys spilopterus** Günther. S. W. P. (1258)
1586. **Citharichthys macrops** Dresel. S.
1587. **Citharichthys arctifrons** Goode. B. (1259)
1588. **Citharichthys unicornis** Goode. B. (1260)
1589. **Citharichthys microstomus**[4] Gill. N. (1261)

543.—ETROPUS Jordan & Gilbert. (461)

1590. **Etropus crossotus** Jordan & Gilbert. S. P. (1296)

544.—HIPPOGLOSSUS Cuvier. (451)

1591. **Hippoglossus hippoglossus** Linnæus. N. G. A. Eu. (1261)

545.—REINHARDTIUS[5] Gill. (452)

1592. **Reinhardtius hippoglossoides** Walbaum. G. (1262)

546.—ATHERESTHES Jordan & Gilbert. (453)

1593. **Atheresthes stomias** Jordan & Gilbert. C. A. (1263)

547.—PARALICHTHYS Girard. (454)

1594. **Paralichthys adspersus**[6] Steindachner. P.
1595. **Paralichthys californicus** Ayres. C. (1264)

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[1] *Aramaca* Jordan & Goss, sub-genus nova, type *Hemirhombus pætulus* Bean. This group includes species which have the broad, concave interorbital space, elongate pectorals, and other characters of *Platophrys*, but are without arch in the lateral line, as in *Hemirhombus* and *Citharichthys.*

[2] *Hemirhombus ovalis* Günther, Proc. Zoöl. Soc. London, 1864, 154; Günther, Fishes Centr. Amer., 1869, 472. Mazatlan to Panama.

[3] *Citharichthys panamensis* Steindachner, Ichth. Beiträge, III, 62, 1875. Mazatlan to Panama.

[4] *Citharichthys microstomus* Gill, Proc. Ac. Nat. Sci. Phila., 1864, 223. Atlantic coast. This species, lately rediscovered by Dr. Bean, is distinct from *C. spilopterus*, having a considerably smaller mouth. It approaches *E. crossotus*, but the latter species has the mouth still smaller and the body deeper.

[5] *Reinhardtius* Gill, has priority over *Platysomatichthys*, but was proposed without definition or explanation.

[6] *Paralichthys adspersus* Steindachner, Ichth. Notizen. V. 1867–9. Mazatlan to Peru.

1596. Paralichthys dentatus[1] Linnæus. N. S. (1265)
1597. Paralichthys lethostigma[2] Jordan & Gilbert. N. S. (1266)
1598. Paralichthys albigutta Jordan & Gilbert. S. (1267)
1599. Paralichthys squamilentus Jordan & Gilbert. S. (1268)
1600. Paralichthys oblongus Mitchill. N. (1269)

548.—ANCYLOPSETTA[3] Gill.

1601. Ancylopsetta quadrocellata Gill. S. (1270)
1602. Ancylopsetta dilecta[4] Goode & Bean. B.

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[1] *Paralichthys dentatus* (L.) *Common Spotted Flounder, Northern Flounder.*

Cape Cod to Florida, most abundant northward. The description in the synopsis (p. 822) of *P. ophryas*, belongs here. From *P. lethostigma*, it is especially distinguished by the more numerous (5 + 14) gill-rakers, and by the much more spotted coloration. The interorbital space is also narrower in specimens of the same size.

(*Pleuronectes dentatus* L., Syst., Nat., Ed. XII, 1766, 458, from a specimen from Dr. Garden; this specimen has been examined by Dr. Bean; it belongs to the present species. *Pleuronectes melanogaster* Mitchill, Trans. Lit. & Phil. Soc. N. Y., 1815, 1, 390; *Platessa ocellaris* DeKay, New York Fauna, Fishes. 1842, 300; *Paralichthys ophryas* Jor. & Gilb., Syn. Fish. N. A., 822; *Paralichthys ocellaris* Jor. & Gilb., l. c., 972, and Proc. U. S. Nat. Mus. 1882, 617; *Pseudorhombus ocellaris* Günther, IV, 430.)

[2] *Paralichthys lethostigma* Jordan and Gilbert.

Cape Cod to Florida and Texas, most abundant southward. Darker and more uniform in color than the true *dentatus*, the gill-rakers smaller and fewer (2 + 10) and the interorbital space broader.

(*Platessa oblonga* DeKay, New York, Fauna, Fish., 1842, 299, not *Pleuronectes oblongus* Mitchill; *Pseudorhombus dentatus* and *oblongus* Günther, IV, 425, 426, *Paralichthys dentatus* Jor. & Gilb., Synopsis 822, and Proc. U. S. Nat. Mus. 1882, 617; *Paralichthys lethostigma* Jordan & Gilbert, Proc. U. S. Nat. Mus. 1884, 237. The original type of *P. dentatus* examined by Dr. Bean in London proves to belong to the species having numerous gill-rakers.

[3] It seems more natural to regard *Ancylopsetta* and *Xystreurys* as genera distinct from *Paralichthys*. *Notosema* Goode & Bean (*dilecta*) seems scarcely different from *Ancylopsetta*.

[4] *Ancylopsetta dilecta* (Goode & Bean).

Dark brown, speckled with darker; three large, subcircular ocellated spots, nearly as large as eye, with white center, dark iris, narrow dark margin, and a brown encircling outline. These spots arranged in an isosceles triangle, the apex on the lateral line, the others distant from the lateral line a distance equal to their own diameter; the lower near tip of ventral. Fins blotched with darker brown. Right side white. Body elliptical, the caudal fin pedunculate; mouth moderate, the maxillary 2½ in head; teeth uniserial, those in front much largest. Eye large, 3 in head, the interorbital space very narrow. Gill-rakers subtriangular, moderately numerous. Pectoral fins unequal, the left 5½ in body. Ventral of colored side much produced, more than three times length of right ventral. First eight rays of dorsal exserted, forming a somewhat separate division, the second and third longest half greatest depth of body. Scales small, highly ctenoid. Head 3½; depth 2. D. 69; A. 56; P. 11; V. 6; lat. l. 48 (in straight portion). Gulf Stream, off the Carolina coast. (Goode & Bean.)

(*Notosema dilecta* Goode & Bean, Bull. Mus. Comp. Zoöl., XIX, 193.)

The genus *Notosema* is distinguished from *Paralichthys* "on account of its elongated ventral fin, the triangular elongation of the anterior rays of the dorsal and the highly ctenoid character of the scales on the colored side of the body." These characters are all, however, of degree only, and all exist in *Ancylopsetta quadrocellata*.

549.—XYSTREURYS Jordan & Gilbert.

1603. Xystreurys liolepis Jordan & Gilbert. C. (1271)

550.—HIPPOGLOSSINA[1] Steindachner. (455)

1604. Hippoglossina macrops Steindachner. P.

551.—HIPPOGLOSSOIDES Gottsche. (456)

§ *Eopsetta*[2] Jordan & Goss.

1605. Hippoglossoides jordani Lockington. C. (1274)

§ *Hippoglossoides.*

1606. Hippoglossoides platessoides Fabricius. N. G. Eu. (1272)
1607. Hippoglossoides elassodon Jordan & Gilbert. C. A. (1273)

§ *Lyopsetta*[3] Jordan & Goss.

1608. Hippoglossoides exilis Jordan & Gilbert. C. A. (1275)

552.—PSETTICHTHYS Girard.

1609. Psettichthys melanostictus Girard. C. (1276)

553.—PLEURONICHTHYS Girard. (456)

1610. Pleuronichthys decurrens Jordan & Gilbert. C. (1277)
1611. Pleuronichthys verticalis Jordan & Gilbert. C. (1278)
1612. Pleuronichthys cœnosus Girard. C. A. (1279)

554.—HYPSOPSETTA Gill. (457)

1613. Hypsopsetta guttulata Girard. C. (1280)

555.—PAROPHRYS Girard.

1614. Parophrys vetulus Girard. C. A. (1281)

556.—ISOPSETTA Lockington.

§ *Isopsetta.*

1615. Isopsetta isolepis Lockington. C. (1282)

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[1] HIPPOGLOSSINA Steindachner.

(Steindachner, Ichth. Beitr. V, 13, 1876; type *Hippoglossina macrops* Steindachner.)

This genus is very close to *Paralichthys*, differing chiefly in the dentition, the teeth being small and uniform in size, arranged in a single row. The scales are ctenoid. The eyes are unusually large in the single known species, which bears a remarkable resemblance to *Hippoglossoides jordani*. The lateral line is however anteriorly arched in *Hippoglossina*, but straight in the latter species. (Name a diminutive of *Hippoglossus*.)

Hippoglossina macrops Steindachner, l. c. Mazatlan, probably from rather deep water.

[2] *Eopsetta* Jordan & Goss, subgenus nova, for *Hippoglossoides jordani* Lockington (ἠύς, excellent; ψῆττα, flounder), characterized by the biserial upper teeth and by other peculiarities.

[3] *Lyopsetta* Jordan & Goss, subgenus nova, for *Hippoglossoides exilis* Jordan & Gilbert (λύω, to loosen; ψῆττα, flounder), characterized by the large, loose scales, biserial upper teeth, and feeble structure.

§ *Inopsetta*[1] Jordan & Goss.

1616 **Isopsetta ischyra** Jordan & Gilbert. A. (1283)

557.—LEPIDOPSETTA Gill.

1617. **Lepidopsetta bilineata** Ayres. C. A. (1284)

558.—LIMANDA Gottsche.

1618. **Limanda ferruginea** Storer. N. (1285)
1619. **Limanda aspera** Pallas. A. (1286)
1620. **Limanda beani** Goode. B. (1287)

559.—PLEURONECTES[2] Linnæus. (458)

§ *Platichthys* Girard.

1621. **Pleuronectes stellatus** Pallas. A. C. (1288)

§ *Pleuronectes.*

1622. **Pleuronectes quadrituberculatus** Pallas. A. (1289)
1623. **Pleuronectes glaber** Storer. N. (1290)
1624. **Pleuronectes glacialis** Pallas. A. (1291)

§ *Pseudopleuronectes* Bleeker.

1625. **Pleuronectes americanus** Walbaum. N. (1292)

560.—GLYPTOCEPHALUS Gottsche. (459)

1626. **Glyptocephalus cynoglossus** Linnæus. N. Eu. B. (1293)
1627. **Glyptocephalus zachirus** Lockington. C. (1294)

561.—CYNICOGLOSSUS Bonaparte. (460)

1628. **Cynicoglossus pacificus** Lockington. C. A. (1295)

562.—DELOTHYRIS[3] Goode. (462)

1629. **Delothyris pellucidus** Goode. B. (1296)

563.—MONOLENE Goode. (463)

1630. **Monolene sessilicauda** Goode. B. (1298)

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[1] *Inopsetta* Jordan & Goss, subgenus nova, type *Parophrys ischyrus* Jordan & Gilbert. (Ἴς, sinew; ψῆττα, flounder.) This fish is allied to *Pleuronectes stellatus*, but has an accessory dorsal branch to the lateral line as in *Isopsetta isolepis*, from which it differs in form, and in the rough, loosely imbricated scales.

[2] The genus *Pleuronectes* as retained in the Synopsis, is unnatural, species very diverse in their characters being retained in it. I have, therefore, here recognized its chief constituents as distinct genera. *Parophrys, Isopsetta, Lepidopsetta,* and *Limanda* seem certainly worthy of such recognition. Possibly *Platichthys, Inopsetta* and *Pseudopleuronectes*, also, are worthy of such retention.

[3] DELOTHYRIS Goode.

(Goode, Proc. U. S. Nat. Mus. 1883, 110; type *Thyris pellucidus* Goode; name a substitute for *Thyris*, preoccupied; δῆλος, clear; θυρίς, window.) We have no doubt that this is a larval form, possibly of some fish as yet unknown, allied to *Citharichthys*. Small transparent flounders having all the characters of *Delothyris*, but less elongate than *D. pellucidus*, have been taken by the writer at Key West. These are thought to be larvæ of some *Platophrys* or *Citharichthys*.

Family CXLVIII.—SOLEIDÆ. (123)

564.—ACHIRUS Lacépède. (464)

§ *Bæostoma*[1] Bean.

1631. Achirus brachialis Bean. S. (1299 *c.*)
1632. Achirus comifer[2] Jordan & Gilbert. W.
1633. Achirus mazatlanus[3] Steindachner. P.
1634. Achirus inscriptus[4] Gosse. W.

§ *Achirus.*

1635. Achirus achirus[5] Linnæus. W. S. (1299 *b.*)
1635 b. *Achirus achirus mollis* Mitchill. N. (1299)

565.—APHORISTIA Kaup. (465)

1636. Aphoristia atricauda Jordan & Gilbert. C. (1300)
1637. Aphoristia plagiusa Linnæus. S. (1301)
1638. Aphoristia nebulosa[6] Goode & Bean. B.

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[1] *Bæostoma* should probably be regarded as a subgenus of *Achirus* rather than as a distinct genus. Among the numerous species, the pectoral of the right side is found in every degree of development. In some species, a small pectoral is found on the left side in some specimens, while it is wanting in others. Still other species have also two pectorals developed.

[2] *Achirus comifer* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 31. Key West.

[3] *Solea mazatlana* Steindachner, Ichth. Notizen, IX, 1869, 23 (July) = *Solea* (*Monochir*) *pilosa* Peters, Berliner Monatsber., 1869, 709 (August). Mazatlan, southward.

[4] *Achirus inscriptus* Gosse.

Olivaceous, covered with an irregular network of blackish lines; this network rather finer on the head; some specimens crossed by irregular but nearly straight vertical lines; others without traces of these; dorsal and anal colored like the body, rather darker, with a paler edge; caudal abruptly whitish, immaculate; blind side immaculate, darker on the fins; hair-like appendages whitish; scales about head enlarged and fringed, especially on blind side; lip of eyed side much fringed; interorbital width less than eye; upper eye slightly in advance of lower; right pectoral of three rays, the middle one somewhat longer than the others; left ventral of one or two very small rays often entirely absent; right side with scattered cilia, which are mostly whitish; ventrals 5-rayed, the right ventral joined to the anal; head, 3⅘; depth, 1⅘; D., 54; A., 40; lat. l., 75 to 80. West Indies, north to Key West.

(*Achirus inscriptus* Gosse, Naturalist's Sojourn Jamaica, 52; *Solea inscripta* Günther, IV, 473; *Monochir reticulatus* Poey, Memorias Cuba, II, 1861, 317; *Solea reticulata* Günther, IV, 472; *Achirus inscriptus* Jordan, Proc. U. S. Nat. Mus., 1884, 143.)

[5] The name *Pleuronectes achirus* L. (*Achirus fasciatus* Lac.) was based on specimens from Surinam; the name *Pleuronectes lineatus* on the figures of Brown and Sloane of fishes from Jamaica. If, therefore, the West Indian form is considered distinct from the northern one, the former must be *Achirus achirus* or *Achirus lineatus*, and the latter must take Mitchill's name, "*mollis.*" If considered as varieties of one species, the West Indian form has the prior names.

[6] *Aphoristia nebulosa* Goode & Bean.

Grayish, everywhere mottled with brown; median keel on each scale dark and prominent. Body comparatively slender; scales small, rough; jaws and snout naked; interorbital space with one row of scales. Teeth small, apparently equally developed on both sides. Ventral well separated from anal, its longest ray 3 in head. Head 5⅔; depth 4⅔, D. 119, A. 107, P. O. V. 5. Scales 120–50. L. 3½ inches. Gulf Stream, off the coast of Carolina. (*Goode & Bean.*)

(Goode & Bean, Bull. Mus. Comp. Zoöl., XIX, 1883, 192).

ORDER BB.—PEDICULATI. (V.)

Family CXLIX.—LOPHIIDÆ. (124)

566.—LOPHIUS Linnæus. (466)

1639 **Lophius piscatorius** Linnæus. N. Eu. (1302)

Family CL.—ANTENNARIIDÆ. (125*a*.)

567.—PTEROPHRYNOIDES Gill. (466*b*.)

1640. **Pterophrynoides histrio** Linnæus. S. O. (1303)

568.—ANTENNARIUS Lacépède. (467)

1641. **Antennarius annulatus** Gill. W. (1304)
1642. **Antennarius ocellatus**[1] Bloch & Schneider. W. (1305)
1643. **Antennarius sanguineus**[2] Gill. P.
1644. **Antennarius strigatus** Gill.[3] P.

569.—CHAUNAX Lowe. (468)

1645. **Chaunax pictus** Lowe. B. (1306)

Family CLI.—CERATIIDÆ. (125 *b*.)

570.—CERATIAS Kröyer. (469)

1646. **Ceratias holbölli** Kröyer. B. G. (1307)

571.—MANCALIAS[4] Gill. (470)

1647. **Mancalias uranoscopus** Murray. B. (1308)

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[1] *Lophius vespertilio* Var. *ocellatus* Bloch & Schneider, Syst. Ichth., 1801, 142, based on the Pescador of Parra = *Antennarius ocellatus* Poey, Syn. Pisc. Cub., 1868, 105 = *Antennarius pleurophthalmus* Gill.

[2] *Antennarius sanguineus* Gill, Proc. Ac. Nat. Sci. Phila., 1863, 91 = *Antennarius leopardinus* Günther, Proc. Zoöl. Soc., London, 1864, 151. Cape San Lucas to Panama.

[3] *Antennarius strigatus* Gill, l. c. 92 = *Antennarius tennifilis* Günther, Fish Centr Amer. 1869, 440 = *Antennarius strigatus* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 630. Cape San Lucas to Panama.

[4] The following notes on fishes similar to *Mancalias* were published in Forest and Stream of Nov. 8, 1883, by Dr. Theodore Gill:

"*Typhlopsaras.*—Ceratiines with an elongated trunk, rectilinear back, obsolete or no eyes, far exserted basal joint of the anterior spine and shortened terminal joint, a small intermediate and a pair of pedunculated dorsal appendages some distance in advance of the dorsal fin, and reduced pectoral fin with about 5 or or 6 rays.

"*Typhlopsaras shufeldti.*—The first joint of the rod-like spine reaches to the axil of the dorsal fin, and the bulb to the base of the caudal fin, when the spine is bent backward; the bulb is pear-shaped and without any appendages; the dorsal has 4 rays, the anal 4, the caudal 8 (the median, 4 of which are forked), and there are 4 or 5 pectoral rays. A single specimen was found. I have dedicated the species to my esteemed friend, Dr. R. W. Shufeldt, U. S. A., the well-known ornithotomist.

"The name *Typhlopsaras* is a compound from the Greek *tuphlos* (blind) and *psaras* (angler), meaning 'blind angler.'

"*Cryptopsaras.*—Ceratiines with shortened trunk, longitudinally convex back, small but conspicuous eyes, concealed basal joint of the anterior spine and elongated ter-

572.—ONEIRODES Lütken. (471)

1648. Oneirodes eschrichti Lütken. B. G. (1309)

573.—HIMANTOLOPHUS Reinhardt. (472)

1649. Himantolophus grœnlandicus Reinhardt. B. G. (1310)
1650. Himantolophus reinhardti Lütken. B. G. (1311)

Family CLII.—MALTHIDÆ. (126)

574.—MALTHE Cuvier. (473)

1651. Malthe vespertilio Linnæus. S. W. (1312)
1651b. *Malthe vespertilio radiata*[1] Mitchill. S. (1313)
1652. Malthe elater[2] Jordan & Gilbert, P.

575.—HALIEUTICHTHYS Poey. (474)

1653. Halieutichthys aculeatus Mitchill. W. (1314)

576.—HALIEUTÆA Cuvier & Valenciennes. (475)

1654. Halieutæa senticosa Goode. B. (1315)

Order CC.—PLECTOGNATHI. (W.)

Family CLIII.—OSTRACIIDÆ. (476)

577.—OSTRACION Linnæus. (476)

§ *Lactophrys.* Swainson.

1655. Ostracion triquetrum Linnæus. W. (1316 *b.*)
1656. Ostracion trigonum Linnæus. W. (1316)
1657. Ostracion tricorne[3] Linnæus. W. S. (1317)

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minal joint, a large intermediate globular and a pair of sub-pedunculated lateral dorsal appendages near the front of the dorsal fin, and well-developed pectorals of about 15 rays.

"*Cryptopsaras couesii.*—The basal joint of the rod-like spine is almost entirely concealed and procumbent, and the distal joint alone free, reaching backward to the dorsal tubercles; the bulb is pyriform and surmounted by a long whitish filament; the dorsal and anal have each 4 spines, the caudal 8 (the 4 middle dichotomous), and the pectorals each about 15 rays. The species has been named after the eminent ornithologist, Dr. Elliott Coues. The name is derived from the Greek *cruptos* (concealed,) and *psaras* (fisherman), and has reference to the concealed 'rod' or basal joint of the anterior spine or fishing apparatus."

[1] *Malthe cubifrons* Rich., seems to be only an extreme variety of *Malthe vespertilio.* Every gradation in size and form of the rostral process exists between the very long-nosed var. *longirostris*, to the button-nosed *cubifrons*, and thus far I am unable to show any dividing lines. The original record of *Malthe cubifrons* as from Labrador was an error. It is not certainly known from any point north of Florida. The name *Lophius radiatus* Mitchill, Amer. Monthly Mag., March, 1818, 326, is prior to that of *cubifrons.* The short-snouted form may therefore stand as—

Malthe vespertilio radiata. (See Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 234.)

[2] *Malthe elater* Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 365. Mazatlan.

[3] *Ostracion tricornis* Linnæus. Syst, Nat, X, 1758, 331 = *Ostracion quadricornis* Linnæus, (lower down on the same page.)

Family CLIV.—BALISTIDÆ.

578.—BALISTES Linnæus. (477)

1658. **Balistes vetula** Linnæus. W. (1318)
1659. **Balistes carolinensis**[1] Gmelin. S. W. Eu. (1319)
1660. **Balistes powelli** Cope. Acc. (1320)
1661. **Balistes polylepis**[2] Steindachner. P.
1662. **Balistes capistratus**[3] Shaw. P.

579.—MONACANTHUS Cuvier. (478)

§ *Monacanthus.*

1663. **Monacanthus ciliatus**[4] Mitchill. W. (1321, 1323)
1664. **Monacanthus hispidus** Linnæus. S. N. (1322)
1665. **Monacanthus spilonotus** Cope. W. (1324)

§ *Cantherhines* Swainson.

1666. **Monacanthus pullus** Ranzani. W. (1325)

580.—ALUTERA Cuvier. (479)

1667. **Alutera schœpfi** Walbaum. N. S. (1326)
1668. **Alutera scripta** Osbeck. W. (1327)

Family CLV.—TETRODONTIDÆ.

581.—LAGOCEPHALUS Swainson. (480)

1669. **Lagocephalus lævigatus** Linnæus. W. S. (1328)

582.—TETRODON[5] Linnæus. (481)

1670. **Tetrodon politus** Girard. C. P. (1329)
1671. **Tetrodon testudineus** Linnæus. W. (1330.)

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[1] *Balistes carolinensis* Gmelin, Syst. Nat., 1788, 1468 (as variety of *B. vetula*). *Balistes capriscus* Gmelin occurs first on page 1471, and is based on a confusion of several species. *Balistes powelli* is possibly the young of this species.

[2] *Balistes polylepis* Steindachner, Ichth. Beitr., V, 21, 1876. Mazatlan to Panama.

[3] *Balistes capistratus* Shaw, Gen. Zoöl., V, 417, 1804 (based on *Baliste bridé* Lacépède) = *Balistes mitis* Bennett = *Balistes frenatus* Richardson. Mazatlan to Panama.

[4] *Balistes ciliatus* Mitchill, Amer. Monthly Mag., 1818, 326 = *Monacanthus occidentalis* Günther = *Monacanthus davidsoni* Cope. See Jordan, Proc. U. S. Nat. Mus., 1884, 145.

[5] The earliest attempt at subdivision of the genus *Tetrodon* as left by Cuvier seems to be that of Swainson. In his restricted genus *Tetrodon* no Linnæan species are retained, his "*Tetrodon testudineus*" being that of Bloch, not of Linnæus. The next attempt is that of Müller, who did not retain the name *Tetrodon* for any of his subdivisions. The next attempt at subdivision seems to be that of Bleeker, who retained the name *Tetrodon*, in accordance with his custom, for the first species mentioned by Linnæus, *T. testudineus*. This seems to me the earliest use of the restricted name *Tetrodon* which can stand.

In a recent paper, Dr. Gill (Proc. U. S. Nat. Mus., 1884, 420) has adopted a different view. The *Tetrodon* of Swainson contains three species congeneric with one of the Linnæan species (*lineatus*). This species belongs to Müller's genus *Arothron*, and to *Arothron* Dr. Gill transfers the name *Tetrodon*, reserving for the *Tetrodon* of Bleeker and of our Synopsis the name *Cirrhisomus* of Swainson.

1671 b. *Tetrodon testudineus annulatus*[1] Jenyns. P.
1672. Tetrodon spengleri Bloch. W. (1331)
1673. Tetrodon nephelus[2] Goode & Bean. S. W. (1332 *b.*)
1674. Tetrodon turgidus Mitchill. N. (1332)
1675. Tetrodon trichocephalus Cope. Acc. (1333).

583.—PSILONOTUS[3] Swainson.

1676. Psilonotus punctatissimus Günther. P.

Family CLVI.—DIODONTIDÆ.

584.—TRICHODIODON Bleeker. (482)

1677. Trichodiodon pilosus Mitchill. O. (1334)

585.—DIODON Linnæus. (483)

1678. Diodon hystrix Linnæus. W. P. (1335)
1679. Diodon liturosus Shaw. W. P. (1136)

586.—CHILOMYCTERUS (Bibron) Kaup. (484)

1680. Chilomycterus geometricus Mitchill. N. S. (1337)
1681. Chilomycterus fuliginosus DeKay. N. (1337 *b.*)
1682. Chilomycterus reticulatus Linnæus. W. (1337 *c.*)

Family CLVII.—ORTHAGORISCIDÆ. (130)

587.—MOLA[4] Cuvier. (485, 486)

1683. Mola mola Linnæus. N. S. W. O. C. Eu. P. (1338, 1339)

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[1] *Tetrodon annulatus* Jenyns, Zoöl. Beagle, 1842, 153 = *Tetrodon heraldi* Günther, VIII, 283. Gulf of California to Peru. This species is little, if at all, different from *T. testudineus.*

[2] *Tetrodon nephelus* is extremely variable in regard to its spinous armature. Specimens from Key West show all gradations from entire smoothness above and below to the condition described in the text (page 966). Older specimens are generally less prickly than young ones.

[3] PSILONOTUS Swainson.

(*Anosmius* Peters; *Tropidichthys* and *Canthogaster* Bleeker; *Anchisomus* Richardson.)

(Swainson, Nat. Hist. Classn. Anim., II, 1839, 328; type *Tetrodon rostratus* Bloch.)

This genus differs externally from *Tetrodon* in having the nostrils obsolete, and the back compressed to a keel. The skeleton differs so widely from that of *Tetrodon* that Dr. Gill (Proc. U. S. Nat. Mus., 1884, 422) has proposed to regard it as forming a distinct family, *Psilonotidæ.* Species rather numerous in the tropics. (Ψῖλος, bare; νῶτος, back.)

Psilonotus punctatissimus Günther. *Tetrodon punctatissimus* Günther, VIII, 302 = *Tetrodon oxyrhynchus* Lockington, Proc. Ac. Nat. Sci. Phila., 1881, 116. Gulf of California to Panama.

[4] The generic name *Mola* first appears in Cuvier, Tableau Élementaire, 1798, p. 423, thus having three years priority over *Orthagoriscus* (1801).

The recent researches of Mr. John A. Ryder render it very probable that the small fishes known as *Molacanthus* are, after all, young forms of *Mola.* I therefore omit *Molacanthus nummularis.*

Ranzania truncata (No. 1139 *b*) should not be included in the present list, as it has not been taken nearer our coast than the Bermuda Islands.

RECAPITULATION.

The following is an approximate statement of the number of species and subspecies, now known, belonging to each of the principal faunal areas. No species is counted twice, but in case of the numerous species which range over several faunal areas each is referred to that area which is supposed to be most properly its home, or to that in which its occurrence has been longest known. In regard to many species such an assignment is simply arbitrary, and in this fact lies the chief element of error in the following list. Thus many Arctic shore fishes belong to the Bassalian fauna of New England, while many West Indian species occur northward more or less frequently as far as Cape Cod. No faunal region on our coast is bounded by sharp lines:

	Species.
Bassalian or deep-sea fauna of the Atlantic	105
Arctic (Greenland) fauna	65
New England (Newfoundland to Cape Hatteras)	95
South Atlantic and Gulf coast (shore fauna)	140
West Indian fauna (including Florida Keys and "Snapper Banks" of Pensacola)	290
Tropical fauna of the Pacific (Gulf of California, southward)	240
Californian fauna (Cape Flattery to Cerros Island)	220
Alaska (Cape Flattery to Bering's Straits)	90
Pelagic species	35
Fresh waters: East of Rocky Mountains	465
Fresh waters: Between Rocky Mountains and Sierra Nevada (Great Basin, &c.)	75
Fresh waters: West of Sierra Nevada and Cascade Range	50
Total	1,870

INDIANA UNIVERSITY,
January 1, 1885.

INDEX.

[NOTE.—Figures in parenthesis refer to the consecutive numbers assigned the species in their natural order; the page references are to figures in brackets on the inside of the page.]

ERRATA.

Species No. 8 should stand as *Petromyzon concolor*, Kirtland, instead of *P. bdellium*. *Ammocœtes concolor* seems to be the larva of this species.

Species 11 *b*. The subspecies should stand as *Petromyzon marinus unicolor* DeKay, instead of *P. m. dorsatus*. *Ammocœtes unicolor* DeKay is the larva of this form.

Genus 39. The name *Dasybatis* (Klein) Rafinisque, is prior to *Trygon* Adanson (1817), and must be used for this genus (cf. Garman, Proc., U. S. Nat. Mus., 1885).

Genus 61. *Hypentelium* should be reunited to *Catostomus*.

Species 328. Should stand as *Hybopsis kentuckiensis* Rafinesque, instead of *H. biguttatus*. It seems to be the *Luxilus kentuckiensis* Raf.

Species 601. Should apparently stand as *Esox masquinongy* Mitchill instead of *E. nobilior*.

The name of Family LXVIII *a*.—*Scomberesocidæ* was inadvertently omitted before genus 195, *Scomberesox*.

Species 1637 should apparently stand as *Aphoristia fasciata* Holbrook, instead of *A. plagiusa*.

XXV.—PATENTS ISSUED BY THE UNITED STATES DURING THE YEARS 1882, 1883, AND 1884, RELATING TO FISH AND THE METHODS, PRODUCTS, AND APPLICATIONS OF THE FISHERIES.

By Robert G. Dyrenforth,

Assistant Commissioner of Patents, United States Patent Office.

ANALYSIS.

Section C.

I.—Hand implements or tools.

2.—Knives; heading knives.

IV.—BAITED HOOKS; ANGLING TACKLE.

Hooks; set traps.

Hooks; plain hooks.

Hooks; jigs and drills.

Hooks; spoon-baits, plain and fluted.

Hooks; artificial flies on hooks.

Snoods, leaders, and traces.

Hooks; trout and grayling flies.

Sinkers.

Floats.

Reels.

Gunwale; winches.

Rods.

V.—NETS.

Pocket nets.

Hoop nets; landing nets.

Trailing nets; dredges.

Folding or jerk nets.

Parts of nets and apparatus for manufacture.

VI.—TRAPS.

Pocket traps.

Canning meats.

II.—PREPARATION OF OILS AND GELATINES.

Extraction of fish oils.

III.—MANUFACTURE OF FERTILIZERS.

Preparation of guano.

SECTION E.

I.—FOODS.

Dry salted preparations.

DESCRIPTION OF PATENTS.

No. 266134.

(James B. Grady, Philadelphia, Pa.; patented October 17, 1882; fish-cutter. See Plates I, II, III.)

A machine for removing the heads and tails of fish as a preliminary step in preparing them for boxing. The usual method of preparing the fish by hand is as follows: The fish are brought to the operating-table in baskets, crates, &c., where they are to be laid out in regular rows. The operator then removes the heads and tails with a knife, after which the fish are carried to the flakes or drying dishes. The removal of the heads and tails is laborious work, and even when performed by a skillful workman not always well done. In preparing the fish for boxing it is necessary that none of them should be over a certain size, the boxes being all of a standard size. If the fish are longer than the standard, they must either be trimmed by the person employed in boxing or be returned to the cutting table. If a gauge is used by the cutter, it takes longer time to dress and prepare the fish. The object here is to provide means whereby the fish may be carried from a series of hoppers and automatically delivered by a system of elevators and endless belts to a series of pairs of saws or other cutting apparatus, which removes their heads and tails, after which they are delivered into a receptacle. The fish are placed in a hopper, A, as they come from the water. This hopper has an opening, *a*, at its lower end, through which they pass, and they are then taken up one at a time, by buckets, *b*, on endless apron B, moving on the pulleys b^1 b^2. The fish are carried by the apron to the of the top roll b^1, where they drop off into the trough C, which is wider at the top than the bottom, and has running through it, at its bottom, the endless belt D, moving on the pulleys d d^1. The fish are thrown into the trough C crosswise, but the trough being V-shaped, they fall on the carrier lengthwise. They are then carried by the belt D forward toward the pulleys d^1, under which are placed the saws or cutters I I^1 for removing the heads and tails; but as it is necessary that all the fish should arrive at the saws with their heads on the same side of the belt, or with their heads toward the larger saw, the gate E is placed over the apron D. This gate is placed at an angle over the apron, with its lower edge very near to but not in contact with the apron, and it is held in place by the arms *e e* passing through the sides of the trough C. It is also held down by a spring. When the fish are moving on the belt with their tails forward, or in the direction of the pulleys d^1, the tail acts as a wedge or lever and raises the end of the gate E and allows the fish to pass under it. If, on the contrary, they approach the gate heads forward, the head strikes against the edge of the gate and the fish slides up and over the gate and is thrown into or against the lower end of the semicircular-shaped turner F. The momentum carries them partly around the circumference of the inner side of this turner, when they fall back on the belt D behind the gate E, having been turned in an opposite direction from what they were when they met the gate E. By this arrangement all the fish are carried tails forward, after either going over or under the gate E. From there they are carried forward to the pulley d^1. At this point is placed what is called a deflector, and which is intended to place the fish on the carrier or belt H, with the heads toward the saws or cutters I^1. This deflector is made in the shape of a longitudinal section of a cone bent to a semicircle and having an extension or flattened side, *g*. The fish enter the deflector at its larger end, tail first, and, following the shape of the cone, the tail strikes the brush or stop g^1. The head slides along the flattened side and the fish drops on the belt with the head toward the saw or cutter I^1. The belt H moves on the pulleys $h\ h^1$ in the direction of *h*, and it also runs under the pulley d^1 and belt D. The fish are carried by the belt H forward and under belt D and pulley d^1, which hold it in position while the cutters I I^1 remove the heads and tails. They are then carried forward by the belt H and deposited in the box K, whence they may be removed from time to time and cleansed of their entrails, or otherwise further prepared for boxing.

CLAIMS.

"1. In a machine for dressing fish, the combination of the hopper A, the elevator-belt B, provided with buckets *b*, chute C, endless belts D and H, with their pulleys *d h* and $d'\ h'$, and knives I and I^1, substantially as shown and described.

"2. In a machine for dressing fish, the combination of the endless belt or carrier D, pulleys *d* d', swing-gate E, deflectors F and G, chute C, and the cutters I and I', substantially as shown and described.

"3. In a machine for dressing fish, the combination of the endless belts D and H, with their pulleys *d h* and $d'\ h'$, and the cutters I I' on each side of the belt, with the chute C and deflector G, whereby the fish are delivered sidewise to the cutters, substantially as shown and described.

"4. In a machine for dressing fish, the combination, with the chute C and carrier D, of the inclined gate E and curved deflector F, whereby the position of the fish on the carrier is automatically regulated, substantially as described.

"5. In apparatus designed to prepare and dress fish by mechanical means, a deflector made, substantially as described, as the longitudinal section of a cone or conoid, and having a flattened side or projection, and adapted to alter the relative position of fish while descending from one carrier to another carrier parallel to it."

No. 253363.

(Jeremiah W. Foard, San Francisco, Cal.; patented February 7, 1882; fish-hook extractor. See Plate IV.)

A shaft of brass, of malleable iron, or of rubber, has a recess formed by overlapping flanges riveted to the shaft, and of such width as to cover the point of a hook and prevent its reinsertion in drawing.

To extract a hook from a fish's throat the line is drawn moderately taut and the instrument is inserted into the shank of the hook, embracing it within the recess, and is then pushed down upon the inside of the bend of the hook till the barb is liberated. This done, the extractor is withdrawn, bringing the hook with it.

CLAIM.

"The fish-hook extractor herein described, consisting of the shaft C, having overlapping flanges A at the point and adjacent sides, forming recesses B, substantially as shown, and for the purposes specified."

No. 295611.

(Louis A. Amouroux, New York, N. Y.; patented March 25, 1884; machine for opening oysters. See Plate V.)

The object is to open oysters quickly and conveniently. The shell is separated at the hinge to avoid losing the juice.

A frame has standards for supporting a fulcrumed lever having a serrated jaw, against which the oyster is placed, and an adjustable standard is rigidly locked to the slotted base of the frame, and provided at its upper end with a twisted and pointed knife for severing the butt or hinged part of the shell. In operation, the hook *d* of the detachable upright standard D is first so placed over any one of the transverse rods a^2, as to be at a desirable distance from the serrated lever B, according to the size of the oyster to be opened. The oyster is then placed with its mouth against one of the teeth of the jaw, while the butt or hinged end of the shell is placed against the knife. The lever is then pressed down, and the butt of the oyster forced against the knife, whereby the muscle that holds together the two halves of the shell is severed by the point of the knife, while the sections of the shell are separated by the twisted portion. The shell is then opened by a recessed knife, by which also the oyster is removed.

The inventor says:

"I am aware that oyster-openers in which a fixed serrated abutment and a reciprocating knife are employed have been used heretofore, and I do not claim the same."

CLAIMS.

"1. An oyster-opener consisting of a supporting frame, a fulcrumed lever having a serrated jaw, an adjustable standard having a fixed and twisting knife, and means whereby the standard is rigidly locked to the base of the frame, substantially as set forth.

"2. The combination of a base, A, having fixed upright standards A′, and a recess with transverse rods a^2, a fulcrumed lever, B B′, an adjustable standard, D, having a fixed and twisted cutting-knife, *e*, and a bottom hook, *d*, and heel, whereby the standard D may be rigidly locked to the base at varying distances from the jaw, substantially as set forth."

No. 299756.

(Cuningham Drake, Philadelphia, Pa.; patented June 3, 1884; oyster-clamp. See Plate VI.)

In opening oysters difficulty is often experienced in holding the oyster firmly and the hands are frequently cut.

This invention is intended to present an inexpensive and convenient clamp for holding the oyster firmly during the operation. The clamp consists of two parts, of wood or metal, hinged together at their rear ends. The bottom part is longer than the top, and has a recess rounded at its inner end and gradually increasing in depth from the open front side, forming an inward-inclined bottom. The top has a similar recess. As the oyster is held between the hinged parts or jaws, its projecting end may readily be broken with a knife or hammer, and a pointed implement inserted for prying the shells apart.

CLAIM.

"The oyster clamp or holder consisting of the recessed bottom part A, and short recessed top part, B, hinged together at C, the bottom part projecting beyond the top, as shown, substantially as and for the purpose set forth."

No. 297079.

(J. Frank and Franklin L. Homan, New Haven, Conn.; patented April 15, 1884; apparatus for catching star-fish. See Plate VII.)

An apparatus for the removal of star-fish from oyster-beds. The great destruction of oysters due to star-fish is well known. A dredge or drag to be drawn over the oyster-beds to start the fish from the oysters over which they may be, has, behind it and above its plane, a receptacle in which the fish, naturally rising when disturbed by the drag, will be caught. The oysters which have been disturbed and passed over the drag will fall back between this and the mouth of the receptacle, and be left on the bed. A separate receptacle, however, may be attached directly to the drag and thus below the first, to catch the oysters as they pass over.

CLAIM.

"The combination of the drag A provided with means, substantially such as described, whereby it may be drawn over the surface of the oyster-bed, with an opened-mouthed receptacle, D, in rear of the drag, the mouth arranged to open above the plane of the drag, and so as to leave an open space downward between the drag and the mouth, substantially as described."

No. 256041.

(Ebenezer Pierce, New Bedford, Mass.; patented April 4, 1882; breech-loading bomb-gun. See Plates VIII and IX.)

This invention comprises a combined bomb-gun and harpoon, in which the gun can be charged without detaching the barrel. In this respect it differs from a patent for a similar invention granted the present inventor January 28, 1879, No. 211777. The gun barrel is hinged to the breech-piece so that it can be dropped down or turned away from the breech when the gun is to be charged. Within a chamber in the breech are a hammer, its main spring, and a firing-pin which explodes the charge when struck by the hammer. The chamber is closed by top and bottom plates which prevent the access of water thereto. The journal pins of the hammer project through the sides of the chamber. One of these pins carries a pawl which engages a trigger pivoted to the face plate of the breech-block. On one side of the gun is a rod which is divided near the breech of the gun. The lower portion of this rod is supported by and slides in guides upon the breech piece, and the upper portion is supported by and slides in guides upon the barrel. The outer end of the rod projects beyond the muzzle of the gun. The lower end engages with the firing mechanism in the breech-piece. A spiral spring encircles the upper portion of the rod above the breech, and keeps it from contact with the divided lower portion of the rod. The gun is thrown and when the front end of the rod strikes the body of the whale it is pushed back against the lower portion of the rod, which strikes the trigger and explodes the charge, which projects the harpoon into the whale.

The inventor says:

"Of course it is well understood that as breech-loading guns have long been in use no attempt is made in this application to broadly claim a breech-loading bomb-gun; but by making the bomb-gun breech-loading by hinging the barrel to the breech-piece it is found to be far more serviceable and convenient than in my patent hereinbefore referred to, in which the barrel is not hinged, but must be entirely detached from the breech-piece for loading.

"It is obvious that if in the present instance the rod for firing the gun were held by guides both upon the barrel and the breech-piece, as in the case in my said patent, the barrel could not be turned upon the hinges for purposes of loading; but by carrying the sliding rod which operates the firing mechanism by impact, as before described, solely upon guides on the barrel, the barrel can be turned upon its hinge for the purpose of loading without detaching the rod therefrom. Therefore the rod will be in position on the barrel of the gun at all times and always ready, so that after the insertion of a cartridge the barrel can be closed and the gun will be ready for instant action without necessitating the attaching of the rod. Moreover, the rod cannot be lost, which, were it detachable, would often occur."

CLAIMS.

"1. In a breech-loading bomb-gun, the combination of a hinged barrel with the breech-piece carrying firing devices, a sliding rod adapted to connect with and actuate the firing devices by impact, as described, said rod being arranged in guides on the hinged barrel to move therewith during the act of inserting a cartridge or charge in the barrel of the gun when it is turned on its hinge, as and for the purpose set forth.

"2. The combination, with a breech-loading bomb-gun, of the divided sliding rod, which operates the mechanism employed for firing the charge by impact, one portion of said rod being supported by a guide upon the breech-piece and the remaining part of the rod being supported by guides upon the barrel, whereby the barrel can be turned back on its hinge without disconnecting either of the rods, substantially as described."

No. 256548.

(Patrick Cunningham, New Bedford, Mass.; patented April 18, 1882; bomb gun. See Plates X and XI.)

The object here is to provide a combined bomb-gun and harpoon which may be loaded and unloaded with ease and celerity, and one which will be safe to handle and use, and also one in which can be used the bomb-lance and cartridge combined, patented to this inventor December 28, 1875, which bomb-lance requires a breech-loading gun in which to be fired.

With a hinged-barrel breech-loading bomb-gun is combined a rod, the rear end of which fits in a socket attached to the breech-piece of the gun, that part of the rod which is inclosed in the socket having a spur which passes through an elongated slot in the side of the breech and connects with and actuates the firing devices when the rod is shifted to the rear by force applied at its front end.

CLAIMS.

"The combination of a breech-loading bomb-gun, having a hinged barrel and provided with the slot *l*, with the socket B, having spring *i*, and the rod C, provided with the projection *g*, substantially as shown."

No. 10392, reissue.

(Ebenezer Pierce, New Bedford, Mass.; patented October 9, 1883, original patent No. 256041, April 4, 1882; breech-loading bomb-gun. See Plates XII and XIII.)

The details of the invention are more fully described than in the original patent. The construction and operation of the device are, of course, the same as that of the original patent, a description of which has already been given. The change is in the description and claims.

CLAIMS.

"1. In a breech-loading bomb-gun, the combination of a hinged barrel, with the breech-piece carrying firing devices, and a sliding rod adapted to connect with and actuate the firing devices by impact, as described, said rod being arranged in guides on the hinged barrel to move therewith during the act of inserting a cartridge or charge in the barrel of the gun when it is turned on its hinge, as and for the purpose set forth.

"2. The combination, with a breech-loading bomb-gun, of the divided sliding rod which operates the mechanism employed for firing the charge by impact, one portion of said rod being supported by a guide upon the breech-piece and the remaining part of the rod being supported by guides upon the barrel, whereby the barrel can be turned back on its hinge without disconnecting either of the rods, substantially as described.

"3. In a breech-loading bomb-gun wherein a hollow breech-piece contains the firing apparatus, and a catch is provided to engage with a tumbler-tooth on the hammer-axis when the gun is cocked, a push-rod on the exterior of said breech-piece, adapted, when pushed, to release said tumbler-tooth, in combination with a barrel hinged to the upper edge of one of the sides of said breech-piece, and latched or pinned to the upper edge of the opposite side of said breech-piece, substantially as described.

"4. In a breech-loading bomb-gun, a flat-surfaced breech-piece having a barrel hinged thereto at one of its upper edges on a line with the surface of said breech-piece, and latched or pinned thereto at the opposite edge, substantially as described."

No. 253456.

(Marciene H. Whitcomb, Holyoke, Mass.; patented February 7, 1882; fishing apparatus. See Plate XIV.)

This apparatus, designed to be set after the fashion of a trap, is for fishing through holes in the ice, and when a fish is caught on the hook a signal denoting the fact is automatically displayed. A cylindrical tube forms the body of the apparatus, and into the end of this tube is inserted a stick which serves as a standard. On the outside of the tube is hung a spool to hold the fish-line. The lower end of this spool bears on a stop, the upper end being kept in place by an elastic clasp, which can be moved up and down on the tube, permitting the removal of the spool, and can be set to bear against the end of the spool with sufficient friction to prevent the spool from turning too rapidly. In the tube is a piston, to the upper end of which is attached a pompon, or flag, as a signal, the pompon or flag being drawn into the tube when the trap is set, but shooting up into sight when the trap is sprung. The piston is impelled upward by a coiled spring, one end of which is attached to the tube and the other to the piston. The piston is a rod bent out laterally at its lower end, which projects through a vertical slot in the side of the tube and forms a tappet for co-operation with the tripping-lever, which is pivoted to the outside of the tube and has its inner end hooked to catch upon the lateral projection of the piston, with the other end (when the trap is set) projecting laterally for connection with the fish-line. A loop at a convenient point is tied in the line and hung upon the out end of the tripping-lever. Thence it drops into the water with a hook depending therefrom. When a fish is caught its pull upon the line detaches the hook of the tripping-lever from the lateral projection of the piston, which being freed flies up and displays the signal at the top.

CLAIMS.

"1. The combination of the tubular body, the spring-piston with its signal-top, the tripping-lever, and the fish-line, all substantially as described, and for purposes specified.

"2. The combination of the tubular body, the spool thereon, the spring-piston, the tripping-lever, and the fish-line, all substantially as described, and for purposes specified."

No. 263638.

(Richmond A. Wentworth, Appleton, Me.; patented August 29, 1882; fish-trap. See Plate XV.)

This invention relates to that class of attachments for fishing-lines in which the bait-hook and line, when pulled by the fish, operate a trigger, releasing a spring to jerk the hook suddenly into the mouth. A metal rod has an eye in its upper end for the attachment of the line. Encircling the upper end of the rod, and fastened with one end near its top, is a coiled spring, the lower end of which is fastened to a cross-piece, which slides upon the rod, and is enlarged where the rod passes through it. To this cross-piece is fastened the lower part of the fish-line, to which the bait-hook is attached. This part of the line passes down along the rod and over a small sheave at its bifurcated lower end. Thence it passes through the forked lower end of the trigger and over a little sheave or roller inserted therein. Upon the lower end of the trigger is a spring, the free end of which bears against the lower part of the rod which is grooved longitudinally to receive it, and prevent its slipping sidewise. By moving this spring up or down upon the trigger the force required to spring the trap may be adjusted at pleasure according to the size and species of fish which it is desired to catch. The upper part of the trigger is hinged in a short arm which is fastened upon and projects from the rod.

CLAIM.

"The herein-described fish-trap or hook-spring, consisting of the rod A, spring C, sliding cross-head D, trigger E, having the adjustable spring F, and hook-line B′, passing through the lower ends of rod A and trigger E, all constructed and combined to operate substantially as and for the purpose shown and set forth."

No. 272232.

(Charles J. B. Gaume, Brooklyn, N. Y.; patented February 13, 1883; fishing-tackle. See Plate XVI.)

The fishing-line is thrown out into the water, and the land end is passed over the pulley H, around the cleat or catch O on the arm N, and is received on the cleat C, the arm L having been previously raised and the inner end of the latch-lever M passed into the aperture *a*, and the stud *b* passed under the outer end of the latch-lever M. As soon as a fish touches the hook or the bait on the same, this slight tension on the line will be sufficient to cause the bell at the upper end of the rod of F to ring. If the fish nibbles at the bait, the tension on the line will be sufficient to draw the outer end of the arm N upward, and thus release the outer end of the lever M, which will then swing downward with its outer end, thereby causing the inner end to pass out of the aperture *a*. The spring J will then draw the arm L down very suddenly, and will jerk the line, as the same is attached to this arm L. This jerk on the line pulls the hook into the fish's jaw.

CLAIMS.

"1. In a fishing-tackle, the combination, with the block A, of the slotted tube E, the spring J, the disk K, the arm L, the latch-lever M, and the pivoted arm N, substantially as herein shown and described, and for the purpose set forth.

"2. In a fishing-tackle, the combination with the block A, of the slotted tube E, the spring J therein, the disk K, the arm L, the latch-lever M, the pivoted arm N, provided with a lateral stud, *b*, and the cleat or catch O on the arm N, substantially as herein shown and described, and for the purpose set forth.

"3. In a fishing-tackle, the combination, with the block A, the slotted tube E, the spring J, the disk K, the arm L, the latch-lever M, the pivoted arm N, provided with the catch O, the rod F, provided with the beli G, and the pulley H, substantially as and for the purpose set forth."

No. 279508.

(David B. Tiffany, Xenia, Ohio; patented June 12, 1883; fishing-stake. See Plate XVII.)

The stake is driven into the ground. Inserted into one side at a suitable distance above the ground is a screw-rod or clamping-bolt on which is a line winding-reel. The contact of the inner end of the reel with the stake is prevented by a washer on the screw-bolt. The clamping-rod can be loosened to allow the reel to revolve upon it, or it can be so tightened as to hold the reel rigid and prevent its revolution. On the upper end of the stake is a gong which sounds an alarm when a fish is hooked and draws the line from the reel.

The inventor says:

"I am aware there is nothing new in the mere use of an alarm used in connection with a reel, and I do not therefore broadly claim such a device.

"I am aware that a fishing-stake provided with a reel and an alarm mechanism is not new, and this I disclaim. My invention differs from these in placing the reel upon a clamping-screw, so that the reel can be allowed to freely revolve and thus sound an alarm, or be locked in place, so that the line cannot be drawn off when left at night."

CLAIMS.

"The combination of the stake A, the reel D, the washer F, screw clamping-rod G, which passes through the reel directly into the stake, the projection H on the end of the reel, the spring-actuated hammer J, and gong O, the parts being combined and arranged to operate substantially as shown."

No. 279556.

(Cicero Fisher, Temperance Hall, Tenn.; patented June 19, 1883; fish-trap. See Plate XVIII.)

The invention relates to improvements in fishing-tackle in which, by means of a spring and trigger and hooks, the fish is fastened without jerking the pole by the hand; and the object of the invention is to hook the fish immediately upon its seizing the bait. On the end of the block or pole is fixed a metallic plate, *b*, containing a niche, *c*, for the end *e* of the trigger. When the spring is drawn down to be set the trigger passes through the loop or staple *s*, which is in the end of the block and serves as a rest for the trigger while in the niche *c*, and prevents the end where the line is tied from rising up with the spring.

CLAIM.

"The combination with the block or pole B, provided with loop or staple *s*, of the spring A, trigger T, link *a*, and line L, having one or more hooks, all substantially as and for the purpose described."

No 283444.

(Richmond A. Wentworth, Appleton, Me.; patented August 21, 1883; fish-trap or spring-hook. See Plate XIX.)

The invention relates to that class of spring attachments for fishing lines in which the bait, hook, and line, when pulled by the fish taking the bait, operate a trigger, releasing a spring and suddenly jerking the hook into the mouth of the fish biting; and it consists in an improvement upon the fish-trap, for which letters patent of the United States, No. 263638, were granted this inventor August 29, 1882.

A metal rod has an eye or hole at its upper end to which is attached the fishing line. Encircling the upper end of this rod, and fastened with one end near its top is a coiled spring, the lower end of which is fastened in a cross-piece which slides upon the rod. To this cross-piece is fastened the lower part of the fishing line, to which the bait hook is attached. This part of the line passes down along the rod and through a small piece of cord or wire, which passes through an eye in the lower end of the rod to the lower end of the trigger. On the trigger is a spring, the free end of which bears against the lower part of the rod, which is grooved longitudinally to receive the end of the spring and prevent its slipping sidewise. By moving this spring up or down upon the trigger, the force required to spring the trap may be adjusted according to the size and species of fish which it is desired to catch. Around the top of the rod inside of the coiled spring is placed another small coiled spring, against which the shoulder of the cross-head strikes when the trap is sprung, thus cushioning the stroke of the cross-head.

CLAIMS.

"1. The herein-described fish-trap or spring-hook, consisting of the rod A, spring I, spring C, sliding cross-head D D′, trigger E, having the adjustable spring F, and connected by a cord or wire, *b*, with eye *a*, and hook-line B′, passing through said eye *a*, all constructed and combined to operate substantially as and for the purpose shown and set forth.

"2. The combination, in a fish-trap or spring-hook of the described class, of the rod A, spring C, having cross-head D D′, and cushion-spring I, substantially as and for the purpose herein shown and set forth."

No. 286494.

(Merrill R. Skinner, Hamburg, N. Y.; patented October 9, 1883; fish trap-hook. See Plate XX.)

This invention relates to those hooks which are provided with auxiliary hooks or gaff-hooks, so connected with the bait-hook that a pull on the bait-hook will cause the gaff-hooks to swing down and seize the fish or other animal which is pulling on the bait-hook. The bait-hook is attached to the coil of the spring by a snood. When a fish or other animal seizes the bait-hook and pulls on the same, the draft is transmitted by the spring-arms to the gaff-hooks, which latter are swung outward and downward on their pivots, whereby the spring-arms are distended, until the gaff-hooks have passed a position at right angles to the bail, when they begin to close, this movement being accelerated by the pressure of the spring-arms. The inclined position of the slots produces a wedging action, which tends to facilitate and accelerate the closing of the hooks. As the spring-arms are attached to the gaff-hooks at a short distance from their pivots, the downward movement of the gaff-hooks will be very quick, thereby enabling the gaff-hooks to seize the fish immediately. For some kinds of fish a very light spring is employed for connecting the bait-hook with the gaff-hooks, and if such a light spring is used in the device, and it is desired to use the hook with a greater spring pressure, this is accomplished by stretching a rubber band, *i*, over the spring-arms *e*, as represented in the drawings. The rubber band can be moved toward or from the coil *e′*, thereby reducing or increasing the pressure on the spring-arms, as may be desired. By increasing or reducing the length of the snood *k*, the point at which the fish is seized by the gaff-hooks can be regulated. The gaff-hooks are set by pressing them back into the frame, in which position they are held by the spring.

CLAIMS.

"1. The combination, with a bail D, of gaff-hooks C, pivoted to the bail, a spring B, having its arms *e* attached to the gaff-hooks near their pivots, and a bait-hook, A, attached to the spring B at the junction of its arms, substantially as set forth.

"2. The combination of the bail or frame D, gaff-hooks C C, pivoted to the frame D, and provided with inclined slots *h*, a spring, B, constructed with arms *e*, engaging in the slots *h* of the gaff-hooks, and a bait-hook, A, attached to the spring B, substantially as set forth."

No. 254313.

(William E. Hemming, Redditch, county of Worcester, England, assignor to Charles F. Imbrie, New York, N. Y.; patented February 28, 1882; fish-hook. See Plate XXI.)

The object is to provide barbed fish-hooks with a baiting needle, upon which living bait may be placed and held securely, or upon which a trolling-spoon may be quickly adjusted. A duplex-barbed fish-hook has rigidly secured to and between its shanks one limb of a bent baiting needle, the lower end of the limb terminating in a catch which clasps the lower end of the needle when it is pressed down. When released the needle springs out to an angle with the limb when anything desirable may be slipped upon the needle. The needle may be passed through any small and not necessarily vital part of live bait, and when the needle is held in the catch it will hold the bait securely. A trolling-spoon provided with staples may be adjusted on the pin instead of the live bait, being held by the catch, the same as the bait.

CLAIMS.

"1. As an improved article of manufacture, a fish-hook made substantially as herein shown and described, with a baiting-needle, B, attached to the rear portion of its shank, as set forth.

"2. The combination, with the hooks A, of the spring baiting-needle B and clasp *b′*, substantially as specified.

"3. The combination, with the hooks A and baiting-needle B, of the trolling-spoon C, provided with hooks or staples *d*, whereby said trolling-spoon may be removably attached to and locked next the barbed hooks, substantially as herein shown and described."

No. 264256.

(Frank De Forest, De Soto, Mo.; patented September 12, 1882; fish-hook. See Plate XXII.)

Two hooks with their barbs in opposite directions, and bent so that their barbed ends may separate, are jointed near the top of the shank. The shanks have the usual eyes for receiving the fishing line, which passes through them, so that when it is drawn upon, the upper ends of the hooks are brought together and the barbs are spread. The bait of sufficient size to retain the barbed ends together is placed over the hooks. When thus baited, the hooks cannot separate by being drawn through the water; but when taken by the fish, and the line is thus drawn upon, the barbs spread.

CLAIM.

"The double-jointed fish-hook consisting of the two hooks A pointed in opposite directions, with their points arranged to stand in close contiguity to each other, whereby they are held against being spread apart by the action of the water by the bait placed thereon, and having their shanks looped or bent into eyes around a pivot, *b*, while their upper ends have passed through them the line *c*, all constructed as shown and described, and for the purpose set forth."

No. 280610.

(William N. Greer, Watertown, Dak.; patented July 3, 1883; fish trap-hook. See Plate XXIII.)

The invention has relation to that class of fish-hooks generally known as "lever-hooks", and more particularly to that class of lever-hooks in which the catch-hook is held by means of a clamp. In using this class of hooks it is desirable to be able to set the catch-hook so that it will be released and strike the fish biting on the bait-hook, while it is at the same time desirable to have the catch-hook set in such a manner that it will not strike the fish which may only be nibbling at the bait. To this end the clamp is made adjustable on the shank, so that it may clamp the catch-hook farther from or closer to the fulcrum of the latter, according to the nature and manner of biting of the fish for which the bait is set, more force being required to release the catch-hook when it is clamped far from the fulcrum than when it is clamped near to it. The spring-catch F consists of a strip of spring metal forming an eye, F′, at its inner doubled end, which slides upon rod D. The ends are held together by a small set-screw, G, while its outer ends form wings *f*, which clasp the shank of the hook C, when inserted, in such a manner that by a slight pull it may be drawn out of the said clamp. As the fish takes the bait and pulls upon the bait-hook A, this in turn pulling upon the enlargement B of the upper hook, C, will tilt this upon its fulcrum in the eye *d*, so as to release it from the spring-clamp F on rod D, thereby, by the leverage between the points *b* and *d*, throwing the upper hook downward with considerable force, causing its barbed point to penetrate the body of the fish caught on the bait-hook, so that it will be impossible for the catch to escape.

CLAIM.

"The combination, in a fish-hook of the described class, of the spring-clamp F, forming eye F′, and clamping-wings *f*, having set-screws G and sliding adjustably upon rod D, with the catch-hook C hinged to the end of rod D, and having bait-hook A hinged near its fulcrum, as and for the purpose shown and set forth."

No. 310118.

(William C. Bower, Union Springs, Ala.; patented December 30, 1884; fish-hook. See Plate XXIV.)

To prevent the fish from swallowing the hook, this is provided with a lateral branch arm which may be formed of the same piece of wire as the hook, and by a return or bend of the same.

CLAIM.

" A fish-hook provided with a rigid rearwardly-extending branch arm, B, permanently attached at or near the upper termination of the lower curve of the hook, and on the side opposite the barb *a*, and having a free unattached end, as shown, as and for the purpose intended, substantially as described."

No. 295369.

(Newton A. Dickinson, Chester, Conn.; patented March 18, 1884; trolling-hook. See Plate XXV.)

A tapering stick has a socket in its lower end, into which the upper screw-threaded end of the hook is secured, and has a reduced upper end, forming a shoulder, upon which a cap of lead is placed, having an aperture in its upper end, through which an eyed screw passes into the end of the stick. The eyed screw holds the cap in place, and serves for the attachment of the line. A spring rod or fender is secured at its upper end in the side of the cap, and its lower end is near the end of the hook, serving to fend off any sea-weeds or the like which the hook may meet, while it is sufficiently elastic not to interfere with the catching of the fish that may bite the hook.

CLAIM.

"The combination of a tapering stick having its upper portion reduced to form a shoulder, and having screw-threaded sockets in the ends of the same, a hook having a screw-threaded shank inserted into the lower end of the stick, a cap of heavy metal fitting over the reduced end of the stick, an eyed screw fitting into the upper end of the stick and holding the cap in place, and a flexible or elastic rod or fender fastened into the side of the cap and extending down to near the point of the hook, as and for the purpose shown and set forth."

No. 253308.

(Karl Müller, Hornberg, Baden, Germany; patented February 7, 1882; bait-hook. See Plate XXVI.)

The bait-hook is inclosed within a fish-shaped casing made of two sections. One section is provided, at that part which represents the head of the fish, with helically-bent wings, the other at the corresponding end with a lug which fits into an eye of the head of the section. The edges of the shell can be sprung together. At the interior of the casing is mechanism for throwing forward the catching-hooks applied to a base-plate. The base-plate is retained at its rear end on one section by a retaining strip at the tail of the same, while the front end is secured by a pin and by a latch piece. To the plate are further attached two guide-brackets, by which a rod is guided. This rod is provided with two fixed cones, one near the rear end of the rod, the other near the front end, back of the head of the shell. Between the front cone and a collar attached to the base-plate is interposed a spiral spring, which bears upon the front cone, and which tends to throw the rod in the direction of the arrow shown in Fig. 2. The spring-pressed rod is locked by a recessed latch-piece that is retained at the front end of the rod by a spring, and by a forked rod, and a fulcrumed lever. The latch-piece may be so moved as to clear the rod by pressure upon the rod *w* and lever *x*, which are extended beyond the shell at opposite sides of the head. When the pressure on the rod *w* and lever is released and rod *l* withdrawn the latch *o* again retains the rod *l*. Guide-brackets serve also for the purpose of applying thereto a number of hooks which extend radially from the grooved cone *t* of each bracket, the ball-shaped inner ends of the hooks being retained in the grooves of the cones *t* by collars *v*. The casing is provided with slits for the free outward passage of the hooks when the actuating mechanism is released. The hooks are thrown outward by the cones *m* as soon as the latch *o* is released from the rod and permits the forward motion of the same. The bait-hook is operated in the following manner: A silver string is attached by means of the hole *n* to the front end of the base-plate *g*, and then passed through the two holes *u* at the head of the section *a*, being then connected with a common string, by which the bait is drawn through the water. The fish tries to bite at the head. This causes the pushing in of the parts *w x* by the force of the bite, and consequently the release of the latch *o* and of the rod *l*, which is instantly thrown forward, so that the cones *m* spread the hooks *i*, which pass through the outside of the shell into the mouth of the fish and hold it in such a manner that a release of the same is impossible.

CLAIMS.

"1. In a bait-hook, the combination of a fish-shaped shell, having helically-bent fins back of the head and longitudinal slits in the body thereof, with outwardly-swinging hooks, a spring-actuated mechanism for throwing out the hooks, and a latch mechanism projecting through the head of the shell, whereby the hook-actuating mechanism is locked or released, substantially as set forth.

"2. In a bait-hook, the combination of the longitudinally-guided rod *l*, having fixed cones *m* and spring *p*, with the outwardly-swinging hooks *i*, hinged to the brackets *k*, substantially as set forth.

"3. In a bait-hook, the combination of the outwardly-swinging hooks *i* and guided slide-rod *l* with a recessed locking-latch, *o*, spring *o′*, forked rod *w*, and fulcrumed lever *x*, substantially as specified.

"4. In a bait-hook, the combination of the guide-brackets *k*, having each a grooved cone, *t*, with hooks *i*, retaining-collars *v*, shell *a b*, hav-slits *i′* for the hooks *i*, and means for operating the hooks, substantially as set forth."

No. 256843.

(William T. J. Lowe, Buffalo, N. Y.; patented April 25, 1882; spoon-bait for fishing. Patented in Canada January 28, 1882. See Plate XXVII.)

The invention relates to that class of spoon-bait in which the lower portion of the spoon is adjustably held out from the rod upon which it revolves. Heretofore spoons have been made with U-shaped guides rigidly secured thereto and embracing the rod upon which the spoon revolves, and having spiral springs surrounding the guide between the spoon and rod. In such construction the U-shaped guide, which projects from the rod, is apt to catch upon the side of the boat or elsewhere and become bent or broken. Again, spoons have been made with a wire secured at the botton of the spoon and extending in a curve downward to the rod, and there loosely secured by an eye in the end of the wire. This form of spoon-bait, like the other just described, is liable to catch upon objects with which it comes in contact. To avoid the difficulty, the spoon is provided with a wire spring, located near the top, or where the spoon is loosely secured to the rod upon which it revolves. The spring is provided at a point near the spoon with one or more spiral turns to give it the proper degree of elasticity. By locating the spring at the upper end of the spoon it is entirely protected by the spoon from being torn away or damaged.

CLAIM.

"The combination, with the rod *a* and the spoon *d* provided with the eye *d'*, of the spring *e*, having the spiral turn or turns e^2, and the eye e^3, the spring *e* being located near the top of the spoon and being rigidly attached to the spoon at one end, and working loosely upon the rod *a* at the other end, substantially as shown and described."

No. 261194.

(Lewis C. Wylly, Patterson, Ga.; patented July 18, 1882; trolling-spoon. See Plate XXVIII.)

This invention relates to that class of baits or decoys, used by fishermen, known as "spinning baits" and trolling-spoons." Ordinarily spinners have had the hooks upon which the fish are caught arranged at some distance from the spinning spoon. Here the hooks are placed directly upon the spoon, which is screw or scroll-shaped, or auger-curved, and of a single piece of metal tapering at the ends, with the barbs above the lower end. A shackle-link is fastened at its lower ends directly to the upper end of the spoon and receives a swivel to which the line is attached.

CLAIMS.

"1. In trolling-baits, the spinner A, consisting of a single piece of metal of elongated screw form, and having taper or convex ends, substantially as and for the purpose set forth.

"2. The elongated screw spinner A, having hooks B rigidly secured to the faces of said screw at equidistant intervals, substantially as and for the purpose set forth."

No. 267203.

(Lysander S. Hill, Grand Rapids, Mich.; patented November 7, 1882; spoon-bait. See Plate XXIX.)

A wire has a loop upon its upper end for the attachment of the swivel or the line and a loop upon its lower end for the attachment of the hook. The inner ends of these loops form stops to limit the movement of the spoon in its vertical play upon the wire. The upper end of the spoon is provided with a loop, which serves as a means of attachment to the wire at this point, and below this upper end there is hinged to the spoon a rod, which has a loop formed on its outer end to catch over the wire and an S-shaped stop on its inner end to strike against the spoon, and thus prevent the spoon from dropping too low. This rod being pivoted to the wire, any pressure upon the lower end of the spoon will cause it to close inward toward the wire and then rise upward, and as soon as the pressure is released the spoon at once drops downward and outward at its lower end. The weight of the spoon is made to operate it entirely, and thus springs are dispensed with.

CLAIM.

"The combination of the wire A, the spoon D sliding thereon, and a hinged connecting-rod, I, having the stops O formed on its outer ends for striking against the spoon, substantially as shown."

No. 273996.

(Christopher Hymers, Saint Louis, Mo.; patented March 13, 1883; self-adjusting fish-shaped fish-hook holder. See Plate XXX.)

This invention is, in some respects, an improvement on the invention described in a patent granted to this inventor January 4, 1881, No. 236161, the hook being held between similar expanding jaws. There is, however, in addition, a safety-hook that may be used to prevent the opening of the jaws by the impingement of the fish's head against the hook when used in trolling. The jaws in this improvement are pushed into their conical socket and held therein by a spiral spring in place of a cam, as before. A spoon is provided, having its body slit transversely and the slit portions bent out in opposite directions to form bands, adapting the spoon to be slipped on and off the bait without disturbing the hook.

CLAIMS.

"1. The combination of the gripping-jaws I, link L, knob M, and spring O, forcing the jaws into a tapering socket of the metal fish F.

"2. The combination of the parts I, L, M, O, and fish F of the safety-hook P, substantially as and for the purpose set forth.

"3. The spoon S, having bands *s*, adapted to be applied to fish-hook body F, as set forth."

No. 276055.

(William T. J. Lowe, Buffalo, N. Y.; patented April 17, 1883; spoon-bait for fishing. See Plate XXXI.)

The invention relates more particularly to certain improvements in spoon-bait for fishing for which a patent was granted this inventor April 25, 1882, No. 256843. It is found in practice that the spoon arranged as shown and described in the above-named patent is liable, in rapid trolling, or when the spoon is drawn through the water against a strong current, to spread too far for advantageous results, and remain so until the wire spring is bent into shape again by hand. This is said to be a serious objection to the perfect working of the spoon-bait, and the object of the present invention is to overcome this difficulty. To this end, to the spoon-bait of the previous patent is applied a link loosely pivoted at both ends, which connects the spoon with the rod or wire upon which it revolves in such a manner as to limit its outward movement without disturbing in any degree its free revolution in the water.

CLAIMS.

"1. In a spoon-bait for fishing, in combination, the spoon *d*, provided with the eye *d'* at its upper end, and the loop or bend *f* upon its inner surface, the spring *e*, located near the top of the spoon, as shown, and provided with the eye e^3, and a connecting-link loosely pivoted at one end in the loop or bend *f*, and loosely encircling at its other end the outer portion of the spring *e*, as and for the purpose stated.

"2. In combination, the rod or wire *a*, the spoon *d*, provided with the eye *d'* at its upper end, and the spring loop or bend *f* upon its inner surface, the spring provided with the eye e^3, and connecting-link *g*, having the eye *g'*, as and for the purpose stated."

No. 281083.

(Louis Kessler, Ludington, Mich.; patented July 10, 1883; fishing apparatus. See Plate XXXII.)

In the usual construction of spoon-bait, the forward end of the spoon is rigid with or hinged to the rotating sleeve, allowing it to yield to a certain degree to the pressure from forward as it is drawn through the water, but still causing it to offer a large amount of resistance, and consequently present a severe strain upon the line, especially if drawn with considerable speed. To avoid this the spoon is attached to the ends of coiled springs fastened to the rotating sleeve, at the center of the inner concave side of the spoon, allowing it to tilt away from the sleeve when drawn speedily through the water, and thus causing it to present only its point, as shown in dotted lines in Fig. 2, and so offer less resistance.

CLAIM.

"In a spoon-hook, the rotating spoon-shaped shield fastened at the center of its inner concave side to the outer ends of coiled springs fastened to the side of the rotary sleeve, as and for the purpose shown and set forth."

No. 289508.

(Artemas Lord Dawson, Elk Point, Dak., assignor one-half to Charles Howard Freeman, of same place; patented December 4, 1883; fish-hook. See Plates XXXIII and XXXIV.)

The hooks are detachably secured in place within grooves in the shaft, and a spoon of peculiar construction may be used, in connection with the hook device, for trolling. The shaft has an enlargement at its lower end which is provided with longitudinal grooves at its sides, which open into cross-grooves provided at its top. The shanks of the hooks are laid into the longitudinal grooves, with their upper ends projecting sufficiently beyond the enlargement of the shaft, the points of the hooks being turned outward, and the projecting ends of the shank are then bent down into the cross-grooves, forming a catch securely to hold the hook against a downward pull. A thimble, fitting the enlargement, is then pushed down upon the same, and is held in place firmly by a screw-nut, the shaft being threaded just above the enlargement for the purpose. At the end of the shank there is an eye for the attachment of the line. The hook may be used thus, but for trolling a spoon or spoon-bait is attached. To permit the ready attachment or detachment of the spoon, the shaft is provided between its enlargement and the eye with an annular projection or collar, and the spoon has a spring wire loop, which is passed over the shaft between the collar and the eye, then with its legs along lateral grooves or recesses in a projection at the upper end of the spoon, and downward from its concave face, and then has its bent ends sprung into holes in the spoon. Below these holes is the attachment of a spring which extends toward the lower end of the spoon on the concave side, has its end bent upward, projecting through a hole in the spoon, and bears against a hinged fin on the convex surface of the spoon. The fin causes the spoon to revolve in the shaft of the hook as it is drawn through the water, and while the spring holds it out in proper extension it permits the hinged fin to be pressed against the body of the spoon when desirable, as in withdrawing the spoon from the mouth of a fish. For trolling, feathers may be secured upon the thimble.

CLAIMS.

"1. In combination with the shaft A, provided with grooves, and with the screw-threads *s*, fish-hooks B, fitting within the said grooves, and thimble C, to incase the said shaft and hooks, and the nut *t*, working on the said screw-threads, as and for the purpose described.

"2. In a device for fishing, a spoon provided with a fin secured by its edge to one face of the spoon, at an angle to the axial line thereof, whereby a progressive motion of the spoon through the water causes it to rotate, substantially as described.

"3. In combination with a shaft or holder for the hooks, the trolling-spoon D, provided with a projection, *r*, or similar device, and the spring *o*, to embrace the shaft or holder A and the said projection, having its ends detachably secured to the said spoon, substantially as described.

"4. In combination with a trolling-spoon, the fin E, hinged at one edge to one face of the spoon, at an angle with the axial line of the same, and a spring to hold the said fin at an angle with the face of the spoon when acted against by the water, substantially as described.

"5. In combination with a trolling-spoon, D, fin E, hinged in an oblique position to one face of the said spoon, spring *m*, secured to the opposite face and passing through an opening in the said spoon, to maintain the fin at an angle to the spoon in opposition to the passage of the water, and mechanism for connecting the said spoon to the shaft or holder for the hooks, substantially as described."

No. 295350.

(William Dudley Chapman, Theresa, N. Y.; patented March 18, 1884; artificial fish-bait. See Plate XXXV.)

This invention relates to revolving metallic bait used in trolling for fish, or so-called "minnow-propellers;" and it consists in an improvement upon the minnow-propeller, for which a patent was granted this inventor July 5, 1870, No. 104930. Two corresponding plates of silver-plated or nickel-plated sheet metal are cut of the shape shown in the drawings, each plate being gradually enlarged toward its rear end, where it is provided with a series of notches. At their upper reduced ends these plates are fastened upon a small metallic tube. They are then bent around said tube in opposite directions, and again fastened to it near its lower end. An open space is left on opposite sides of the central rod or tube, whereas in the minnow propeller shown and described in patent No. 104930 the contiguous concave faces of the two plates are secured together the greater portion of their length. By the improved construction not only is the resistance of the water reduced when the device is used for trolling, inasmuch as the water will pass between the central tubular rod and the openings or water-ways on both sides of the same, but the device will revolve with greater speed and regularity than the old one, without reducing its strength or increasing the cost of manufacture. That part of the tubular stem which is between the points of attachment of the plates is wrapped with foil, which is held in place by silk cord of variegated colors, or fine wire twisted spirally around the tube. This adds to the attractiveness of the bait without materially increasing its cost. The lock-snood is of ordinary construction, and upon its central portion the tubular stem D rotates.

CLAIMS.

"1. The artificial trolling-bait, composed of the central tube D, the curved plates A B, of gradually-increasing width toward their lower ends, having the notches C, and fastened to the central tube at the points E and F, whereby open spaces G are left on opposite sides of the tube, between it and the contiguous edges of the plates, and the lock-snood C′, inserted through the tube, all constructed and combined substantially as and for the purpose set forth.

"2. The artificial trolling-bait, composed of the central tube D, having a foil envelope or wrapping, H, held in place by cords or a fine wire, I, the curved plates A B, of gradually-increasing width toward their lower ends, having the notches C, and fastened to the central tube at the points E and F, whereby open spaces G are left on opposite sides of the tube, between it and the contiguous edges of the plate, and the lock-snood C′ inserted through the tube, all constructed and combined substantially as and for the purpose set forth."

No. 295758.

(Charles B. Hibbard, Grand Rapids, Mich.; patented March 25, 1884; spoon-bait. See Plate XXXVI.)

The invention relates to spoon-baits of the class wherein the spoon is attached to a supporting-wire by a yielding connection which permits the spoon to be moved inward, and, when the pressure is released, to return to its ordinary position. The object is to simplify the construction of the connecting devices, and also to locate them so that they will not interfere with the action of the spoon or with the line. The spoon has at its forward end an eye which slides upon the rod, and is limited in its motion by the inner end of the loop. Upon the spoon is soldered a spring composed of a length of wire bent to form a double spring and having its bent portion formed into a loop. Between the parallel sides of the spring is soldered a stop, the free end of which is curved outward and then down. The spring is connected to the wire by an arm or lever, having at one end an eye which slides upon the rod, and at the other end a curved loop, which is illustrated in detail in Fig. 2. The straight portion of the lever passes between the parallel sides of the spring, and is then curved around and under the spring, the lower portion of the loop fitting into the space left by forming the curve in the end of the stop. The spoon may now revolve on the wire and slide freely back and forth thereon. At the same time the spoon may be pressed inward, which will cause the loop on the end of the lever to work under the spring and slightly raise the same, the stop limiting such motion at the proper point. When the pressure is released the return of the spring forces the loop outward, and thereby changes the relative position of the spoon and its supporting-wire, until these parts assume their first position.

The inventor says:

"I am aware that spring connections between the spoon and its supporting wires are not new, and I do not make any claim, broadly, to such construction, my claims being limited to the improvement in details which I have invented."

CLAIMS.

"1. The combination of the wire A, the spoon C, the spring D, secured to the spoon, and the independent lever F, connected to the spring at one end, as described, and at the other to the wire A.

"2. The combination, with the wire A and sliding lever F, of the sliding revolving spoon C, having the doubled spring-rod D and stop E, substantially as described."

No. 271424.

(Harry Comstock, Fulton, N. Y.; patented January 30, 1883; artificial bait. See Plate XXXVII.)

An artificial fish or insect is provided with fins or wings, each of which is capable of independent and substantially axial rotation, so that as the bait is drawn through the water its fins or wings will, by their free and rapid rotation, give a highly animated appearance to the object.

CLAIMS.

"1. An artificial bait for fishing, consisting of an artificial fish or insect having independently rotating fins or wings, substantially as described.

"2. An artificial fish or insect having fins or wings supported to turn upon the arms of a rod extending out from the sides of the insect or fish, substantially as described.

"3. An artificial fish or insect provided with a rod passing transversely through its body, and having its projecting ends bent back with fins or wings fitted to turn upon said arms, substantially as described.

"4. The combination, with a rod to which the line and hook are connected, of an artificial fish or insect fitted to turn on said rod, and provided with swinging and independently rotary fins or wings, substantially as described."

No. 272317.

(Ernest F. Pflueger, Akron, Ohio; patented February 13, 1883; artificial fish-bait. See Plate XXXVIII.)

Coats the showy or attractive parts of artificial bait with a substance which will be luminous in the dark. This substance may be applied upon the outside, or upon the inner surface when the bait is hollow and of glass.

The material used is in the form of a paint, and may be either self-luminous, as phosphoric compounds, or luminous "by an inherent retentive power, whereby after having been exposed to light it remains luminous for hours afterward." The substance preferred is a paint composed of sulphide of calcium and a drying oil or varnish.

A bait thus made can be used as any ordinary bait in the daylight, and at night, or in the shaded and darker places in the water, it becomes luminous and affords a bright object to attract the fish.

The inventor says:

"I am aware that lamps, lanterns, and luminous objects have been employed as decoys to entice fish into nets and to bait."

CLAIM.

"As a new article of manufacture, an artificial fish-bait, coated with a substance which is luminous in the darkness and having one or more fish-hooks attached thereto, substantially as and for the purpose specified."

No. 284056.

(Ernest F. Pflueger, Akron, Ohio; patented August 28, 1883; artificial fish-bait. See Plate XXXIX.)

The bait is hollow, and of malleable glass. On the upper half of the interior surface is deposited silver or gold liquid, to produce a highly reflective appearance. The lower half of the interior surface is coated with any suitable luminous composition, either self-luminous, as phosphorous compositions, or "luminous by an inherent retentive power." The substance named is a paint composed of sulphide of calcium and a drying oil or varnish. Longitudinally through the bait is passed a snood, to which the hook is attached. The hook and snood are held in position, and the interior coated surface of the bait is protected, by a filling of cement, or other suitable material, which also gives to the bait the proper weight or buoyancy.

The inventor says:

"I do not wish to lay claim, broadly, to the idea of a luminous fish-bait, as that has already been secured to me by letters patent No. 272317."

CLAIM.

"As a new article of manufacture, an artificial fish-bait, composed of hollow glass, having the upper half of its interior surface coated with silver or gold fluid to produce a highly reflective surface, the lower half of the interior surface coated with a luminous compound or paint, and a centrally-arranged hook-snood, the whole protected by a filling of cement or other suitable material, substantially as and for the purposes set forth."

No. 289612.

(Carl L. Boilerman, New York, N. Y.; patented December 4, 1883; rotary leader link for fishing lines. See Plate XL.)

The invention relates to that class of fishing lines generally termed "hand-lines," in which there is a weight at the end which goes into the water, and above the weight two or more knots, which are made to receive the snells carrying the hooks. The land end of the line is secured to the person of the fisherman, or to the bank or boat on which he may be. The fisherman throws the leaded end of the line out in the stream, where it sinks to the bottom, leaving the snells with their hooks at varying distances from the ground and from the lead. In throwing out the line the latter receives a greater or less number of turns, whereby the snells become wrapped about or tangled up with the line; and it is the object of the invention to produce a hand-line not open to this objection.

C represents a fishing line, which has been cut at two points, and between the cut ends are rods AA. On each rod is a loose tube, D, having at right angles thereto a fastening, E, which is rigidly attached. This fastening is a wire, coiled about the tube, one of its ends being bent to form a hook for convenient attachment and detachment of the snell F. At each end of the rod is an eye, to which the cut ends of the line are attached. A coil is made on the inside of each eye, and against this is a bead, H, with which the tube comes in frictional contact when the line turns. By this means the snells F will always assume the position shown in the drawing when the lead has reached the bottom, thus avoiding the usual tangle.

The inventor says:

"I am aware that it is not broadly new to apply a rotatable sleeve or cylinder to a rod having an eye to adapt it for attachment to a line. For example, patent No. 271424 illustrates a trolling or spoon bait, in which the body of the bait represents a fish or insect, and is applied eccentrically to a rod, around which it is free to rotate. Nor is it novel to reduce friction by means of beads of glass or other equally serviceable material."

CLAIM.

"The improved attachment for fishing lines, consisting of the rod A, having a loop and coil at each end, the beads H, placed in contact with said coils, the tube D, made concentric with said rod, around which it is free to rotate, the fastening E, applied to the tube, and the snell F, secured to said fastening, all as shown and described, to operate as specified."

No. 258393.

(Francis Endicott, Clifton, N. Y., assignor to Charles F. Imbrie, New York, N. Y.; patented May 23, 1882; fly-book. See Plate XLI.)

This invention relates to books used for carrying fishing flies and snelled hooks, and is to prevent the flies from becoming tangled, and to permit their convenient insertion and removal. At the top or bottom of each leaf are attached metal clips, and at the opposite end of the leaf are retainers. These are spiral springs attached at one end by a thread sewed into the material of the leaf, and formed at the other end with an eye for attachment of the snell. A thread, preferably of silk-worm gut, passes through each spring to a point below it and through the leaf to and through the spring on the opposite side. This holds the springs in place when the flies are detached, and at the same time allows the springs to stretch. At the edges of the leaves a re-enforcing strip of metal is secured between the two sheets to protect the edges and stiffen the book. The clips and retaining springs may be alternated on each end of the leaf, and intermediate retainers applied for shorter snells.

CLAIM.

"In fly-books, the threads *d*, in combination with retainers *b*, as and for the purpose described."

No. 275703.

(Henry F. Price, Brooklyn, N. Y.; patented April 10, 1883, fishing-tackle case. See Plate XLII.)

A box is divided by a horizontal partition longitudinally into two compartments, each compartment being provided with a separate lid. The compartment shown in fig. 1 has near each end a rigid transverse strip of less depth than the compartment to retain in place a strip of cork placed just outside of it. At the center of the inside of the compartment is a shallow well, its top flush with the inside of the case. The well is of sufficient depth to contain coiled lines, leaders, &c., which are held in place by two strips or guards which cross the top. The points of the hooks are stuck into the cork strips, and the snells to which the hooks are attached are passed from each end under the well, little uprights or strips there serving to separate them and keep them in place.

The other compartment may be divided in any desirable manner, as shown in Fig. 2.

CLAIM.

"A fishing-tackle case consisting of two compartments having a single partition adapted to serve as the bottom of both, and provided with the partitions *a*, cork strips *b*, and well *c*, substantially as shown and described."

No. 294888.

(Chancellor G. Levison, Brooklyn, N. Y.; patented March 11, 1884; fishing fly-book. See Plate XLIII.)

Fly-books, as commonly made, are provided at one end of the leaves with fixed hooks or clips, into which the fly-hooks are hooked, and at the other end of the leaves with spring-retainers, which are provided with hooks, on which the loops at the end of the snells are secured. These retainers are elastic, so that they will hold the snells stretched taut, and they usually are formed by rubber bands or spiral springs of light wire. To hold the retainers in position and prevent them from becoming entangled when not holding snells separate eye-guides, one for each retainer, are provided, and through these the retainers, free to move lengthwise thereon, severally pass. Two forms of eye-guides are shown. The eye-guides for the spiral-spring retainers consist each of a short tube. Those for the india-rubber retainers consist of rings, and two eye-guides, which are coincident with each other on opposite sides of the leaf, are formed of a single piece of tube or of a single ring, which is flattened slightly and inserted through a slot in the leaf as in Figs. 2 and 3. The single tube or ring thus applied, serves as an eye-guide for two retainers, one on each side of the leaf, and is held in place by the retainers passing through it. At the other end of the book, corresponding hooks or clips on opposite sides of the leaf are secured by a single rivet. To get, without lengthening the book, a retainer capable of considerable elongation, at the left hand of Fig. 1 is shown a spiral-spring, attached at one end to the leaf and at the other to a cord which passes around a pully, and has at its free end a hook. When the looped end of a snell is attached to the hook the spring will be elongated in a downward direction, while the cord will be drawn upward. Eye-guides may be applied both to the spring and attached cord. The pulleys are attached to the leaf by a wire inserted through the leaf, then bent up into U-shape, and then turned outward at a right angle, the portions of the wire thus projecting laterally from the leaf on opposite sides serving as the journals for two pulleys, one on each side of the leaf, and the ends of the wire being then turned down to prevent the pulleys from coming off the journals.

CLAIMS.

"1. The combination, with the leaf of a fly-book having hooks or clips at one end and elastic or spring retainers at the other end, of eye-guides for the several retainers, each attached to the leaf and receiving a retainer through it, substantially as herein described.

"2. The combination, with the leaf, of elastic or spring retainers on opposite sides thereof, and an eye-guide consisting of a tube or ring inserted through the leaf and receiving the two said retainers through its portions which are presented on opposite sides of the leaf, substantially as herein described.

"3. The combination, with the leaf A, having hooks or clips *a* at one end of retainers, each consisting of the spring D and attached cord D^2, and a pulley, *f*, around which said cord passes, substantially as herein described."

No. 252628.

(Sylvester E. Smith, Saint Louis, Mo.; patented January 24, 1882: combined sinker and fish-hook holder. See Plate XLIV.)

The shank of the hook is inserted into a tubular recess in the fish-shaped holder or sinker, one part of the recess being formed by a cam, which, when turned, firmly gripes and holds the hook-shank. The line is attached to the center of the holder, so that the holder and hook will assume a horizontal position.

CLAIMS.

"1. A sinker for fishing lines, formed in imitation of a fish and provided with a holding device for the fish-hook, as described, and for the purpose set forth.

"2. A fish hook holder formed with a tubular recess, *b*, in combination with the cam B, all arranged as herein described, and for the purpose set forth.

"3. A sinker for fishing lines, provided with a device for holding the fish-hook and an eye, *c'*, located as described, for the attachment of the line, as described, and for the purpose set forth."

No. 279206.

(Henry Van Altena, Milwaukee, Wis.; patented June 12, 1883; fishing-tackle. See Plate XLV.)

The object is readily to attach hooks and sinkers to the lines. The description is exceedingly crude and inartificial, but the following, based principally upon the drawing, would seem to describe the invention exactly.

A rod or wire is bent upon itself at its ends to form loops, and in such manner that a short shank will project beyond the loop along the body of the wire. The wire is elastic, and so the shank tends to spring away from the body of the wire and open the loop. In this condition the loop is ready for attachment or detachment of the line or of snells or hooks. To close a loop and retain it so, the shank is pressed against the body and an annular piece of metal on the body is slid over it. The annular piece of metal serves as a sinker and may be a piece of spirally coiled wire. If two hooks are directly attached, their points may be kept in opposite directions by means of the loop.

CLAIMS.

"1. The combination of the rod A, provided with loops C C, with sliding sinkers adapted to retain the loops in a closed position, substantially as set forth.

"2. The combination, with the rod A, of spiral-wire sinkers adapted to retain the loops at its respective ends in a closed position, as shown.

"3. The combination of the line E, rod A, sinkers B, cord F, and hook D, substantially as shown."

No. 285075.

(Hale Rix, San Francisco, Cal.; patented September 18, 1883; sinker for fishing tackle. See Plate XLVI.)

A sinker for use in connection with a line employed for fishing purposes, and commonly designated as a "hand-line" or "lead-line," in contradistinction to such lines as are used with a rod.

In fishing, it is said, with an ordinary sinker (made usually of lead cast in conical form, with an opening near the apex for the attachment of the line) great inconvenience has been experienced, owing to the fouling of the sinker with rocky obstructions upon the bottom of the fishing ground, such fouling frequently resulting in the parting of the line, and loss of the sinker; and the object of this invention is to avoid these difficulties and provide a sinker which may be easily and quickly disengaged from any cramped or wedged position among rocks or other obstructions upon the bottom of the sea or fishing ground.

To this end the sinker is made of cylindrical form with semispherical ends, and has side rods, upon each of which travels a ring to which the line is attached. The rods of wire extend a short distance from the sides of the sinker and lengthwise thereof up to a short distance from each end. These rods form travelers for metal rings which slide on them, and to the rings is attached a bifurcated cord or line. Should the sinker while in use meet with any obstruction, a steady pull upon the line converts the sinker into a lever of the second class (in the specification it is said to be of the third) and causes it to move or fulcrum upon that end nearest the line, and as the strain continues or increases the sinker assumes a vertical position and the rings slide upward upon the guide rods, throwing the sinker over and releasing it.

CLAIM.

"A sinker or plummet for fishing-tackle consisting of a cylindrical body, A, having rounded ends and projecting guide-rods, B B, extending lengthwise of the body and adapted to carry the rings or loops D D, to which the line is attached, substantially as shown and set forth."

No. 286188.

(Daniel Erickson, Chicago, Ill.; patented October 9, 1883; sinker for fish nets. See Plate XLVII.)

Heretofore, it is said, sinkers had either been formed of certain predetermined lengths and tubular, their only method of attachment to the lines or nets being to string them thereon before knotting the line to the net, or by splitting shot and then placing them on and pinching the open edges over the line. In each of these constructions fishermen are confined to the use of such sizes of sinkers only as are to be found in the market.

In the present case cylindrical sinkers are formed with a deep longitudinal groove enlarged at its bottom, into which the line is laid and there secured by contracting the outer edges of the groove, and the sinker-lead is drawn or rolled in continuous rods that can be sold in coils or by the yard, and can be cut off by the fishermen to form sinkers of various lengths and suitable weights as they may require them on different nets.

CLAIM.

"As a new article of manufacture, a sinker for fishing-nets, composed of a cylindrical bar of lead provided with a slot, *a*, enlarged at its bottom, as and for the purpose set forth."

No. 261505.

(Oliver G. Wilson, Gallatin, Tenn.; patented July 18, 1882; fishing-float. See Plate XLVIII.)

The body of the float is of cork, wood, or other light material, and has a central opening extending longitudinally through it. The float stem of hard wood or composition, and either solid or in sections, is inserted into this opening with its ends projecting above and below the body. Thread is wound around the tapered ends of the float-body binding it firmly to the stem and protecting the ends. In the ends of the stem are longitudinal guide holes extending inward. From these extend counter holes to the exterior of the stem. Between the guide holes and the body of the float are holes which extend diagonally through the stem. The float is strung upon the line by the holes in the stem. The friction of the line at the holes prevents the moving or slipping of the float when the line is suddenly jerked. The line passes out of the float at the upper end of the stem, which causes the float to sit perpendicularly on the water, and prevents the wrapping or tangling of the line about the stem.

CLAIM.

"The combination, with the body *a*, of the stem *b*, provided at each end with the stem-guide holes *d d'* and friction-holes *e e*, substantially as described, and for the purpose set forth."

No. 270358.

(Ralph W. E. Aldrich, Northampton, Mass.; patented January 9, 1883; fishing-float. See Plate XLIX.)

The float is made of a block of wood in form of a boat, and is from a foot to a foot and a half in length, and has a recess formed in it. In this recess is a sheet-metal housing, in which is journaled the reel, on which the line to which the fish-hook is attached is wound. The shaft of the reel terminates at one end in or is provided at one end with a crank for winding in the line, and for setting or locking the reel and mast by means of rods attached to the deck of the float, as shown in Fig. 3. The mast is attached to the float by springs. These springs are fast to a metal socket in which the lower end of the mast is held, and are placed upon a rod which is held in the upright plates which are a part of a plate secured to the float. The free ends of the springs are of considerable length, and extend in rear of the rod and rest in the plate, as shown in Fig. 2, and thus serve to hold the springs so that they will lift the mast when released.

The sail is attached to the mast by rings which are attached respectively to the boom and gaff, and is hoisted when the mast is lifted to vertical position, by the cord *j*, which is attached to a ring and passes through a block, and thence down to the stern of the float, where it is made fast in an eye, as shown in Fig. 1.

In the keel of the float is a small hole immediately under the reel for the passage of the baited hook and line, and in the stern of the float is an eye for attaching to the float the anchor-line.

To prepare the float for fishing, the hook is first to be baited, then passed through the hole *a*, and the length of line required drawn off from the reel. The mast is then to be brought down to the deck of the float, and the rod *h'*, passed at right angles over it and under the rod *h*, and this rod *h* is then to be placed under the crank *f* of the reel, which will cause the rods to hold the mast and reel. In this condition the float is to be anchored out in the water and the hook dropped. The mast and reel will remain in this locked condition until the line is disturbed sufficiently by the biting of a fish to turn the reel, whereupon the crank will be moved off from the rod *h* and set the reel and mast free, thus giving play-line to the fish and signaling the biting or catching of a fish.

In most cases the fisherman will provide himself with several of the floats, and after anchoring them out in the water will await the hoisting of a sail, upon which he will proceed to the float, pull in the fish and rebait the hook and reset the float, and in most cases the bottom of the floats will be painted green, so that when in the water they will resemble the leaf of some water-plant and not frighten the fish.

CLAIMS.

"1. The combination, with the float A, of the spring-supported mast B, reel C, and means, substantially as described, for locking the mast and reel in the manner and for the purposes set forth.

"2. The automatic fishing-float, made substantially as herein shown and described, consisting of the float A, spring-supported mast B, reel C, sail D, and locking-rods *h h'*, as and for the purposes set forth.

"3. The float A, formed with the recess E and hole *a'*, in combination with the reel C, housing *d*, and line *a*, substantially as shown and described.

"4. The reel C, having the handle *f*, in combination with the rods *h h'* and spring-supported mast B, substantially as and for the purposes set forth.

"5. The combination, with the spring-supported mast B, of the sail D, block L, and cord *j*, made fast to the float, substantially as and for the purposes set forth."

No. 290154.

(Victor Vidal, jr., Pignans, France; patented December 11, 1883; fishing-float and method of manufacturing the same. See Plate L.)

Avoids unnecessary waste of cork, by using slabs, plates, or small pieces of cork from which is built a float of approximately the shape required without cementing or otherwise gluing the several pieces, plates, or slabs together, though this may be done if desired. When the float is built up as described (which may done in a suitable matrix or form) it is subjected to compression, and the pieces are tied together with cord or wire; when so tied the pressure upon the float is removed. The ties sink into the cork and form grooves for the reception of the cord for attaching the floats to the object to be buoyed. After the pressing the float may be cut or turned into any shape desired.

CLAIMS.

"1. The method of constructing floats for fishing-tackle and utilizing refuse cork, which consists in subjecting scraps or pieces of cork to pressure, and tying, while subjected to pressure, to form a practically homogeneous mass, and finally shaping the float, as described.

"2. A float for fishing-tackle, composed of scraps or pieces of cork having grooves *c*, in combination with the tie *b*, all arranged and constructed substantially as and for the purposes specified."

No. 252554.

(Julius Vom Hofe, Brooklyn, E. D., N. Y., assignor to himself and Charles F. Imbrie, New York, N. Y.; patented January 17, 1882; fishing-reel. See Plate LI.)

The object is to provide for adjustment of the bearings, so that wear can be readily compensated, and to this end screw-pivots are provided. The reel is sustained by pivot-screws tapped through the outer end-plate and the cap-plate, and having conical ends entering recesses of the same form in the ends of the axis, so that by turning the screws in and out the reel can be positioned and adjusted. The arbor of the crank-pinion has a bearing at one end in the inner end-plate, or the end-plate adjacent to the cap-plate, and at the other end is sustained by a screw-sleeve fitted in the cap-plate. The arbor has a beveled portion within the sleeve, and the sleeve is correspondingly beveled at its outer end, so that by endwise adjustment of the sleeve the arbor is set to run smoothly without endwise motion. An outer sleeve screwed on the first sleeve and against the cap-plate, serves as a set-nut and gives a finished appearance. The pivot-screws for the reel are covered by screw-caps, which serve as set-nuts and protect the projecting screws.

CLAIMS.

"1. In a fishing-reel, the combination, with the frame *a b*, the cap *c*, and the axis *i*, having conical recesses in its ends, of the pivot-screws *h*, having conical ends, and the caps *m*, screwed upon the said pivot-screws, substantially as and for the purpose set forth.

"2. In a fishing-reel, the combination, with the plates *a c*, and the arbor *e*, having beveled portion *k'*, of the sleeve *k*, having its outer end beveled, and the outer sleeve, *l*, substantially as and for the purpose set forth."

No. 253090.

(Warren Ohaver and Taylor O'Bannon, Indianapolis, Ind., assignors to the American Reel Company, of same place; patented January 31, 1882; fishing-reel. See Plate LII.)

The multiplying gear and an alarm-bell are inclosed in a cap on the crank end of the fishing-reel. A sleeve upon the outer plate of the cap serves as the sole bearing of the crank-shaft, thereby allowing this shaft to be in line with the spool-shaft without being directly connected therewith. A large gear-wheel on the inner end of the crank-shaft meshes with a small pinion fixed upon a counter-shaft upon the other end of which is a larger gear-wheel, which, in turn, meshes with a small gear-wheel upon the spool-shaft. The multiplying gear increases the speed of the spool-shaft, and the object is rapidly to draw in the line when catching game fish, such as, for example, black bass, which if they get a slack line are apt to jump and break it. The bell is a small stationary bell, and serves as an alarm to be sounded from the fish-line upon the spool. The bell-hammer is mounted upon a pivoted lever, which is thrown back and forth by a sliding device. When this device is pushed in, the point of the lever enters a notch which leaves the bell-hammer relatively nearer the center of the bell. When the device is pulled out, it throws the bell-hammer and its shank back toward the gear-wheel on the counter-shaft, which meshes with the gear-wheel on the spool-shaft. The gear-wheel on the counter-shaft has small studs upon its sides, and the rear end of the shank of the bell-hammer when pulled out comes in contact with the studs when the gear-wheel is turned, thus sounding the hammer. As the wheels must be revolved when the lines are pulled out, the pulling of a fish upon the line will sound the hammer. A spring fastened to the inner plate of the cap acts as a brake. A pin upon the spring passes through a hole in the plate, and when not forced away rests against the end of the spool, thus serving as a brake to retard the progress of the spool, but the spring may be forced away by a sliding wedge pushed in from the outside.

CLAIMS.

"1. The combination, in a fishing-reel, with the gear-wheels thereof, one of which is mounted on the spool-shaft and another on the crank-shaft without any direct connection between them, of a crank and a crank-shaft, the latter of which is mounted in a single bearing directly in line with the bearings of the spool-shaft, but entirely separated therefrom, substantially as shown and specified.

"2. The combination, in a fishing-reel, with a bell, of a bell-hammer, a lever which is adapted to throw said hammer into or out of operative position, a wheel, and studs on said wheel, which operate to vibrate the bell-hammer when in operative position, and thereby ring the bell, all substantially as set forth."

No. 254025.

(Louis A. Kiefer, Indianapolis, Ind.; patented February 21, 1882; reel-lock. See Plate LIII.)

A metallic plate, curved to fit the rod, is secured thereto. The plate is provided with a flat fixed button cut away on one side. The device containing the locking mechanism to which the reel is to be attached forms the base of the reel-frame. The said device consists of a metallic block having a boss on its lower side, and provided with a circular seat for the button of the metallic plate, the front portion of the boss being cut away to permit the device to be passed over the button in a longitudinal direction. The head of the button is of a diameter somewhat less than the circular seat, so that the device may be turned easily upon the button. A flat spring is secured at one end to the block. The free end is provided with an angular plate, which rests when in a normal position in the opening in the front or cut-away portion of the boss. A transverse strip of metal is secured to the plate, by means of which it can be manipulated to unlock the device. The operation of the device is as follows:

The block F is passed longitudinally backward over the button D, the head entering the opening at the front of the boss, the plate K being automatically pressed upward and out of the way. When the block F has been thus placed upon the button it is turned on the same at right angles to its longitudinal position, when the straight side of the plate K will engage the straight or cut-away side of the button and lock the parts firmly together. To remove the device the plate K is elevated by means of the strip L, so as to clear the straight edge of the button, and the block is then turned to its longitudinal position, when it can be removed by sliding it longitudinally forward.

CLAIM.

"The combination, with the metallic plate provided with a button cut away on one side, of the metallic block having a boss and recess, the boss being cut away in front to permit the device to be passed over the head of the button, and the spring and angular plate attached thereto, and the transverse strip for operating the same, all constructed and arranged substantially as and for the purposes specified."

No. 259935.

(Franklin R. Smith, Syracuse, N. Y., assignor of one-half to Willis S. Barnum, of same place patented June 20, 1882; fisherman's reel. See Plates LIV and LV.)

This invention relates to improvements in that class of fishermen's reels in which the spool is caused to automatically wind up the line by the medium of spring-actuated gearings connected with said spool, and has more particular reference to the reel for which a patent was granted this inventor July 26, 1881, No. 244828. The invention consists, first, in detachably connecting the line-spool with its actuating mechanism to admit of readily interchanging spools provided with lines specially adapted for the different species of fish to be caught; secondly, in connecting the line-guide to the attaching-arm eccentrically in relation to the pivot of the spool, and having its free end extending across the periphery of the spool, whereby it serves the additional function of a brake for limiting the movement of the spool; thirdly, in the construction of the line-guide with a lateral inlet to the eye thereof for the introduction and removal of the line to and from the said eye; fourthly, in the combination, with the case inclosing the spring, of a plate secured to the free edge of the case and provided with concentric gearing, said plate serving to close the case effectually to exclude dust and water from said case and the inclosed spring, and also affording an additional axial bearing for the case, and thus more effectually preventing lateral vibration of same; fifthly, in the combination, with the spool, of an attaching-plate provided with a square or polygonal post, a collar fitted to said post, and the spring connected to said collar, thereby facilitating the attachment and removal of the spring.

CLAIMS.

"1. In combination with the tubular post *m*, the stud *a*, provided with a female-threaded socket at one end and with external screw-threads at the opposite end, the interchangeable spool S, provided with a screw-threaded eye *e*, for the reception of the externally threaded end of the stud *a*, and the attaching-screw fitted to the cavity in the opposite end of the stud *a*, all as shown and described for the purpose set forth.

"2. In combination with the attaching-plate A and the spool S, pivoted thereon as shown, the combined line guide and brake, consisting of an arm, B, pivoted on the attaching plate in eccentric relation to the pivot of the spool, and having its free end extended across the periphery of the spool and provided with an eye, *i*, the whole constructed and operating to control the motion of the spool and guide the line substantially as set forth.

"3. In combination with the spool S, the line guide, having a guarded lateral inlet, *o*, to the eye thereof, for the introduction and removal of the line to and from said eye, substantially as set forth.

"4. The combination with the pivoted spring case C, of the geared plate K, rigidly attached to and closing the case, and provided with an axail bearing, substantially as described, for the purpose specified.

"5. In combination with the spool S and case C, the post *m*, having inside of said case a square or polygonal form externally, the collar *n*, fitted detachably to the exterior of said post, and the spring *s*, connected at its inner end to the collar *n*, substantially as and for the purpose shown and set forth."

No. 260932.

(James B. D'A. Boulton, Jersey City, N. J., assignor to William Mills and Thomas Bate Mills, New York, N. Y.; patented July 11, 1882; fishing-reel. See Plate LVI.)

The invention consists in the combination with the spool and frame of a reel, of a non-rotary internally-toothed stationary ring attached to the frame of the reel, a spur-wheel upon the spool of the reel, and a pinion engaging with said ring and wheel, to be revolved around the wheel, and at the same time rotated on its axis by reason of its engagement with the non-rotary ring, whereby a reel is provided in which the handle and spool are moved in the same direction, the latter being rotated at a much quicker speed than the former. The wheel, the pinion, and the internal gear are all in the same plane, and the pinion may be pivoted on the inner side of the handle-plate which covers the gearing. With the spool is combined a stop which serves as a friction brake or drag when required.

The inventor says:

"I am aware that a reel has been heretofore made in which the rotary motion is imparted to the spool by an outer rotary internal gear, to which the handle is attached, and an intermediate wheel mounted on a fixed pivot and engaging both with said internal gear and the wheel upon the spool shaft or arbor. This reel I do not claim as of my invention, and my reel differs from it in that my internal gear is fixed instead of rotary, and my intermediate wheel, instead of being mounted on a fixed pivot, is mounted on a movable pivot, so that it may be revolved around the wheel on the spool arbor or shaft, and at the same time rotate on its pivot. The advantages resulting from this difference in construction are various. In the old reel the multiplied rotations of the spool are all transmitted through the rotation of the wheels on their axes, and hence the friction of the gear-teeth is greater than in mine, where one rotation of the spool is due to the revolving motion of the intermediate wheel around the wheel on the spool shaft or arbor. It is necessary in a multiple reel that the handle should always be made to turn toward the right, or 'in the right direction,' as it is termed, and no fisherman would like to use a reel in which the handle was intended to be turned toward the left. In my reel, when the handle is turned to the right the spool will be turned in the same direction; but if the handle of the old reel be turned to the right the spool will be turned to the left, or in a reverse direction, and the line, instead of being carried to the under side of the spool, as in my reel, must be carried to the upper side of the spool and several inches away from the rod. The carrying of the line to the upper side of the spool and away from the rod is a serious disadvantage, as the hand must hold the rod in advance of the reel, and the line would make a considerable angle at the hand or through an eye on the rod, and would be apt to cut the hand, or else rapidly wear itself out in the eye. With my reel the line follows the rod clear up to the reel and winds on the under side of the spool, and any experienced fisherman will at once appreciate the desirability of a construction which will admit of this."

CLAIMS.

"1. The combination, with the frame and spool of a reel, of a non-rotary internally-toothed ring attached to the frame, a spur-wheel upon the spool, and a pinion engaging with said ring and wheel and adapted to be revolved around said wheel and between it and said ring and rotated on its axis by engagement with said ring, substantially as and for the purpose described.

"2. The combination, with the frame and spool of a reel, of a non-rotary internally-toothed ring attached to the frame, a spur-wheel upon the spool, a rotary-handle plate, and a pinion pivoted to the handle-plate and engaging with said wheel and toothed ring and adapted to be revolved around said wheel, and at the same time rotated on its axis by reason of its engagement with said ring, substantially as described.

"3. The combination, with the spool of a multiplying-reel and a handle geared therewith to rotate slower than said spool, of a ratchet-wheel, a coiled spring having an attached pawl or tooth engaging with said ratchet-wheel, and a friction-box containing said spring, the said box, spring, pawl, and ratchet-wheel being interposed between said spool and handle, and the whole being and operating substantially as described.

"4. The combination, with the spool of a multiplying reel, of a wheel adapted to rotate therewith and having in it a friction-box, a ratchet-wheel adapted to rotate in the same direction, but at slower speed than said spool, and a spring coiled in said friction-box, and having at its inner end a pawl or tooth for engaging with said ratchet-wheel, substantially as described."

No. 264092.

(George H. Matthews and John T. Ostell, Montreal, Quebec, Canada; patented September 12, 1882; fishing-reel. See Plate LVII.)

Upon the ordinary plate by which a reel is attached to the rod are mounted, instead of the usual solid side disks, two rings connected by radial arms with centers, in which is carried the spindle. Upon the spindle are secured rigidly two rings similarly constructed, and of somewhat less diameter than the fixed rings and revolving just inside them. These inner rings carry on their radial arms transverse bars, upon which the line is wound, set equidistant from the center. At opposite points in the fixed outer rings are placed transverse bars in pairs, the line passing between them. Thus there is a diminution in weight without any lessening of the strength of the apparatus, and from the fact that the line by passing between the bars F F or F′ F″, even with but little tension, is to a great extent freed from the water imbibed by it during immersion, and also that as the core upon which the line is wound allows air to come in contact with its inner coils, and the sides are equally exposed to evaporation, the line can at once be wound on the reel and allowed to dry there without risk of becoming rotten. In addition to this the arrangement of the transverse bars surrounding the spindle, it is declared, enables the line to be wound up almost as fast as by the use of a "multiplier," and with less trouble and risk of breakage.

CLAIMS.

"1. In a fishing-reel, the inner open revolving rings, both mounted on and connected by a central spindle, and also connected by a series of parallel bars, each placed equidistant from the central spindle, substantially as and for the purposes set forth.

"2. The combination, with the stationary open rings, of the connecting and parallel guide-bars placed in pairs near the periphery of said wheels, substantially as shown, and for the purpose described.

"3. The combination, in a fishing-reel, of stationary open rings with parallel guide-bars, a spindle, and inclosed revolving open rings with connecting parallel bars equidistant from spindle on which said rings are mounted, all substantially as shown, and for the purposes specified."

No. 271166.

(Edward C. Vom Hofe, Brooklyn, N. Y.; patented January 23, 1883; fishing-reel. See Plate LVIII.)

To enable the fisherman, while operating the reel with one hand, to control the position of the click with the thumb of the hand which holds the fishing-rod, the frame which forms the bearings for the axle of the reel has a handle for turning the reel, mounted on one side of the frame, and a ratchet-wheel and a movable click on the opposite side. Springs act on the click to retain it in position when it is in gear with the ratchet-wheel and also when it is thrown out of gear. The frame forms the bearings for the axle of the reel, which is provided with a flange for securing it to the fishing-rod. The reel is operated by a handle on one side of the frame, in the present instance on a separate shaft, which is geared with the reel-shaft by a multiplying gear; but the handle may be mounted directly on one end of the reel-shaft. On the opposite end of the frame is mounted a click, which engages with a ratchet-wheel on the reel-shaft. The click is secured to a pin, which projects through a radial slot in the head of the frame, and is secured to a button situated on the outside of the head. This button is in such position that it can be manipulated by the thumb of the hand which holds the fishing-rod, and by moving it in a radial direction the click is thrown in or out of gear with the ratchet-wheel. Thus, the fisherman can throw the "ratchet drag" in or out of operation while he retains control of the reel. The click swings on its pin and is subjected to the action of two springs similar to the click in the patent granted this inventor September 2, 1879, No. 219328; but the head of the new click is arrow-shaped, as shown in Figs. 2 and 3, and, furthermore, the pin which supports the click is mounted in the sliding button. When the button is moved inward to the position shown in Figs. 3 and 5 the springs catch behind the head of the click (Fig. 3), and retain the click in gear with the ratchet-wheel, the button being thereby prevented from moving out spontaneously; and when the button is moved out to the position shown in Figs. 2 and 4, the springs bear upon the inclined sides of the head of the click and retain the click out of gear with the ratchet-wheel.

The inventor says:

"I do not claim broadly as my invention the combination of a ratchet-drag with a fishing-reel, such being well known."

CLAIMS.

"1. The combination, substantially as hereinbefore described, of the frame which forms the bearings for the axle of the reel, the handle for turning the reel mounted on one side of the frame, the ratchet-wheel and click mounted on the opposite side of the frame, and the button which carries the click and serves to throw the same in and out of gear with the ratchet-wheel, said button being so situated that it can be operated with the finger or thumb of one hand while the handle is operated with the other hand.

"2. The combination, substantially as hereinbefore described, of the click having an arrow-shaped head, the button which serves to move the click in and out of gear with the ratchet-wheel, and the springs which bear on the click and lock the same when in gear and also when out of gear with the ratchet-wheel."

No. 281918.

(George H. Palmer, Fair Haven, Mass., assignor to Thomas M. Bissett and Thomas J. Conroy, New York, N. Y.; patented July 24, 1883; fishing-reel. See Plates LIX and LX.)

The drum constituting the frame of the reel, and serving to connect the two end plates rigidly together, is formed of a strip of metal which has portions cut away. This strip is rolled up to form a cylinder and screw-threads are cut upon the outside at the ends. Cup-shaped end-caps are provided with internal screw-threads to fit on the ends of the drum. At their centers they are provided with outward extending hub-like portions, in which, as well as in the plates, are central openings, in which are journaled the bearing-spindles of the spool. In the hubs are adjustable plugs forming bearings for the end of the spool-spindles, a conical point on each plug fitting into a corresponding recess in the spindle ends. Over the ends of the hubs, and covering the central openings, are plates fastened by screws. The spool has its center bored out from end to end, to be light. Into the ends of the bore are inserted the bearing pieces or spindles. These extend into the passage only a sufficient distance for a firm fastening. Their outer ends are reduced to fit the journal-bearing openings in the caps. The cup-shaped cap nearest the crank is deeper than the other, to leave sufficient room to receive the multiplying-gearing. Upon the bearing-piece here a pinion is screwed, and it is locked in position by a small screw. This pinion gears with a larger wheel below, fast to a shaft journaled at its inner end in a bridge-piece projecting from the cap, and at its other end in the cap-plate, through which, and through the hub-like projection on the external face of which, it extends. To the outer end of this shaft is attached the balanced crank. To the lower side of the drum is screwed the usual longitudinally-grooved piece which fits upon the pole and over which the holding-rings are to be slipped. The object is do away entirely with the usual pillars or bolts, with their screw-nuts in the frame-work of the reel, and in the end plates or caps, these nuts being so liable to become loose. The consequent loosening of the frame and play of the parts will, as reels are ordinarily constructed with multiplying mechanism, cause this to get out of gear and become inoperative until the parts are tightened up again. In the present case the caps and drum have such an extended bearing surface that they cannot work loose, but hold the parts and gearing firmly in place, while they can yet readily be taken apart. The cap performs the double function of end-plate and a cover for the gearing.

CLAIMS.

"1. In a fishing-reel, the drum made in one piece, with suitable openings cut therein to make an open frame, and provided at each end with screw-threaded portions, in combination with the end caps provided with corresponding screw-threaded portions to fit those on the drum, substantially as and for the purpose set forth.

"2. In a fishing-reel, the drum made in one piece, with suitable openings cut therein, and provided at each end with screw-threaded portions, in combination with the end caps provided with corresponding screw-threaded portions to fit those on the drum, and a reel-attaching device fastened directly to the side of drum, substantially as shown and described.

"3. In a reel, the cup-shaped covering-cap screw threaded to fit the threaded portion on the end of the drum, and with a bearing for the spool-spindle, and a bridge and bearing to receive the crank-shaft, substantially as and for the purpose set forth.

"4. In a reel, the combination of the drum, made in one piece, the end-caps screwed upon the ends thereof, the spool provided with bearing-spindles journaled in said plates, the pinion on one of the spindles between the cap and end of spool, and the gear-wheel on the crank-shaft, journaled in the cap and the bridge-piece on the same, substantially as and for the purpose set forth.

"5. In a fishing-reel, the spool bored out centrally and longitudinally, the short bearing-pieces inserted into the central passage at the ends thereof, the pinion screwed and locked upon one of the bearing-pieces, and the adjustable screw-plugs in the end plates bearing against the ends of the spool-bearings or spindles, substantially as and for the purpose set forth.

"6. In a fishing-reel, the combination of the spool, its bearings journaled in the end caps, the screw-plugs in the hubs on the caps bearing against thee nds of the spool-spindles to adjust the longitudinal position of the spool, and the covering-plates on the ends of the hubs, substantially as and for the purpose set forth."

No. 282270.

(Thomas H. Chubb, Post Mills, Vt.; patented July 31, 1883; fishing-reel. See Plate LXI.)

The cross-plate or reel-seat for attaching the reel to the rod is made in two parts independently pivoted to the side plates to be folded within the circumference of the latter. A spring formed of a single piece of wire extends from the inner face of that side plate at which the crank is, and bears against a flange on the spool, the middle of the wire being coiled around the axis to form a collar which presses against the flange to prevent any play and rattling of the spool within the supporting-frame. The click mechanism consists of a toothed wheel mounted on the axis between the plates opposite the handle end and a pawl which is held in a position radial to the axis by a circular spring, the ends of which fit into side grooves in the pawl. The spring is soldered to the end plate, being sunk in a depression or circular rabbet, in said plate, of substantially the depth of the spring and of not much larger circumference. The pawl and its pivotal pin are rigid with one another, and the pivot has a substantial bearing in a boss in the side plate.

The inventor says:

"I am aware that pawls engaging radially with the toothed wheel controlled by a substantially circular spring engaging with its opposite sides, and adapted to click in either direction, are old, and I do not claim such as my invention."

CLAIMS.

"1. In a fishing-reel, a reel-seat constructed to be arranged longitudinally of the rod, and engaging with one side only thereof, said real-seat being adapted to be folded for transportation, substantially as set forth.

"2. In a fishing-reel, a reel-seat arranged longitudinally of the rod and engaging with one side only thereof, said seat being divided and adapted to be folded for transportation, substantially as set forth.

"3. In a fishing-reel, the combination, with the side frame-plates, of the reel-seat hinged to the same on axes parallel to the axis of the reel, and folding within the frame of the reel, substantially as set forth.

"4. The combination, with the side frame-plates, of the folding reel-seat having sleeves of a length equal to the distance between said plates, and pins passing through said sleeves and connecting the frame-plates, substantially as set forth.

"5. In a fishing-reel, the combination, with the reel-frame, of a reel-seat made in two parts, the parts being pivoted to the reel-frame and abutting against each other to prevent further oscillation when in position for attachment to the rod, substantially as set forth.

"6. In a fishing-reel, the combination, with the frame-plate having a boss, a^2, making an increased length of bearing for the pawl-pin, of the pawl H, situated between the frame-plate and the spool, and having the pin h rigid therewith, substantially as set forth.

"7. The combination, with the frame-plate of the reel, having the rabbet a and pawl H, of the substantially circular spring I, partially coinciding with the wall of the rabbet and secured at its middle to the frame-plate, substantially as set forth.

"8. The combination, with the side plates, A A′, and the spool of the reel, of the spring c c' c', of one piece of wire, coiled about the axis of the reel and pressing against plates A′ D′, substantially as set forth."

No. 283084.

(John Dreiser, New York, N. Y.; patented August 14, 1883; fishing-reel. See Plate LXII.)

A fishing-reel of that class in which the reel follows the tension of the line when the latter is thrown out, but on which the reel can be revolved very quickly when the line is to be wound up. The reel is supported not at one side of the fishing-rod, but in line with the axis, the actuating mechanism being close to the rod at one side of the same, so that it cannot only be handled with great convenience, but without the small parts that make fishing-rods so expensive. A is the reel, and B is the spindle made square at its middle portion to apply the reel rigidly thereto, and round at the points where it is journaled to a metallic stock, C, which forms a part of the fishing-rod. The stock is provided with sockets C′ at both ends, to which sockets the upper and lower sections of the fishing-rod are securely applied. The stock has an open part, a, between the end sockets C′, within which the reel A is supported, so that it projects at both sides of the fishing-rod, its spindle being in line with a vertical center plane passing transversely through the longitudinal axis of the rod. The spindle has at one side a screw-button, b, and at the other side a pinion, b', which meshes with a gear-wheel, d, that is keyed to a shaft, D, to the outer end of which the crank-handle, D′, is keyed. The crank-shaft D passes through the openings of the lower socket C′ of the stock C, and is loosely supported thereby, to be capable of laterally shifting motion between the terminal button e, at the opposite end of the shaft D, and the crank-handle D′. The pinion and the gear-wheel are inclosed by a casing, E. The gear-wheel and the shaft are acted upon by a strong band-spring, f, which is attached at its outer end to the casing, and forked at its inner end, bearing upon the gear-wheel. The spring tends to throw the gear-wheel into mesh with the reel-pinion to cause the rapid winding up of the line on the reel when the shaft is turned. By shifting the shaft and its gear-wheel laterally against the tension of the spring, the gear-wheel is thrown out of gear with the pinion, so that the reel can then turn independently of the winding-up mechanism, whenever it is desired to throw out the line. The casing is further provided with a semicircular portion, *g*, that is secured by a transverse pin or key, *g′*, to the lower socket of the stock C, by means of which the casing is rigidly attached to the stock without exerting any strain upon the reel-spindle and shaft. When it is desired to separate the parts of the fishing rod after use, in order to bring them into a smaller compass, the casing is detached from the stock by unscrewing the screw-buttons *b* and *c* and releasing the pin *g′*. The reel is then taken out of the recess *a* of the stock and the rod-sections removed from the sockets of the stock.

CLAIMS.

"1. The combination of a supporting stock having end sockets for the pole-section and a central recess, a reel-spindle passing through said recess, and provided with a button at one end and a pinion at the other, a reel fixed to said spindle within said recess, a crank-shaft passing through one of the sockets of said stock, and provided with a button at one end and a crank at the opposite end, and a gear-wheel fixed to said crank-shaft, the latter being adapted to slide in its bearings to bring the gear-wheel into or or out of gear with the pinion aforesaid, the said parts being readily detachable for packing the pole, substantially as described.

"2. The combination of a metallic stock, C, having sockets C′ for the rod-sections, a reel, A, supported in a recess of the stock, a reel-spindle, B, having pinion *b′*, a crank-shaft, D, supported loosely in one of the sockets, a gear-wheel, *d*, keyed to the crank-shaft D, and a spring, *f*, pressing upon said gear-wheel *d*, so as to throw it into or out of mesh with the pinion *b′* by the laterally-shifting motion of the crank-shaft D, substantially as and for the purpose set forth.

"3. The combination of a recessed supporting-stock, C, forming part of the fishing-rod, a reel, A, a reel-spindle, B, supported in bearings of the stock C, pinion *b′*, gear-wheel *d*, crank-shaft D D′, spring *f*, and casing E, provided with means to attach it to the stock C, substantially as set forth."

No. 283496.

(Anton Lang, Brooklyn, N. Y.; patented August 21, 1883; fishing-reel. See Plate LXIII.)

An improvement in fishing-reels by which considerable speed can be imparted to the spindle when the line is wound up, while in throwing out the line the spindle follows the motion of the line as the same is paid out.

A fishing-reel is provided with a spindle which turns in independent steel bearings of the frame or housing, said spindle being provided with a pinion that can be thrown by an intermediate pinion into or out of mesh with a gear-wheel that turns on the bracket of the spindle-bearing, and is operated by a crank-handle. A slide-piece throws the transmitting mechanism into gear for winding up the line at great speed, or out of gear to admit the independent motion of the spindle in throwing out the line.

CLAIMS.

"1. As an improvement in fishing-reels, the combination of the reel-frame, a reel-spindle turning in bearings of the reel-frame and having a pinion at one of its ends, an actuating gear-wheel arranged concentrically to the spindle-pinion, an intermediate pinion, and means by which the latter is thrown in or out of gear with the spindle-pinion and gear-wheel, substantially as set forth.

"2. As an improvement in fishing-reels, the combination of the supporting-frame having steel bearings for the spindle, one of said bearings being arranged in a bracket-shaped support, a spindle having a pinion at one end, an intermediate pinion, a gear-wheel revolving on the bracket-shaped support, and means for throwing the intermediate pinion in or out of gear with the gear-wheel and spindle-pinion, substantially as specified.

"3. As an improvement in fishing-reels, the combination of the supporting-frame or housing A, spindle B, turning in steel bearings *a a*, spindle-pinion *b*, intermediate spring-pressed pinion, b', gear-wheel *c*, turning on bracket-support *a*, forked slide-piece *d*, and set-screw d^2, substantially as set forth."

No. 284217.

(Frederick Malleson, Brooklyn, N. Y.; patented September 4, 1883; fishing-reel. See Plate LXIV.)

Heretofore, it is said, in nearly all multiplying reels the results desired have been obtained by attaching to the head-plate of the reel a rigid post, upon which revolved a gear-wheel operated by a crank-handle supported by the post, by a revolving plate which substantially constituted a crank-handle, or by a short shaft not extending through the reel, but with a single bearing in the head-plate. The effect in either event was to bring the strain in one direction upon a point between the center and periphery of the head-plate and one side of the reel in another, reducing the leverage of the crank-handle, and increasing the friction by reason of the lateral strain on the gear-wheel, crank, and main shaft. The object is to overcome these difficulties and produce a multiplying reel so constructed as to give the benefit of the entire leverage from the center to the periphery of the reel and bring the strain on the longitudinal center of the reel.

In operation, the crank-handle, being revolved, revolves the shaft *c*, which operates the gear *f*. This engages the gear *g*, which is one-half the size of gear *f*, and, being permanently attached, gear *g* revolves the gear *h*, which is in turn twice the diameter of gear *g*, or the same as gear *f*. Gear-wheel *h* engages gear-wheel *i*, which is the same size as gear-wheel *g*, and is attached to and drives the hollow spool-shaft K. The degree of multiplication will of course be determined by the relative sizes of the gears.

CLAIMS.

"1. In a fishing-reel, the hollow revolving drum-shaft mounted in central bearings in the end plates, in combination with the independently-revolving driving-shaft passing therethrough and having its bearing therein, and provided with the crank and means for transmitting motion to the said hollow shaft, as set forth.

"2. In a fishing-reel, the operating-gear arranged upon the tail-plate *o*, in combination with a central shaft driven by a crank on the head-plate, substantially as described.

"3. In a fishing-reel, a reversible check or click consisting of the combination of the ratchet-wheel mounted on the drum-shaft, between the end plate and the spool-head, the pawl engaging therewith, the spring engaging the pawl, the post carrying the pawl and projecting through the end plate, and the switch-lever attached thereto for throwing the pawl into or out of engagement with the ratchet at will, as set forth."

No. 285346.

(William B. Doubleday, Binghamton, N. Y., assignor to Henry H. Doubleday, Washington; D. C., patented September 18, 1883; device for attaching reels to fishing-rods. See Plate LXV.)

A metal plate, curved in cross-section to correspond substantially to the curved outer face of the rod, is secured thereto. The edges of a portion of this plate are turned up, forming ways or channels. At one end of the plate the edges are closed down forming stops, and a portion adjacent to the end is cut away, in order that at the extreme end the edges may be bent down into contact with the body of the plate without carrying with them the adjacent portions. A locking-stud is thrust upward through an opening in the plate by a spiral spring within a cylindrical case attached to the under side of the plate, a hole being bored in the rod to receive the case. The reel is mounted on a curved plate, the sides of which slide in the ways of the plate on the rod, and which abuts against the stops, and is held in place by the locking-stud.

CLAIMS.

"1. In a device for attaching a reel to a fishing-rod, a concave plate adapted to be secured to the rod, and provided upon its sides with projecting lips to receive the sliding reel-plate D, in combination with a movable stop to prevent the accidental displacement of the reel, substantially as set forth.

"2. The combination of the reel, the sliding plate D, the concave plate provided upon its sides with projecting lips, and the yielding stop, substantially as set forth."

No. 285630.

(Henry C. A. Kasschau, New York, N. Y.; patented September 25, 1883; fishing-reel. See Plate LXVI.)

The object is to supply a fishing-reel that can be used without a rod. The reel is of wood or is a skeleton of metal, and has one or more crank handles. The reel-frame may be of a single post, or of fork shape, the spindle being in one case fixed to and in the other case revoluble in the reel frame. The reel frame is fixed upon a handle, and at its point of attachment thereto, at one or both sides, has a hook-shaped finger-rest, by means of which the reel can be firmly grasped, thus allowing the line to be thrown a great distance from the shore without risk of slipping from the hand.

CLAIM.

"A hand fishing-reel consisting of a revolving reel, A, reel-frame B, handle D, and hook-shaped finger-rest E at the base of the reel-frame, substantially as set forth."

No. 294429.

(Gilbert L. Bailey, Portland, Me.; patented March 4, 1884; reel fastening for fishing-rods. See Plate LXVII.)

The objects are, first, to provide means for fastening the loose reel-band, in any desired position, and, in connection therewith; second, to provide a loose reel-band which, when fastened, will hold reel-plates of different thicknesses and widths upon a reel seat having a plain surface, and without the intervention of the usual fins or ribs. The operation is as follows: Lever *g* being opened one end of the reel plate is placed in receptacle *f*, andthe receptacle *c* in band *b* is placed over the other end. The lever is then brought into position, as shown in Figs. 1, 2, and 4, and through the action of cam *h* band *b* is drawn firmly down upon the reel-plate, the round part of the cam acting against the inside of groove *i* and the surface of tube *a*.

The inventor says:

"I do not claim a metal reel-seat, nor a band having a raised receptacle for a reel-plate and fastened to the lower end of a fishing-rod, as these are already in use."

CLAIMS.

"1. In a reel-fastening for a fishing-rod, a loose or sliding band having a raised receptacle for one end of a reel-plate on one portion of its surface, and a groove struck from the inside on an opposite portion, in combination with a cam working in said groove, having a lever attached and adapted to fasten said band over said reel-plate, and a metal reel-seat adapted to surround the butt of a fishing-rod, and having a raised raised receptacle for the other end of said reel-plate, fixed thereto, substantially as and for the purpose herein set forth.

"2. In a reel fastening for a fishing-rod, a loose or sliding band having a raised receptacle for one end of a reel-plate on one portion of its surface, and a groove struck from the inside of an opposite portion, in combination with a cam working in said groove, having a lever attached and adapted to fasten said band over said reel-plate, and with the butt of a fishing-rod, having a raised receptacle for the other end of said reel-plate, fixed thereto, substantially as and for the purpose herein set forth.

"3. In a reel-fastening for fishing-rods, a loose or sliding band having a raised tapering receptacle for one end of a reel-plate, and a groove struck from the inside, in combination with a cam to work in said groove, having a lever attached adapted to tighten said band upon and release it from said reel-plate, substantially as and for the purpose herein described.

"4. In a reel-fastening for fishing-rods, a loose or sliding band having a groove struck from the inside for the reception of, and in combination with a cam to work in said groove, having a lever attached adapted to tighten said band upon and release it from a reel-plate, substantially as and for the purpose herein described.

"5. The combination of sliding band *b*, with its raised portions *c* and *i*, lever *g*, with its cam *h*, and tube *a*, provided with receptacle *f*, substantially as herein described."

No. 296196.

(William N. Lockwood, Campville, Conn.; patented April 1, 1884; line-reel. See Plate LXVIII.)

This invention consists of a reel inclosed and having bearings in a case composed of two end pieces connected together by three rods, and a cylindrical shell open about one-third the circumference, one of the end pieces being so formed as to incase a gear-wheel which meshes into a pinion on the reel-shaft, the gear-wheel having a crank-handle on its shaft, by means of which the reel may be rapidly rotated and the line wound evenly thereon and without kinks. A spring-catch pivoted to one of the end pieces falls between the spokes or into the openings of one of the flanges of the reel, thereby holding the reel and preventing it from rotating when sufficient line has been paid out. This spring-catch is conveniently located to be operated by the thumb or one of the fingers of the hand holding the case, while the reel may be rotated by the other hand actuating the crank-handle. The whole of the device is made very strong and light.

CLAIMS.

"In a line-reel the combination with the shaft *b* of the plain flange *c* secured to one end thereof, and the flange *c'* secured to the other end, and provided with a lug, c^2, projecting inwardly therefrom adjacent to the shaft *b*, and to which is attached one end of the line, substantially as and for the purpose hereinbefore set forth.

"2. In combination, the inclosing-case *d d' f*, the gear-wheel *h*, provided with the crank-handle *j*, the line-reel *b c c'*, provided with the pinion, and the bell-crank spring-catch *k*, having its outer end lying along the inclosing case, substantially as and for the purpose set forth."

No. 303186.

(Henry F. Price, Brooklyn, N. Y.; patented August 5, 1884; reel-fastening for fishing-rods. See Plate LXIX.)

The object is more generally to adapt rods to receive the varying sizes of seats of reels. Sliding bands of different diameters are nested on the rod. These are employed respectively according to the size of the reel-seat, and are applied to hold either or both ends of reel-seat rod.

CLAIMS.

"1. The combination of a rod, a reel-seat, and a series of separate sliding nested bands or rings, whereby a reel-seat of varying size may be securely clamped to a rod, as set forth.

"2. The combination of a rod, a reel-seat, and a series of connected sliding nested bands or rings, said reel-bands being so constructed that they shall not separate from each other longitudinally by what is known as a "bayonet-fastening," whereby a reel-seat of varying size may be securely clamped to a rod, as set forth."

No. 303347.

(Archer Wakeman, Cape Vincent, N. Y.; patented August 12, 1884; fishing-tackle. See Plate LXX.)

A device to be applied to fishing-lines for the purpose of twirling or rotating the line, and with it the fly or bait at its end. A rotary disk or head to which the line or gimp is attached is connected with a crank, or with automatically-operating mechanism by which the line may be rotated. Ordinarily the device will be applied to a pole or rod, and may be used in connection with a reel for winding in the line. The line B, or so much thereof as extends from the reel to and through the tubular guide *a*, is made of gimp, or of other material having sufficient stiffness to turn without buckling or twisting to any material extent, yet capable of being readily wound upon the reel. The line being provided with the usual fly or bait, and the latter being allowed to hang from the rod and thereby to straighten the line, it will be seen that rotation imparted to the shell or cylinder by the train E will be transmitted to the line B, and through it to the bait or fly, the swivel of the bait being made sufficiently tight to prevent rotation therein until a fish is hooked, and resistance thereby offered to the rotation of the bait. A brake, F, is provided with which to hold the cylinder or shell against rotation, and the reel is provided with a square stem, *f*, to receive a handle or key by which to turn it and wind in the line. The brake is arranged to enter a hole or notch, *g*, which is so located as to stop the shell with the stem *f* in proper position for operation.

CLAIMS.

"1. In combination with a fishing line or gimp, provided with a fly or bait, a rotary wheel or body connected with said line or gimp, and serving to impart a rotary or twirling motion thereto.

"2. In combination with a fishing-line or gimp, a wheel or body connected therewith, and a spring-driven train connected with said wheel or body and arranged to rotate the same, substantially as and for the purpose set forth.

"3. The herein-described device for imparting rotary motion to fishing-bait, consisting of the shell C, having tubular journal *b*, and internal reel D, and provided with means, substantially such as described, whereby it may be rotated as set forth.

"4. In combination with a bait-twirling mechanism, a fly or bait provided with a tight-fitting swivel, such as described, whereby the bait is caused to turn with the line or gimp until resistance is offered, whereupon the friction is overcome and the line or gimp permitted to turn independently of the bait."

No. 306162.

(John Kopf, Brooklyn, N. Y., assignor of one-half to Thomas B. Mills, of same place; patented October 7, 1884: fishing-reel. See Plate LXXI.)

The main point in this case seems to be the appearance which it is designed to give the finished reel. Panels of vulcanite are let into the ends where they are held by rims or bezels, and the cap-nut over the end of the outer spool journal was devised, it is intimated, to do duty as an assistant in this respect.

The inventor says:

"I do not claim as of my invention a reel having its plates or heads composed of hard rubber or vulcanite bushed to form bearings for the spool journals, with or without metal bands encircling the rubber or vulcanite, the object of my invention being to provide a reel which shall equal in appearance one having plates or heads of rubber or vulcanite, and which shall be far more durable and strong; neither do I claim, broadly, as of my invention a reel having a recess on its inner side to receive the spool-flange, and a hub on its outer side to form a bearing for the spool-journal, the said hub having a cap-nut applied to it. Such a reel is shown in United States letters patent No. 214495, granted April 22, 1879, to L. T. Dickson; but its plate or head has no panel applied to its outer side, and having a central aperture through which said hub projects, nor has the plate or head any rim or bezel on its outer side to receive within it such a panel as I employ; neither does the cap-nut serve the double purpose of covering the spool-journal and its bearing and securing a panel in place, as does my cap-nut *f*."

CLAIMS.

"1. In a reel, the combination of the head A and the cap C, recessed on their outer side so as to form rims *c*, the head A comprising a bearing, *d*, for the spool-journal, and the panels H H′, applied to the recessed outer sides of said head and cap and fitting within the rims *c*, substantially as described, and for the purpose set forth.

"2. In a reel, the combination of the spool F, the head A, having on its exterior the hub *d*, forming a bearing for the said spool, and having the rim or bezel *c*, the panel H, fitting within the rim or bezel *c*, and having a central aperture, through which the hub *d* projects, and the cap nut *f*, applied to the hub *d*, and serving both to cover the latter and to secure the panel in place, substantially as herein described."

No. 309305.

(John Kopf, Brooklyn, N. Y., assignor of one-half to Thomas B. Mills, of same place; patented December 16, 1884; method of making fishing-reels. See Plate LXXII.)

Heretofore the base-plate and heads of a fishing-reel have been made of separate pieces secured together by screws or other means, and the heads have been connected by one or more pillars or cross-braces, which are also separate pieces from the heads; hence in the simplest reel, having but a single pillar or cross-brace between the heads, the frame has consisted of four parts, irrespective of the screws whereby said parts are often connected. A blank is cut or stamped from sheet metal by dies, the blank comprising disk-like portions for the heads of the reel, and a portion, between the disk-like portions, connected with them by necks to form the base-plate of the reel. These necks are subsequently bent so as to bring the disk-like portions into positions parallel with each other, and at right angles to the base-plate. To complete the frame of the reel a cross brace or tie is secured between the disk-like portions at a point opposite to the base plate, to hold the heads at a proper distance apart. This tie may be a piece separate from the other parts of the frame, in which case the frame would consist of but two pieces; or the tie may be produced as a narrow tongue projecting from one of the disk-like portions of the blank, and after these are bent into positions parallel with each other to form the heads the tie is bent down to extend between them, and is secured at its free end to one of the heads. The frame would then be composed entirely of one piece of metal.

CLAIMS.

"1. The method of forming the base-plate and heads of a reel, consisting in producing a blank having disk-like head portions B′ on opposite sides of an intermediate base portion, B, and in bending the blank upon the lines *x x* to bring the said head portions into positions parallel with each other and at right angles to said base portions, substantially as herein described.

"2. The method of forming the base-plate, heads, and cross brace or tie of a reel, consisting in producing a blank having disk-like head portions B′ on opposite sides of an intermediate base portion, B, and a tongue, B^2, extending from one of said head portions, in bending the blank upon the lines *x x* to bring the head portions B′ into positions parallel with each other and at right angles to said base portion, in bending the blank upon the line *y y* to bring the tongue B^2 into a position at right angles to the head from which it projects, and in securing the free end of said tongue to the opposite head, substantially as herein described."

No. 272870.

(Thomas R. Ferrall, Boston, Mass.; patented February 27, 1883; trawl-roller. See Plate LXXIII.)

By making the trawl-roller in three different parts, that is, a central one, *d*, and side rollers, *e e*, all secured to the spindle *c*, a very strong and durable trawl-roller is produced from smaller pieces of lignum-vitae, as compared with a continuous solid roller, and thus pieces of wood are utilized that otherwise would be wasted; and if a portion of this roller should get damaged or broken such injured part may easily be replaced with another at a small expense, as compared with an entire new roller. By securing the roller to the spindle and locating the bearings outside, it will run without much friction, as compared with rollers running loosely on a fixed spindle. The bearings are self-lubricating.

CLAIM.

"In a trawl-roller, the central spindle *c*, adapted to rotate loosely in the outer bearings *b b*, and having secured to it the grooved center roller, *d*, and side rollers, *e e*, as and for the purpose set forth and described."

No. 252008.

(George P. Andrews, Staffordville, Conn.; patented January 10, 1882; fishing-rod. See Plate LXXIV.)

The sections or lengths of the fish-pole are hinged, but may be made rigid by thimbles which slip over them. The thimbles have eyes for the line. Within the but-end of the lowest section is a small steel balance, and upon the pole there is a graduated scale for the pointer of the balance. The end can be closed by a cap when the balance is not in use, it is said. What the balance is for, or how it is to be used, is not stated. It is presumed that it is to weigh fish, to be hung on the eye or little hook after removal of the cap. The rod is folded by throwing up the thimbles and laying the hinged lengths together. They are held so by a spiral spring fast to the butt. In folding the sections, the spring H is grasped at one end and straightened out to allow the sections to come together. Upon its release it will spring once or twice around the folded sections.

CLAIM.

"The combination, with a fishing-pole composed of lengths or sections hinged together, of the spring fastening device H, for the purpose specified."

No. 258902.

(Hiram Eggleston, Manchester, Vt., assignor to Charles F. Orvis, of same place; patented June 6, 1882; reel-seat for fishing-rods. See Plate LXXV.)

A spring is fastened centrally in a recess in the rod. Fixed bands project over the ends of the recess. The reel-seat plate is slid with one end under one band, and then with the other end under the other, so that both sides will be under the bands, and they will be held up against the bands by the spring. The seat may as readily be detached as attached, and in a manner that will be obvious.

CLAIM.

"In a reel-seat for fishing-rods, a spring-clamping seat, *b*, in combination with the rod having the fixed ring-bands, substantially as described."

No. 263484.

(Thomas H. Chubb, Post Mills, Vt.; patented August 29, 1882; tie-guide for fishing rods. See Plate LXXVI.)

The tie-guide through which the line passes is secured to the rod by cords or wire wound around the rod and the points of the guide, or by ferrules or bands slipped upon the rod over the points of the guide. The guide-blank is cut from sheet metal with points, inclined side edges leading inward from the bases of the points, and curved recesses between the inner ends of the inclined side edges 2 and the bases of the points 1. The blank is then bent around a former.

CLAIM.

"The tie-guide for fishing-rods, cylindrical in cross-section at its middle, and constructed of the piece of metal C′, having pointed ends 1, inclined side edges 2 leading inward from the bases of said points, and curved recesses 3 between the inner ends of the inclined side edges and the bases of the points, substantially as described."

No. 264243.

(Thomas H. Chubb, Post Mills, Vt.; patented September 12, 1882; ferrule for fishing-rods. (See Plate LXXVII.)

The object is to promote reliability in securing ferrules, such as the ferrules of fishing-rods in place. An annular groove is formed in the ferrule after it has been arranged in place. The ferrule is indented in the bottom of the groove, and the surface of the groove is then milled. The grooving, indenting, and milling are designed to be done in a machine successively, but at one operation, by suitably formed tools, as indicated in dotted lines in Fig. 3.

The inventor says:

"I am aware that ferrules have been secured to sticks by means of annular grooves, and by means of singular indentations made here and there without method, and that ferrules have been ornamented with milled rings, and I do not claim either of these alone or broadly as my invention."

CLAIM.

"The combination, with a stick, of a ferrule, E, having an annular groove formed in it by pressing the metal into the wood, and having indentations formed in it at the bottom of its groove, substantially as herein shown and described, whereby the said ferrule will be held securely in place, as set forth."

No. 270460.

(William Mitchell, New York, N. Y.: patented January 9, 1883; fishing-rod. See Plate LXXVIII.)

The object is to obtain a uniform strain and spring in fishing-rods throughout their entire length.

A represents the butt of a fishing-rod, B is the grip, and C is the rod. The grip forms a part of the butt, and the rod passes in through the upper end of the butt, and has a screw-hole in its end, or in a cap or ferrule attached to its end, to screw upon a screw D, secured to the butt-cap E. The interior of the butt A is made so much larger than the rod C that the rod will be free to bend from end to end, so that the strain and spring will be uniform throughout its entire length, the rod coming into contact with the butt only at its ends. The aperture through the forward end of the butt is made to fit the rod exactly, in order to hold the rod steady.

CLAIM.

"The combination of the cap E, having a central screw on the inside, a hollow handle, B, having a central hole in the butt, and the fishing-rod C, having an end open tubular cap working on said screw, as shown and described."

No. 277230.

(Thomas H. Chubb, Post Mills, Vt.; patented May 8, 1883; fishing-rod tip. See Plate LXXIX.)

The head of the funnel-top is provided with a deep annular groove for the reception of the tube of the funnel-head. A center hole is drilled in the back end of the head for entry into it of a round swaging tool. The tube of the funnel-head is then pushed into the annular socket, after which the swaging-tool is driven down into the center hole to expand the central portion of the metal of the head circumscribed by the seat, and cause it to give a flaring or spread configuration to such seat, and a corresponding figuration to the inner end of the tube. After the funnel-top has been formed, it has a hole made through it for the line. By this construction the tube is secured to the head by a dovetailed joint, and if this joint should become loose or spring inward it can readily be tightened by driving the swaging-tool into the center hole.

CLAIMS.

"1. As an improved article of manufacture, the funnel-top for a fishing-rod herein described, consisting of the head C, provided with the deep annular groove or seat *b* at its inner end, and inclined opening *g*, made through the head, and tube D, having its outer end inserted in the annular groove *b* of the head, and secured thereto by the dovetailed joint *h*, as set forth.

"2. The combination, with the tapering tube D, of the head C, provided with the opening *g*, annular groove *b*, and central hole *c*, substantially as described, whereby the dovetail joint can be expanded when sprung inwardly, as set forth."

No. 279988.

(Richard Smith, Sherbrooke, Quebec, Canada; patented June 26, 1883; tension equalizer for fishing-rods. See Plate LXXX.)

A device for equalizing the tension and compression arising from strains incidental to fishing-rods when in use. Hitherto in the ordinary jointed rod the resistance to strains, both tension and compression, which arise in bending, have been borne by the inherent elasticity of the rod. But as the rod cannot be uniformly elastic, it will not bend equally, nor have a uniform curve, but will assume a sharper curve in the less stiff portions. Hence the rod is liable to be sprung or broken when undue strain is exerted. Even in the split-bamboo rod, in which the several parts comprising joints are adjusted and arranged to overcome the defect arising from the unequal strength of several individual pieces, full success has not been attained. To overcome the effect of the unequal strength of the several parts comprising a rod, or in case the rod is integral, to overcome a like defect which would exist, there is attached to the upper or top portion of the rod a small steel jointed wire. This wire is to be fixed at one end to the tip, and at the other extremity to the but-end of the rod. The rear end has attached to it a head or button, which actuates a coiled spring fitting within a small double cylinder fastened to the butt.

CLAIMS.

"1. The combination, with a fishing-rod, of a tension wire or cord secured thereto, and an elastic connection, which permits the wire or cord to accommodate itself to the varying curvature of the rod, for the purposes set forth.

"2. A fishing-rod provided with a back-bone or support, consisting of a continuous or linked wire or cord attached to the tip and but-ends of said rod, the rear end being secured to the butt indirectly by a coiled or other spring contained and carried within a tube screwing within another tube or cylinder attached securely to the but, substantially as herein described.

"3. In a fishing-rod, the individual joints furnished with a wire link attached thereto by suitable devices, and when united forming an entire rod with a continuous linked wire, the latter adjustable to the curvature of said rod, and provided with a spring to equalize and distribute strains brought upon any weak point, substantially as stated.

"4. A fishing-rod, in combination with a wire or cord extending along its upper or top portion, an adjustable coiled spring to which said wire is attached, and a movable tube which incloses said spring, said wire accommodating itself to the bending of the rod by the yielding of the spring, substantially as set forth.

"5. In a fishing rod, A, the combination of the continuous or linked wire B, whose tension is adjustable by means of a coiled spring, *i*, with the closed movable cylinder E, screwing within a primary cylinder or tube, D, securely fastened to the but-end of the rod, substantially as stated."

No. 285493.

(James E. Langdon, Torrington, Conn.; patented September 25, 1883; joint or coupling for rods, &c. See Plate LXXXI.)

Two sections of tube have upon the surface of each a screw-thread. The tube section is fastened upon a rod joint, and one being smaller will pass into the other, the screw-thread upon the smaller engaging the screw-thread upon the larger or outer tube. The screw-thread formed in the surface of these tube sections may be rolled in while the sections are separated from the joints of the rod, or the sections may be put upon the ends of the rod joints and the screw-threads rolled into their surfaces, thus embedding the surface of the metal into the wood of the rod and holding the sections in place.

CLAIMS.

"1. A coupling for the joints of rods, &c., composed of two tubular sections, *c c*, of thin metal, each having a screw-thread rolled into its surface, the section *c* being longer than the section *c* and covering said section *c*, when the parts are connected together substantially as set forth.

"2. In combination with the rod-sections *a b*, a tubular coupling composed of the screw-tubes *c c*, in each of which is rolled or formed a screw-thread, which performs the double duty of holding the tube-sections upon the rod-joints and coupling the sections together, substantially as set forth."

No. 303474.

(Justice Webb, Georgetown, Ky.; patented August 12, 1884; lock-joint for fishing-rods. See Plate LXXXII.)

With a sleeve secured to the end of a rod-section in such manner that it projects beyond the end and provided with an annular ridge or collar and two studs is combined another sleeve which will fit closely into the first, provided with two annular ridges and secured to another rod-section in such manner that it will be flush with the end, and carrying a sliding ring provided with an inward projecting flange, and with two L-shaped slots for receiving the studs on the other sleeve. To unite the rod-sections the sleeve E is passed into the sleeve A, and then the ring H is pressed down on the ridge or collar C to cause the studs M to pass into the longitudinal parts of slot K. The ring H is then turned to cause the studs M to pass to the ends of the transverse parts of the slots K. The ring is thus held on the sleeve A, and as the flange J of the ring rests on the annular ridge or collar G of the sleeve E, it holds the said sleeve and the rod-section to which it is fastened in place. Either one or two L-shaped slots K can be formed in the sleeve H.

CLAIMS.

"1. In the lock-joint for fishing-rods, the combination, with the sleeve A, provided with a locking-stud of the sleeve E, constructed to fit within the sleeve A, and a collar, H, held to slide and rotate on said sleeve E, and formed with an L-shaped slot for engaging the locking-stud on the other sleeve, substantially as set forth.

"2. In a lock-joint for fishing rods, the combination with the sleeve A, provided near one end with the collar or annular ridge C and the the studs M between the end of the sleeve and the said collar, of the sleeve, E, fitting in the sleeve A and provided with the annular ridge or collar G, and of the sliding sleeve H, having an inwardly projecting flange, J, above the collar G, and also having two L-shaped slots, K, extending upward from the free edge of the said sleeve H, substantially as herein shown and described."

No. 309028.

(William W. Byington, Albany, N. Y.; patented December 9, 1884; fish line and hook guard. See Plate LXXXIII.)

A piece of elastic metal resembling the ordinary "eye" of the "hook and eye" of commerce is slipped over the fish-rod and the shaft or shank of the fish-hook.

CLAIM.

"The combination, with a fishing-rod and the line dependent from end thereof, of a detachable spring-band encircling the rod and clamping the line between the inner surface of the band and the outer surface of the rod, whereby during transportation the rod and line are maintained in close relationship with each other throughout their length while the line may be readily and speedily released for use, substantially as described."

No. 255671.

(Matthew and Thomas Reynolds, Havre De Grace, Md.; patented March 28, 1882; gill-net. See Plate LXXXIV.)

The net consists of three parts, viz, a double net externally, the mesh of which is large enough to permit fish to pass through, and an intermediate net, which constitutes the gill-net proper, and which is therefore of finer mesh. The three nets are united at top and bottom by ropes, thus forming two pockets, one on each side of the middle net. As the fish come against the net, they pass through the coarse mesh net into the pocket, where they are caught in the gill-net, which is reinforced or braced in its bulged position by the net on the opposite side, thus preventing breaking of the net however great the strain. In hauling, the side nets forming a pocket prevent the fish caught in the middle net from becoming disengaged, so that there is no loss in the haul, however large the catch may be.

CLAIM.

"The improved gill-net herein shown and described, composed of a middle net, F, or gill-net proper, placed between two nets, E and E, to form the pockets *a* and *b*, the inner net being of finer mesh than the two side nets between which it is placed, substantially as set forth."

No. 270641.

(Jasper N. Dodge, Detroit, Mich.; patented January 16, 1883; fish-net. See Plate LXXXV.)

A collapsing landing and minnow or bait-net which can be expanded readily for use or collapsed ready to be packed without unscrewing the head from the pole. A hoop is constructed of two spring arms, which are perforated to secure the netting, are made heaviest at their inner ends where the greatest strain is, are jointed together at their outer ends, and at their inner ends are hinged to a sleeve. These arms have hinged to them two braces, which are also hinged to a thimble, the sleeve and thimble being passed over the end of a staff, and secured thereon by a head plate held firmly against the thimble. When the sleeve is pushed toward the end of the staff the braces will be extended and hold the spring arms out forming a hoop.

For the purpose of catching minnows or bait a separate net is provided, secured to narrower and thinner spring-arms of a hoop, F and F′, as shown in Figs. 5 and 6, said arms being turned at the ends to form flanges, or otherwise provided with lips, *f*, whereby they may be secured in the arms D and D′. This separate bait-net is thus adapted to be put into that previously described. When not in use it is intended to be taken out, folded up, and stowed away in any convenient place.

The inventor says:

"I am aware that heretofore the hoop of a bait-net has been provided with hinges so as to be folded, and having its sides connected by rods with a sliding sleeve on the staff or rod, so that by operating said sleeve the hoop may be expanded or collapsed, as desired, and I do not claim such construction, broadly."

CLAIMS.

"1. In a collapsable landing and bait-net, a hoop constructed of two spring-arms, hinged together at their outer ends and at their inner ends hinged to a sleeve, in combination with two braces hinged to said arms and to a thimble, said sleeve and thimble adapted to pass over a staff, substantially as described.

"2. A collapsable landing and bait net consisting of a hoop constructed of two spring-arms, hinged together at their outer ends and at their inner ends hinged to a sleeve, in combination with two braces hinged to said arms and to a thimble, a net secured to the arms of the hoop, a staff inserted through the sleeve and the thimble, and secured therein by a head plate adapted to engage with the thimble when the hoop is expanded, said head-plate held firmly against the thimble, when thus engaged, by the projecting ends of the braces, to keep the net from turning on the pole, substantially as described.

"3. In a collapsable landing and bait net, a hoop constructed of two perforated spring-arms, hinged together at their outer ends, made heavier at their inner ends, and hinged thereat to a sleeve, in combination with two braces hinged to said arms and to a thimble, said sleeve and thimble adapted to pass over a staff, substantially as described.

"4. In a collapsable landing and bait-net, the spring-arms F and F′, in combination with a suitable net, said arms provided with means whereby they may be secured within the arms D D′, substantially as described."

No. 272305.

(Otho M. Muncaster, Washington, D. C.; patented February 13, 1883; landing net. See Plate LXXXVI.)

A hollow handle of bamboo will hold the wire of the net ring, which is sufficiently elastic to be straightened or bent without injury. The wire has its ends bent outward, and to one of the ends is attached a longitudinally grooved nut, threaded a portion of its length. The handle has on one end an internally threaded ferrule to receive the screw portion of the nut. To form the net ring the nut of one end of the wire is screwed into the ferrule, and the free end is then slipped into the groove, where it will be held by the handle into which the ferrule having the groove is sunk.

CLAIMS.

"1. The combination of the net-wire B and the longitudinally-channeled nut b^2, the latter being adapted to fit a threaded ferrule on the end of the handle, substantially as described.

"2. The combination of the hollow handle or rod A and the elastic net-wire carrying the longitudinally-grooved nut b^2, substantially as described."

No. 273651.

(Richard J. Welles, Chicago, Ill., assignor to William Mills and Thomas Bate Mills, Brooklyn, N. Y.; patented March 6, 1883: landing net. See Plate LXXXVII.)

The invention relates to landing-net rings which are detachable from their handles, and which may be slipped inside of them. The handle may be of a single piece, or of two or more pieces connected by ferrule. The ring-piece may consist of a single strip or band, elastic or flexible, and continuous from end to end, or of two sections to be connected by a slide. In either case the two ends of the ring-piece are entirely unconnected with each other. The upper end of the handle is provided with a ferrule, in which is fixed a nut; and a rod or stem is screwed into the nut, and has a head consisting of two widely diverging arms. A crotch, the upper surface of which is recessed, or which is formed with flanges, receives the arms between these. The two sides of the crotch diverge at the same angle as the arm, and the crotch is provided with a tubular shank, which loosely surrounds the stem, and fits inside the ferrule. In the upper surfaces of the crotch are recesses, and the ends of the ring-piece are hooked slightly to enter the recesses. By holding the crotch in one hand and turning the handle, the stem will be extended or drawn in by the action of the nut, and when extended the ends of the piece may be inserted between the parts C′ and D and into the recesses. The handle is then turned to draw in the stem, and as the inward movement of the crotch is arrested by the ferrule the end portions of the ring-piece will be securely clamped in place and held against withdrawal, and also against lateral shifting, by reason of their fitting between the flanges of the crotch. The ring-piece, when detached, will straighten by reason of its elasticity, and may be placed inside the hollow handle. The construction of the crotch and arms is such that when the ends of the ring-piece are inserted between them a ring of oval form will be produced, which is considered preferable for a landing-net to a round ring.

CLAIMS.

"1. The combination, with a handle, A, provided with a nut, *a*, and a ring-piece, B, of the crotch D, the stem C, and diverging arms C′, all substantially as described.

"2. The combination, with the handle A and ring-piece B, of the nut *a*, the screwed stem C, the diverging arms C′, and the crotch D, provided with flanges *b*, which receive between them the ends of said ring-piece B and said arms C′, substantially as described.

"3. The combination, with the handle A and the ring-piece B, provided with bent ends *c*, of the nut *a*, screwed stem C, arms C′, and crotch D, provided with recesses or notches *d*, all substantially as described."

No. 255561.

(Edward Arapian, New York, N. Y.; patented March 28, 1882; sponge fishing net. See Plate LXXXVIII.)

A net of bag shape has attached to the mouth thereof a frame, one portion of which is of heavy material, and the remainder of buoyant material, so that when the net is cast into the water the heavy portion of the frame acts as a sinker, while the buoyant portion thereof floats, thus keeping the mouth of the net open for the reception of sponges or other like objects.

CLAIMS.

"A net of bag shape, for fishing sponges or the like, having attached to the mouth thereof a frame, one portion of which is composed of metal or other weighty material, and the remainder of wood or other buoyant material, substantially as and for the purpose described.

No. 279792.

(Edwin Paterson, Port Washington, N. Y.; patented June 19, 1883; oyster dredge. See Plates LXXXIX and XC.)

The object is to gather oysters from the bed clean, and easily, and rapidly.

Hinged in loops that are attached to the frame above foot-pieces, are two corresponding shafts which have secured to them removable grappling arms or teeth. The ends of the shafts are bent toward the center of the frame to form cranks and the ends of these cranks are attached to the lower ends of a vertically-sliding bail by connecting-rods which are hinged at their ends to the ends of the bail and the ends of the cranks, so that upon the upward movement of the bail, which takes place when the dredge is lifted out of the water, the shafts will be turned upward, bringing the cranks to a vertical and the grappling-arms to a horizontal position, and upon the downward movement of the bail, which takes place when the dredge is being lowered into the water, the shafts will be turned downward, bringing the cranks to a horizontal and the grappling-arms to a vertical position, so that the points of the grappling-arms will properly penetrate the mud at the bottom. The dredge is raised out of the water by ropes attached to the bail, and is lowered into the water by ropes attached to the frame of the dredge. A brush frees the oysters from mud just before or just after they are lifted out of the water. The brush slides upon bars held across the frame of the dredge by cross-pieces, angle-plates, and screws, and may be drawn forward over and in contact with the oysters on the grappling-arms against the tension of a spring, by means of a rope the spring serving to draw the brush backward upon the cord being released. The brush may be adjusted vertically, so that its bristles will come properly in contact with the oysters on the grappling-arms, by turning the screws which will raise the angle-plates which are held in the vertical channel-bars for that purpose. These channel-bars also serve to keep the brush from lateral or endwise movement. The rope for operating the brush passes over a pulley attached to the angle-plate, and thence over the derrick-arm back to the scow; but the brush might be arranged upon the opposite side of the dredge, or the dredge be turned around, in which case the rope might pass directly from the brush to the scow, and the pulley then be dispensed with. An air-chamber or float attached to the top of the frame serves to prevent the dredge from sinking too rapidly when lowered. The derrick-arm is hinged to the carriage, is provided at its outer end with pulleys, over which the ropes pass, and is held at the proper angle from the carriage by tie-rods that reach from its outer end back to the carriage. The carriage runs upon rails, secured upon and forming a track upon the deck of the scow, and is provided with winding drums, over which the ropes pass, and also with a drum, over which the brush-operating rope passes. In operation, to lower the machine into the water, the drum *g′* will be turned to give the ropes *i i* perfect slack, which will throw the weight of the machine upon the ropes *j j* and permit the grappling-arms *e e* to drop to vertical position by the downward movement caused by the weight of the bail *g*. The machine is then lowered to the bottom by letting back the drum *h′*. Having reached the bottom, the weight of the machine will cause the arms *e* to penetrate the mud until the foot-pieces *b b* rest upon the bottom. The drum *g′* is then turned to wind up the ropes *i i*, which will bring the grappling-arms *e e* to a horizontal position, gathering upon them all of the oysters in their reach; and the turning of this drum *g′* is continued until the machine reaches the surface of the water, at which point the turning will cease, and the brush *k* will be operated for cleaning the oysters by turning backward and forward the drum *j*. This having been done, the machine is still further elevated by turning the drum *g′* until a sufficient height has been reached to clear the side of the small boat B′. The carriage C is then run back upon its track to bring the machine over the boat B′. The drum *h′* is then turned to throw the weight of the machine upon the ropes *j j*, whereupon the drum *g′* is set free for dumping the oysters into the small boat. Finally, the carriage being moved forward to the edge of the boat B, and the boat B moved forward or backward the length of the dredging-machine, the operation may be repeated. Instead of using the drum *h′*, a cleat may be attached to the carriage C, over which the ropes *j j* will be passed by hand, the rope being let off from the cleat gradually, for lowering the machine; and instead of placing the carriage C upon a track crosswise of the boat B it may be placed on a track running lengthwise of the boat, so that the carriage, instead of the boat, may be moved the length of the dredge at each grappling. In this case movable blocks are used at the outer end of the derrick-arm for bringing the dredge over the boat B′ for dumping.

CLAIMS.

"1. In an oyster-dredge, the frame *a*, having the foot-pieces *b*, and the grappling shafts *d*, having the arms or teeth *e*, and operating mechanism for the said shafts, substantially as and for the purposes set forth.

"2. The combination, with the grappling-shafts *d* and teeth *e*, of the brush *k*, arranged above the teeth, substantially as and for the purposes described.

"3. In an oyster-dredge, the combination of the cleaning-brush *k*, guides *p p*, the brush-supporting bars *l l*, cross-pieces *s s*, angle-arms *r r'*, and screws *t*, substantially as and for the purpose set forth.

"4. In an oyster-dredge, the combination, with the grappling-arms and their operating mechanism, of the cleaning-brush adapted to be moved over the contents of the said arms or teeth and to be automatically returned, substantially as and for the purpose set forth.

"5. In an oyster-dredge, the combination, with the bars *l l*, of the brush *k* placed thereon, rope or chain *m*, and the spring *o* for returning the brush, substantially as and for the purposes set forth.

"6. In an oyster-dredge, the combination, with the cleaning-brush, rendered vertically adjustable by means of the screws *t*, and angle-arms *r r'*, connected to the brush-supporting bars, of the operating rope or chain *m* and the spring *o*, substantially as and for the purpose set forth."

No. 284156.

(John N. Woodruff, Fairton, N. J.; patented August 28, 1883; oyster-dredge. See Plate XCI.)

The dredge has a continuous shoe or runner ranging along the rake-head or bar, to which the rake-teeth are fastened. This runner lies obliquely with its forward edge about in line with the point of projection of the teeth from the rake-head, so that while the teeth will enter the river bottom their entire projecting length, the dredge will be prevented from sinking further into the soft bottom. The runner also serves to smooth the bottom to leave it in better condition for the subsequent planting and growth of the shell-fish. The rake-head is fitted with a trailing basket, which receives the oysters as they are removed by the rake teeth.

CLAIMS.

"1. In a dredge, a rake-head constructed with cross-bar *a*, teeth *b*, secured to and projecting from the cross-bar, and a shoe or runner, *c*, fitted obliquely with its forward edge about in line with the roots of the teeth *b*, or the point where the teeth overhang or project from the bar *a*, substantially as shown and described.

"2. The combination, with the rake *a b c*, constructed and operating as herein specified, of the draft-frame *e e' f* and the trailing basket *d*, substantially as shown and described."

No. 288650.

(George Merchant, jr., Gloucester, Mass.; patented November 20, 1883; purse-block for seines. See Plate XCII.)

A pulley-block adapted especially for use in "pursing" the seine, and having provision for the "purse-rope" and "bridle-rope," is substituted for the ordinary purse-ring used in seines. Heretofore common iron rings have been placed where the blocks D are in Fig. 1, the bridle-ropes C being fastened to these rings, connecting with the seine, and the purse-rope E passing through them and into the boat at X. To raise the seine and remove the fish the purse-rope E must be drawn into the boat, pursing up the seine and slipping through the rings. There is necessarily much friction in this process, and consequently much strength is required. To relieve this friction the pulley-blocks D are presented. The purse-rope E passes over the pulley G in the shell D′, and the bridle-rope passes under the cross-bar H (through the opening I above the partition J), and is made fast to said cross-bar by means of a cord, K, to accommodate which a gouge or depression, L, is made therein. When the seine is pursed up, the pulley-blocks, being brought close together, are in danger of lapping into each other—*i. e.*, the shells D′ are apt to be forced in upon the pulleys G in the next blocks and interfere with the pulleys and rope E. To prevent this the fenders S are provided, one on each edge of the shell.

CLAIM.

"The herein-described purse-block for seines, consisting of the shell D′, provided with the fenders S, extending laterally across the same, on opposite sides thereof, the horizontal partition J above the pulley G, and the cross-piece H, located at the upper end of the frame, and provided with an indentation for the reception of the cord, by means of which the bridle-rope is secured, all combined and arranged substantially as and for the purpose set forth."

No. 256287.

(Jean Chaunier, of Lyons, France, assignor, by direct and mesne assignments, to Pierre J. Boris, of Boston, Frank G. Kincaid, of Somerville, and Osceola A. Whitmore, of Malden, Mass.; patented April 11, 1882; machine for making fish-nets. Patented in France October 30, 1880. See Plates XCIII to C, inclusive.)

This invention relates to machines for making netting for seines of the description known as the "diagonal mesh." The primary object is to provide devices for tying the threads or cords automatically into knots known as the "fisherman's" or "double-becket" knot, and similar to those employed in the construction of hand-made nets. A further object is to provide mechanism for producing a net similar to that made by hand in a rapid and effective manner, and so to construct and arrange the knot-tying devices that the knots will be tied with great rapidity and in a manner which will prevent their slipping. The means of forming the meshes and tying the knots may be illustrated as follows: The thread-guide and lifter C^2 rises vertically and lifts the warp-threads W up to the thread-bearer H, the slots h of which have been opened to receive the threads by the action of the pivoted arm C^8 striking against the inner sliding section, h^2, carrying the pins h^3, drawing the pins back from said slots. At the moment the threads have reached the inner ends of the slots the projection C^6 upon the thread-guide and lifter C^2 strikes the beveled end of the sliding section h^2 of the thread-bearer, and hence shifts the same, projecting the pins across the slots. The threads will then be held by the inner pins—that is to say, the pins of the sliding section h^2 nearest the inner ends of the slots. At the same time the brocheur-frame D^2 assumes the slanting position shown in Fig. 19, so that the brocheurs will be in the oblique position also shown in said figure. This position on the part of the brocheurs and their supporting frame allows the weft-threads from the reels to rest upon the inner hooks of the fingers G, carried by the brocheur-frame, the threads being held taut by means of the tension device within the reel-carrier. The thread-bearer carrying the warp-threads then rises to some extent and swings over toward the brocheur-frame until it arrives at a position over the mold-bars, so that those portions of the warp-threads forming a loop between said bars and the thread-bearer will be in or about a vertical plane, as shown in Fig. 20. The thread-leader also swings forward over the thread-lifter C^2, which meanwhile has descended by the action of the cam-races, hereinbefore described. This thread-leader in swinging forward strikes against those portions of the warp-threads that are between the thread-bearer and the feed-bar roller B, and brings these portions, which may be designated as the "second" part of the warp-threads, alongside of those portions between the thread-bearer and the mold-bars, which may be designated as the "first" part of the warp, the leader continuing its movement until it brings said second part of the warp-threads nearer the pointed bars or fingers of the mold-bar, thereby forming a loop in each of the warp threads. Meanwhile the brocheur-frame moves forward toward the thread-bearer, and also makes a partial rotation about its axis to bring its fingers into a horizontal position below the thread-holder and between the several loops held by the thread-holder. The reels are now upon the under side of the brocheur-frame and in a vertical position, and the weft-threads, having been caught upon the outer hook of the finger during the rotation of the brocheur-frame, will, in conjunction with the loop formed by the two parts of the weft-thread, form a triangle, as illustrated in Fig. 20. The thread-leader now holding the second part of the warp-thread near the mold-bar, one of the star-wheels will be so moved as to act upon the rack-bars on the brocheur-frame and actuate the pinions thereon in the manner before set forth. This causes a half-revolution of the brocheurs, the free ends passing through the triangle of threads and around the loop formed by the two parts of the warp-thread, which fall into or are caught by the notch d^2 in the base plate of the brocheur as the brocheur is swung from one center to the other, causing the weft-thread to take a half-hitch around the loops, as shown in Figs. 21 and 21^a. In completing its half-revolution the free end of each brocheur will be caught upon the second head of the pair upon which it alternately turns, and as soon as it is thus engaged the other end of the brocheur will be disengaged from the head upon which it has made a quarter of a revolution, and it will then make the next quarter of a revolution upon the second head. The thread-bearer and the brocheur-frame then separate, the latter also making a partial turn backward about its axis, whereby the half-hitch formed by the weft-thread around the loop of the warp-thread will be drawn down toward the first part of the knot which is illustrated in Figs. 21 and 21ᵃ. The thread-leader V then swings back to its first position near the feed-bar roller, and the brocheur-frame and thread-holder approach each other, assuming the position taken in forming the first part of the knot, the thread-holder swinging as before and the brocheur-frame moving toward the thread-holder and making a partial rotation about its axis, to bring the reels underneath and in a vertical position, as shown in Fig. 22. The thread-holder, in moving toward the brocheur-frame, makes a partial rotation about its axis, so that it will slant when it arrives in position over the finger of the brocheur-frame. This movement on the part of the thread-holder is caused by its finger l^2 striking against the upper end of the vertical slide-bar l', which has meanwhile been raised for such purpose by the cam L^2 acting upon the pin l on said bar l', already described. The slant of the thread-bearer opens the loop in the warp-thread, as shown in Fig. 22, such action being effected by means of a pair of the pins that close the slot in the thread-bearer, it being seen that the second part of the warp-thread will be thrown away from the first part by the pin nearest the outer end of the slot. The brocheur is then caused to return or make a half-turn in the same manner, but in a reverse direction to that which it has made in forming the first part of the knot, the second star-wheel coming into play in this instance for the purpose of actuating the rack-bars that cause a simultaneous movement of the pinions carried by the brocheur-frame. In this movement of the brocheur the reel, with the weft-thread, is carried through the loop formed of warp-thread, and this forms the second part of the knot, as shown in Figs. 23 and 23ᵃ, which, when tightened up, will not slip under any circumstances. The brocheur-frame then moves back, and, making a partial revolution about its axis, returns to its first position; that is to say, the one which it occupied preparatory to tying the first part of the knot, as shown in Fig. 19. The thread-holder swings away from the brocheur-frame and drops the warp-threads, the arm C^3 striking one end of the inner section of the thread-holder to effect such release of the threads. The feed-roller bar also moves back, thereby drawing the warp-threads and tightening up the knot. The knots being tied upon the fingers of the mold-bar and the mesh formed around them, the highest mold-bar upon which the meshes have been formed drops, and is also shifted back a sufficient distance to cause its fingers to slip out from the meshes formed and allow the same to be taken between the rollers, as shown in Fig. 24. As this mold thus moves back the second mold-bar is drawn with it by reason of the connection between the two and the spring before referred to. The second mold-bar having thus shifted back and dropped, the other mold-bar, which is now the highest, will take the place of the mold-bar just employed, and the next row of meshes will therefore be formed upon said highest mold-bar. The fingers of the two sets being diagonally opposite each other, admit of the meshes being formed in diagonal lines, and as soon as a line of knots have been tied, a line of meshes formed, in the manner already described, and the warp-threads taken up by the thread-holder, this thread-holder will be shifted to one side by reason of the forked lever engaging it, so that the warp-threads will be moved laterally, so that when engaged again by the weft-threads the diagonal mesh will be formed. After the next series of meshes have been formed, and the thread-holder, which, it will be remembered, released the warp-threads during the operation of tying the knots, has again taken up the warp-threads, the thread-holder will be shifted in a direction reversely to that just described.

CLAIMS.

"1. The combination, with the devices for forming the warp-threads into loops, of the brocheurs carrying the weft-threads, mechanism for causing said brocheurs first to form a half-hitch of the weft-threads around said loops, and then for passing the weft-threads through the loops to complete the knot, devices for tightening the knots, and devices for shifting the thread-holder so as to move the warp-threads laterally in order to form the diagonal mesh, substantially as described.

"2. The brocheur-frame, the brocheur carrying a reel, and mechanism for causing said brocheur to turn upon two centers upon the brocheur-frame to engage the weft-thread with the warp-thread in the manner described, in combination with devices for manipulating and looping the warp-threads, whereby the brocheur in turning upon one center will pass the weft-thread around a loop in the warp-thread so as to form a half-hitch therearound, and in turning around the remaining center will pass the weft-thread through the loop formed in the warp-thread to form the second hitch and complete the knot, substantially as described.

"3. The combination of the oscillatory brocheur-frame, carrying a series of pinions having heads upon their spindles, and a rack-bar for actuating the said pinions with the brocheur carrying a reel and adapted to engage and turn with the heads of the pinion-spindles, substantially in the manner and for the purpose described.

"4. The combination of the oscillatory brocheur-frame provided with the fingers having hooks, the brocheur supported by said frame and carrying reels for the weft-threads, the swinging thread-holder for the warp-threads, adjusted to be brought into position above the fingers of the brocheur-frame, the thread-leader adapted to bring the warp-thread down to form a loop, and mechanism for imparting the movements specified to the thread-holder and thread-leader, substantially as and for the purpose described.

"5. The oscillatory brocheur-frame provided with a series of fingers having hooks, the rotary pinions d^6, having heads D^3 upon their spindles, and the brocheurs D, each carrying a reel and formed with two grooves capable of receiving the heads of the pinion spindles, combined with mechanism for imparting the necessary oscillatory movement to the pinions d^6, substantially as described.

"6. The combination of the mold-bars M M′ with the swinging thread-leader V, the thread-holder H, constructed and adjusted to engage the warp-thread and to coact with the thread-leader in forming the warp thread into a loop above the mold-bars, the oscillatory brocheur-frame *d*, the brocheur D, carrying a reel for the weft-thread and movable on two centers, and a part revolution upon a second center, in the manner described, so as to carry the warp-thread through said loop, and mechanism for imparting the necessary movements to said devices, substantially as described.

"7. The combination of the oscillatory brocheur-frame, the brocheurs D, carrying reels for the weft-threads, the pinions having heads upon their axles for turning the brocheurs, the slidable rack-bar located to engage said pinions, and the star-wheels adjusted to act at different periods upon the rack-bar in order to reciprocate the same, and mechanism for imparting the necessary movements to the slidable rack-bars and star-wheels, substantially as described.

"8. The combination, with the oscillatory brocheur-frame *d*, of the brocheurs D, carrying reels for the warp-threads, the pinions d^6, carrying the brocheurs upon their spindles, the slidable rack-bar engaging said pinions, the segmental racks engaging said wheels upon the brocheur-frame, the star-wheels, mechanism for intermittently actuating the star-wheels, and mechanism for operating the brocheur-frame, whereby the segmental racks oscillate the brocheur-frame, substantially as described.

"9. The combination, with the swinging bar H^3, carrying the thread-holder H, of the thread-holder H, provided with devices for engaging the warp-threads, and mechanism timed for sliding the thread-holder upon its supporting-bar, substantially as described, and for the purpose set forth.

"10. The combination, with the supporting-bar H^3, carrying the thread-holder H, of the vertically-movable bar l', and devices timed to raise said vertically-movable bar in position to tilt the thread-holder so as to spread the loop, substantially as described."

No. 262140.

(Nathaniel D. Sollers, Cove Point, Md.; patented August 1, 1882; knitting-board for manufacturing nets. See Plate CI.)

A board of nearly semicircular form is provided with a perforation, through which a finger of the hand is to be inserted to hold it steady.

If desired, a rest may be provided for another finger of the same hand underneath the board. In the upper surface of the board, or in a plate set therein, are perforations, in any two of which are inserted the two ends of a holder. This holder is formed of a piece of wire doubled upon itself in such manner that one end will extend across the board at right angles thereto and the other diagonally, giving a tapering form to the holder, while the ends are bent downward to fit into the perforations to hold the device in a plane parallel with the board. The loop end of the holder is bent slightly rearward and upward to prevent the meshes from accidentally slipping therefrom in the process of knitting. The forward end of the board, or that end next to the net, is provided with a recess for giving sufficient room to the needle or shuttle in tying the knots; and a hook is secured to the board near the recess for holding the thread while the knot is being tied. The perforations are formed on a graduated scale, whereby the holder may be so adjusted that the meshes shall be made of any given size. The operation is as follows: After a beginning of the net is made a number of the meshes are engaged with the holder D, and the thumb of the hand holding the board is placed upon these meshes to hold them in position. It is to be understood that the net should be secured to some stationary object, so that the operator can hold the meshes taut. The needle is then to be passed back toward the operator to engage the thread with the holder D. This operation is facilitated by the rearward and upward curve or bend at the loop end of the holder, as well as by the rounded and beveled surface of the board, which serves to guide the thread to the holder. The needle is then passed through the next adjacent mesh, engaging the thread therewith, and the thread is drawn toward the operator until the said mesh is drawn into such engagement with the hook F that the hook will prevent the thread from slipping while the knot is being tied. The thread is then passed to the left over the meshes on the holder, and the needle is passed from the under side up through the recess E, thereby forming a knot, which is completed by drawing the thread toward the operator. The mesh engaged with the hook is released in drawing the knot, and is passed under the thumb, where it is held while another mesh is being formed.

CLAIMS.

"1. A knitting-board for making nets, having a holder for the meshes and a hook to prevent the thread from slipping while the knot is being tied, substantially as shown and described.

"2. A knitting-board of nearly semicircular form, having a perforation through which a finger of the hand may be inserted, in combination with an adjustable holder, substantially as described, and a hook secured to the board to hold the thread in tying the knot, as shown and described."

No. 295262.

(Erick Manula, Astoria, Oreg.; patented March 18, 1884; machine for casting leads on fish-net lines. See Plates CII and CIII.)

The line is wound upon a reel, the circumference of which forms one-half the matrix in which the line lies, a projecting arm under which the reel passes forming the other half. The molten metal is conducted into the matrix and cut off by a trough which slides in the groove of an arm, and is provided with a handle for convenient manipulation (Fig. 1). This trough is perforated at intervals, and when pushed into its place fits with its perforations over those in the groove. The two parts are clamped together during the casting. The reel having the line wound upon it is turned until one of its pieces, G, is brought under the arm B. It is then clamped at its inner end by the vertically-adjustable pin J, which is moved into connection with it. Its outer end is clamped by the lever M. The matrices are formed by the grooves *c g*, in which the line lies. The molten metal is poured into trough P and flows down through the holes into the matrices, and is thus cast in each around the line. The sliding trough is then drawn back sufficiently to cut off the metal, the clamps are released, the reel drops, is relieved, and is turned until its other piece G, is brought into relation with arm B, when the operation is repeated. In this way many sinkers are cast upon the line at regular intervals and at one operation.

CLAIMS.

"1. In a machine for casting leads on lines, a reel or winch upon which the line is wound, said reel having grooves in its circumference, in which the line lies, and forming one-half the matrix, in combination with a stationary piece having corresponding grooves, forming the other half of the matrix, substantially as herein described.

"2. In a machine for casting leads on lines, a reel or winch upon which the line is wound, said reel having grooves in its circumference, in which the line lies, and forming one-half the matrix, in combination with a stationary piece having corresponding grooves, forming the other half of the matrix, and a means for clamping the reel and stationary piece together to form the matrix around the line, substantially as herein described.

"3. In a machine for casting leads on lines, the revolving reel P, having cross-pieces G, on its circumference, provided with grooves *g*, in combination with the perforated arm B, under which the reel revolves, and provided with corresponding grooves, *c*, communicating with the perforations in the arm, and forming with grooves *g* the complete matrix around the line, substantially as herein described.

"4. In a machine for casting leads on lines, the reel F, mounted on a shaft adapted to have a vertical adjustment, said reel having cross-arms G on its circumference, provided with grooves *g*, in combination with the superposed perforated arm B, having grooves *c*, and means for clamping the reel up to the arm, to bring and hold the pieces G in connection with the arm B, substantially as and for the purpose herein described.

"5. In a machine for casting leads on lines, the table A, arms D, pivoted reel-shaft E, and reel F, mounted thereon, having the grooved cross-pieces G, with slotted inner ends on its circumference, in combination with the perforated arm B, having grooves *c*, and the means for clamping the reel up to the arm, consisting of the pin J, passing down through an elongated slot, *i*, in arm B, and having a head, *k*, on its lower end, and a cross-lever, H, on its upper end, adapted to move upon a cam *j*, on said arm to vertically adjust the pin, substantially as herein described.

"6. In a machine for casting leads on lines, the vertically adjustable reel F, having the grooved cross-pieces G, with slotted inner ends in its circumference, in combination with the perforated arm B, having grooves *c*, and the means for clamping the reel up to the arm at both ends, consisting of the vertically-adjustable pin J, engaging with the inner ends of the cross-pieces, and the forked lever M, engaging with their outer ends, substantially as and for the purpose herein described.

"7. In a machine for casting leads on lines, the revolving reel F, having the transversely-grooved cross-pieces G, in combination with the perforated grooved arm B, having transverse grooves, *c*, on its lower side, and the sliding perforated trough P, all arranged and operating substantially as herein described."

No. 257960.

(William R. McCord, East Portland, Oreg., assignor to himself, S. B. Story, C. W. Prindle, and J. M. McCoy; patented May 16, 1882; fish-wheel. See Plate CIV.)

The specification and drawing in this case are in parts very obscure, and are evidently the work of some inexperienced person. The following is substantially the language of the description, from which the reader will have to ascertain as best he can just how the apparatus is constructed. The so-called slats seem to be at right angles to the axis and parallel with one another. Two or three baskets on a shaft are driven by the current. The baskets in small wheels are nearly semicircular at the back; but in larger ones this curve is spiral, having a smaller and smaller radius as it approaches the center. When two baskets are used, buckets are added for turning the wheel when both baskets are horizontal; but with three baskets these are not necessary.

"In Fig. 4 a section of the back of the wheel is shown at an enlarged scale, showing the slats O and the ends of the same where they enter the cross-bars on the ends of the wheel arms G. These pieces, O, are made in this way so that they can be taken out when they are broken by sturgeon or floating drift-wood, when, having a number of duplicate pieces, these are placed in the breaks and business proceeds without delay."

At the lower ends of the slide-pieces C is a frame, H, having a pin at its upper end in each side piece, and below it rests on the floor of the fish-way, and in it are placed two or three grates hinged at the upper ends, the lower ends being loaded to keep it from floating. When a snag or stone comes through the road these open and let it go through without breaking the grates. The grates form a weir to make the fish rise toward the wheel. This is necessary on account of raising the wheel from low to high water. The wheel is inclosed on each side to insure the fish taking to the way.

"On each side of the wheel is an upright timber M, on which is nailed a strip for a tongue, D, and on the central face of each of the slides C are two similar pieces spiked thereto for guides, fitting over the first, and on the side of C next the wheel (on either side) are two wrought-iron hooks (not shown) which pass around to back or down-stream side of M and prevent the loose sliding pieces C from becoming disengaged. C is always on the upstream edge of M. At the top of M a cap, K, is placed, having sheaves L, over which chains or ropes pass to a windlass on the shore for raising or lowering the wheel.

"The wheel-arms G are so placed that they meet the cross-pieces supporting the ends of the pieces O at the outer edge of the baskets F, where the arms and cross-pieces are clamped together with a piece of wrought or cast iron, N, and at the back of the baskets are similarly fastened. The pieces are all bolted together wherever they cross each other, and so form strong braces for keeping the wheel firm.

"The fish are discharged at points E E, on the shore side of the wheel, behind and below the shaft, by sliding down an incline. (Shown by dotted lines in Figs. 1 and 2.) This incline is a board floor placed inside the baskets F at the back side or shaft side, and in such a way that the fish do not discharge until a certain point is reached, when they slide out readily into a box placed at the side to receive them. In this they are sorted, and the small ones returned to the stream. The sides of the baskets F are made of strips of plank screwed or nailed on the inside of the wheel-arms, the outer ends being between two of the segments O and the inside one bolted to the outer one."

The inventor says:

"I am aware of many forms of fish-wheels, but that in which my invention consists is the circular and partially spiral shape of the baskets (so that the fish are taken without injuring them), and the baskets themselves, made of pieces of wood or metal in the form shown, with the slats, arms, and braces at the sides, and in combination the slide-pieces and rising and falling grates in the fish-road, as stated, all made in a similar manner of bars and slats."

CLAIMS.

"1. A fish-wheel, A, having baskets F in the form described, the sides secured to the wheel-arms, the diagonal pieces G, and the bottom made of the segments O, as described.

"2. Pieces C and frames H′, rising and falling, as shown, on guides D, in combination with the wheel."

No. 259143.

(Thomas Heaton, Vancouver, Wash.; patented June 6, 1882; mechanical device for catching fish. See Plate CV.)

An endless chain passes over two skeleton wheels, one of which is journaled in shaft supports upon two connected floats or boats, the other wheel is submerged, the endless chain having nets for catching and elevating the fish. The submerged skeleton wheel may be adjusted to suit different depths of water, and instead of using the nets for catching fish, rakes, forks, or tines may be attached to the chain and used for gathering and elevating oysters and clams.

CLAIMS.

"1. The combination of two endless parallel chains on two skeleton wheels and two floats supporting the same, whereby oyster-dredges, fishing-nets, or sand-elevators may be operated as described.

"2. The combination, with floats having blocks *g* and carrying-shaft *a*, of a submerged wheel D, having its axle suspended both from shaft *a* by the rods *f* and by hooks and eyes from the floats, and held in any desired position by the rods *d*, passing through loops *c* on said blocks *g*, as shown and described.

"3. In combination with the boats or floats A A, skeleton wheel C, journaled upon the boats, the submerged wheel D, hung on the rods *f f*, and the endless chains E, provided with the fish-nets F, the submerged wheel being adjustable by means of the braces *b b* and the rods or chains *d d*, substantially as and for the purposes described."

No. 264395.

(Samuel Wilson, Dallas, Iowa; patented September 12, 1882; fishing-wheel. See Plate CVI.)

A large wheel is constructed of four or more segments which have wire or other netting at their peripheral and side portions, but have their upper projecting portions or scoop ends free. The openings communicate with an escape passage at the center of the wheel, which leads to a chute leading to a cage-net, all so arranged that the wheel being located in a fishway and rotated by the water flowing against it, or by another wheel attached to the shaft outside of the fishway, the mouths of the segments or the scoops will dip against the current—that is, will open at the rear of the wheel to the fish ascending the stream—and will be entered by them as they attempt to pass under the wheel. Then, as each segment rises, the fish will be scooped up, carried in and shunted out into the chute, by which they will be delivered into the trap-cage, to be taken out at pleasure. The wheel may be raised or lowered as the depth of water varies.

Tackle, not shown, for hoisting the wheel will be used mainly in case of raising the wheel for protection in time of floods.

CLAIMS.

"1. A fishing-wheel having sector-nets provided with mouths P and discharge-opening I, in combination with a discharge-chute and a cage-net, substantially as and for the purpose set forth.

"2. The combination, with a fishing-wheel having catching-nets, of cage-net arranged to move up and down in guide-ways, and provided with hoisting and lowering tackle, substantially as and for the purpose set forth."

No. 301653.

(Thornton F. Williams, Cascade Locks, Oreg.; patented July 8, 1884; fishing-machine. See Plate CVII.)

A wheel of revolving dip-nets is mounted on a scow that it may be located in different positions. The supports of the wheel are upon an extension of the stern of the scow, and the nets are provided with double-inclined chutes, for discharging the fish out of each end of the wheel into other chutes extending forward and discharging into the hold of the scow, which may contain water for the fish, and the wheel-arms are contrived with buckets for rotating the nets. The wheel consists of axle *a*, arms *b*, rims *c* and *d*, and floats *e*, attached to the arms for turning the wheel by the current of the water, the floats being on the outside of the arms and parallel to them, instead of extending across from one arm to another, which would turn the fish away from the nets. The wheel may have a crank and be turned by power from the scow or elsewhere. The shaft is mounted in boxes *f*, which may slide on a single post, *g*, by a clip, *h*, connecting it thereto. The boxes, being suspended by cords *i*, form an overhead beam, *j*; or two posts may be used for each box, to form guides between which the boxes may be fitted; or a sash-frame connected over the top of the wheel and having the boxes in it, may be arranged between the posts. The cords will pass over pulleys at the top of the posts, and thence to a windlass *k*, on the scow, for raising and lowering the wheel. The posts are attached to stern timbers or keelsons *l* of the scow *m*, the posts being stayed by rods *n*. The nets consist of two sides *o*, back *p*, and a rim-section, *q*, of wire-gauze attached to the wheel-arms, rim-bars *t*, and backstays *u*, in such arrangement that the rim-section *q* and back *p* receive the fish entering between the sides *o*, gather them in as the nets rise out of the water, pass them toward the center of the wheel, where there are double-inclined chutes *v*, upon which the fish are delivered from the back *p* of the nets as they revolve, and discharge them from the center of the wheel out of both ends into long chutes *w*, alongside and parallel with the ends of the wheel, to conduct the fish directly into the hold of the scow. These chutes will have perforated or slat bottoms to allow the water discharging into them from the nets to escape, in order not to flow into and fill the scow.

CLAIMS.

"1. A fishing-machine consisting of revolving dip-nets having chutes discharging at the ends of the revolving net-wheel, supporting-posts for said wheel, a scow having extension-timbers from one end for the support of the posts, and chutes at the ends of the wheel to receive the fish from the nets and discharge them into the scow, combined and arranged, and the net-wheel being provided with means by which it is turned, substantially as described.

"2. The combination of the revolving shaft *a*, carrying a series of dip-nets having openings in their sides, with the series of double-inclined chutes *v*, mounted on the shaft, and the inclined portions thereof resting upon the lower back portions, *p*, of the nets, with their ends in line with the openings in the sides of said nets, substantially as set forth."

No. 252466.

(Albert N. Hoxie, Foxborough, Mass., and Edward Collins, New York, N. Y.; patented January 17, 1882; fish-trap. See Plate CVIII.)

The posts of the trap are made hollow and of metal, and are strengthened by a movable frame, and by a rod at the top. The frame is about the line of posts on both sides and serves as a buoy. It is attached loosely to the posts, and is permitted to slide up and down, or may be fixed to them. The separate net at the entrance to the trap is stretched from a post in the entrance to the shore, and is on a line transverse to the direction of the channel. Thus fish going up or down the river will be directed into the trap, and thence will pass into the pound.

CLAIM.

"In a fish-trap, the posts A A, made hollow, and of metal, the said posts being arranged as shown, the rods *h*, the frame G, and the net B, all arranged and combined in the manner shown, and for the purpose set forth."

No. 254989.

(Major B. Marshall, Vienna, Md.; patented March 14, 1882; fish-trap. See Plate CIX.)

The trap is formed by poles driven into the bed of the stream near its bank forming three inclosures, one of spear-head shape, and two oblong. To the pole is attached the netting which surrounds each inclosure. One of the oblong inclosures is smaller than, and is placed within, the larger. The spear-head inclosure is closed at its bottom by a netting. Each of the oblong inclosures has an opening in its side near the bank. The inner oblong inclosure has an opening in each end. A net hedge runs from the bank of the stream through the center of the side opening of the inclosure. This hedge prevents the passage of the fish up or down the stream and guides them into the inclosure. The larger oblong has an opening at one end. From this opening extends a net funnel into the spear-head inclosure through an opening in the net and into the spear-head inclosure.

The inventor says:

"I am aware that a seine provided with a netted or closed bottom has heretofore been employed; and I am also aware that a folding net combined with an adjustable fish-pound to close the opening in the heart is not new; and I am further aware that a net with a closed bottom and having endless lines secured at their ends to the upper and lower ends of the corners or angles of the net, which lines pass through upper and lower holes in stakes planted in the stream, to which the corners of the net are secured, by means of which endless lines passing through holes in the stakes the bottom of the net may be raised up or hauled down, has heretofore been employed, and I therefore lay no claim to such inventions."

CLAIMS.

"1. The combination, with the stationary poles *a* and runner-poles *h*, each provided with a hole, *m*, near its lower end, of the spear-head-shaped net *k*, closed at its sides and bottom, and having cords *l* at the angles of its bottom, substantially as described, and for the purpose set forth.

"2. The combination, with the spear-head-shaped net *k*, provided with the opening *k'*, and secured to the stationary and runner poles *a h*, of oblong figure *c*, inclosed by nets *n n'*, and provided with the opening *e o*, funnel *p*, opening into the oblong figure *c* and spear-head, oblong figure *d*, concentric with the figure *c*, open at both ends, inclosed by the net *r*, and provided with the opening *e'*, and net *u*, extending from the opening *e'* to the bank, and secured to the stationary and runner poles *a h*, substantially as described, and for the purpose set forth."

No. 270411.

(James M. Frazer, Portland, Oreg.; patented January 9, 1883; fish-trap. See Plate CX.)

In connection with a ponton or boat is a cage, and a lead-net, with means for vertically adjusting and anchoring the same, the boat being to receive the cage and lead-net, and permit them to be lowered into the water below its bottom. The cage which constitutes the trap proper is rectangular in form, and is to stand in an upright position, and move in the opening in the ponton. It may be constructed with reticulated sides and back and with a slatted bottom, and be provided at its top with crossing beams or pieces, while at its front it has inward inclined or deflected rows of converging staple-shaped bars. The staple-shaped bars are also arranged in a horizontal position, and passed, those of one row through one corner-post or upright of the cage at their looped or connected ends, while their other portions are passed through a second upright of the cage, with their free ends extended beyond the upright to a point a short distance forward and at one side of a vertical plane passing centrally through the cage. The opposite row of staple-shaped bars is similarly arranged and secured in position, whereby a chute, having a narrow longitudinal opening, is provided to direct the fish into the cage or trap. The cage is suspended and vertically adjusted or raised and lowered by a rope or chain, passed through tackle or pulley blocks connected to a cross-beam, a hook and ring, and to the top crossing-bars of the cage or trap in a similar manner. The beam is secured at one end, upon an upright, fastened to the boat at the front side of the opening therein, and upon a cross-bar secured to uprights, also fastened to the ponton at the sides of the opening The rope or chain is further passed over a pulley supported upon the upright, thence under a pulley at the lower end of the upright, and finally connected to a winding apparatus upon the boat.

The lead-net B is hung in the opening in the boat, with its upper edges connected to rods secured to the sides of the opening, while its bottom may be made of slats, G, secured in a bottom frame to rods to which it is attached at its lower side edges. The bottom of the net is connected to the bottom of the trap at one end by eyebolts and hooks, while the ends of the sides of the net are connected by rings to bail-shaped rods fastened to the corner-posts of the front frame of the trap by their horizontal portions. The lead-net is connected near its outer end to a bail to which is attached a rope, passed up over a pulley, hung upon a beam. secured to uprights, fastened to the sides of the opening in the boat near its stern. This arrangement permits the raising and lowering of the lead-net simultaneously with the vertical adjustment of the trap in letting the same down into the water to entrap or impound the fish, and removing the same from the water to enable the fish to be taken from the trap, which is done through a door in one side thereof. The lead-net is extended beyond the stern of the boat, the extension being connected to booms anchored and hung at the stern of the boat, on the sides of the opening therein, by swinging which inward that end of the net is closed as the same is elevated to prevent the escape of the fish. The extension of the net is also weighted or anchored to resist the action of the current by means of iron balls and chains or ropes, with the ropes or chains connected to the extension. An oblique brace, of which there are two, has its upper end passed through the slot of a bar fastened to the sides of the opening in the boat, near its stern, while its lower end reaches down to the bottom of the net and near its inner end, where the two braces are connected together underneath by a cross-rod, supporting the bottom thereat. The upper end of the brace is confined in place by teeth in one end of the slot of the bar, engaging teeth or notches in the brace, and a stud or projection, secured in the side of the opening in the boat in such relation to the brace as to hold its teeth or notches in engagement with those of the bar.

This apparatus permits fishing either in fresh or salt water and to a depth of a single fathom or less, or to a depth of as many as 20 fathoms or more.

CLAIMS.

"1. In a fish-trap, the combination, with a ponton or boat A, having an opening therein, of the cage B and a rope or chain passed over elevated pulleys and under a pulley disposed to permit the convenient manipulation of the rope or chain to move the cage up and down within said ponton or boat, said cage having at its front side rows of inward-projecting converging bars, providing a narrow entrance-opening thereto, substantially as and for the purpose set forth.

"2. In a fish-trap, the combination, with the ponton or boat A, having an opening therein, of the cage B, having the rows of inward-projecting converging bars, forming a chute having a narrow opening, the lead-net B′, connected to the cage B and to the rods secured to the sides of the opening of the ponton, and having an extension, G′, hung upon booms K, connected to the stern of the ponton, and means for raising and lowering the cage and net, substantially as and for the purpose set forth.

"3. In a fish-trap, the combination, with the open ponton or boat A and the lead-net B′, of the oblique brace M, connected underneath the bottom of the net by a rod, M^2, to a similar opposite brace, and the mortised, notched, or toothed support M′, and stud or projection *f*, substantially as and for the purpose set forth."

No. 306896.

(Carol F. Bates, Hughes Springs, Tex.; patented October 21, 1884; mixture for fish-baits. No drawing.)

Half an ounce of asafetida is dissolved in one pint of warm water. To this is added half an ounce of oil of anise and half a pint of honey. For buffalo fishing a bait composed of mush and raw cotton, dipped into the mixture, is employed; but the mixture is to be used with fish-bait of any kind.

The inventor says:

"I am aware that the use of anise-oil and asafetida in similar compounds to the one described by me is not new, and this I disclaim."

CLAIM.

"A mixture for fish-baits that is composed of asafetida, oil of anise, and honey, substantially as hereinbefore set forth."

No. 299690.

(Willis H. Sherwood, Saint Joseph, Mo.; patented June 3, 1884; fishing-bait kettle. See Plate CXI.)

Within an outer pail is suspended a perforated sheet-metal or wire-gauze pail of somewhat less diameter, leaving a space between the two. The outer pail is provided with an annular rim, and downward extending flange. To the rim is hinged a perforated cover, which, in connection with the rim, entirely closes the top of both pails without the necessity of a supplemental cover. The flange holds the inner pail stationary. The pails have separate bails. To the bail of the inner pail a cord may be fastened, so that when this pail is lifted out of the outer, it can be anchored in water for the benefit of the bait. The perforated pail is provided with a dipper, which is also perforated and provided with a wire handle, whereby the minnows to be used as bait may be selected at will.

CLAIM.

"The pail A, in combination with the perforated pail B, provided with the rim *b* and flange *c*, by which the perforated pail is suspended within the outer pail, and provided with the dipper E, substantially as and for the purpose specified."

No. 299765.

(Richard K. Evans, Washington, D. C.; patented June 3, 1884; bait fish can. See Plate CXII.)

To avoid the necessity of frequently changing the water that fish may live, the water when depleted of air is reaërated by means of an air-pump attached to the side of the vessel, the air passing up through the water from a perforated pipe at the bottom of the can.

CLAIMS.

"1. The portable bait-can A, in combination with an air-pump, C, and a pipe to conduct the air from the pump to a point below the surface of the water in the bait-can, for the purpose set forth.

"2. The can A and air-pump C, in combination with the pipe *f*, provided with the return-bend *g* and perforated section *h*, all constructed, arranged, and operated as described."

No. 302086.

(George W. Barton, Bethlehem, Ky.; patented July 15, 1884; fisherman's minnow-bucket. See Plate CXIII.)

The object is to provide a minnow-bucket in which the minnows may readily and conveniently be selected and caught. A perforated, dished false bottom slides on a vertical rod centrally fixed in the bottom of the bucket. The false bottom may be raised and lowered by two spring-rods fixed to it and provided with projections which catch into loops on a short transverse bar at the upper end of the vertical rod (as shown in Fig. 1), to set the false bottom at any determined height, the projections being released from engagement with the loops when it is desired to lower it, by pressing the spring-rods together; or the false bottom may be raised by a spiral spring which encircles the central rod and has one end bearing against the bottom and the other against a sleeve on the rod, to which sleeve the false bottom is fixed, spring-catches at different heights on the sleeve taking into a notch in the rod as desired, and when the sleeve is turned so that the catches will be in vertical line with the notch, and the false bottom is either being raised by the spring or lowered by pushing down the sleeve, all as shown in Fig. 2. Instead of several spring catches on the sleeve and a single notch in the rod, there may be a single catch on the sleeve and several notches in the rod.

CLAIMS.

"1. In a fisherman's minnow-bucket, the combination, with a central guide-rod secured to its bottom, of a false bottom sliding on said guide-rod, and provided with a handle having spring-catches engaging with the guide-rod substantially as shown and described.

"2. In a fisherman's minnow-bucket, the combination, with a guide-rod, B, secured to its bottom and provided with notches, *i*, of a perforated false bottom, C, provided with the apertured tube E, spring-catches, *f*, secured to said tube, and spring F, surrounding the guide-rod and arranged between the false bottom and the bottom of the bucket, substantially as shown and described."

No. 302161.

(Thomas W. Rudolph, of Saint Louis, assignor of one-half to Charles D. Moody, of Webster Groves, Mo.; patented July 15, 1884; minnow-bucket. See Plate CXIV.)

In combined minnow-buckets and minnow-nets here, the bucket and also the net are provided with floating covers. The minnow-bucket has a bail, and also a cover with a depression in its top for holding ice to keep the contents cool. The depression is perforated for the purpose of allowing the water from the melting ice to drip into the bucket. A reticulated bucket of woven wire or fish-net is to be placed inside the minnow-bucket. This wire or net bucket is provided with a perforated cover designed to float the bucket when in the water. If the inner bucket is of net, it has a hoop at its top, having ears which pass through slots made through the floating perforated cover to receive fastenings. The ears may receive a pole when the net is used for catching fish. The net may be provided with hoops between its ends for the purpose of keeping it distended when in use.

CLAIMS.

"1. The combination, with an inner reticulated bucket or net, of a buoyant cover therefor, and an outer bucket inclosing both, substantially as described.

"2. The new article of manufacture described, consisting of a minnow-net or reticulated bucket having perforated ears *a a*, a cover having slots to receive said ears, and a float applied to said cover, substantially as described.

"3. A perforated minnow-bucket having a float attached to it, in combination with an outer imperforate bucket, substantially as described."

No. 307375.

(Charles F. Busche, Saint Louis, Mo.; patented October 28, 1884; minnow-bucket. See Plate CXV.)

The invention relates to that class of minnow-buckets which float when placed in the water. It is said that as heretofore constructed such buckets have generally been provided with an air-tight chamber in the lid to cause the bucket to float. The disadvantage of this construction of bucket, it is declared, is that in lifting the lid, the air-chamber being raised with it, the body of the bucket is tilted by transferring the supporting air-chamber to one side, the result being the upsetting of the contents into the larger bucket. To obviate this, the bucket is made with an annular air-tight chamber, to which both the perforated body and the lid are secured.

CLAIM.

"As a new article of manufacture, a minnow-bucket consisting of an annular air-tight chamber, C, having a lid, B, secured thereto, and a perforated body, A, supported by the chamber, substantially as shown, whereby the lid can be raised without disturbing the horizontal position of the bucket, as set forth."

No. 253501.

(Edward Bourne, Allegheny, Pa.; patented February 14, 1882; sportsman's game-ring. See Plates CXVI and CXVII.)

The ring is of a single piece of wire pointed at one end, which is bent to form a hook. At the other end is formed a loop into which the hook end is caught after passing it through the game that is to be carried.

Near the loop-end an eye is formed by which the ring may be suspended, and below this eye the wire is bent to form an opening into which a strap to be passed over the shoulder may be inserted.

CLAIM.

"The herein described sportsman's game-ring, constructed from a single piece of wire bent to form a circular ring, A, an eye, *e*, for suspending said ring, an opening, *g*, for the reception of a shoulder-strap, a loop, D, and a pointed end, C, bent to form an open loop or hooked end to engage said loop D, as specified."

No. 276945.

(Addison White, Huntsville, Ala.; patented May 1, 1883; game carrier. See Plate CXVIII.)

A frame of a single piece of wire with loops or eyes, formed at opposite sides thereof by coiling the wire at unequal distances from one end. The frame thus constructed has two arms, the ends of which are bent to form hooks which are passed through the game and engage with the loops. A strap or belt with swiveled snap hooks at the ends may be used to suspend the frame from the shoulders.

CLAIMS.

"1. A game carrier or holder consisting of a wire frame, A, having loops *a a* at opposite sides thereof, and arms *c d*, provided with hooked ends *e e*, adapted to engage with the said loops, substantially as described.

"2. In a game carrier or holder, the combination, with the frame A, having loops or eyes *a a* at opposite sides thereof, and hooked arms *c d*, adapted to engage therewith, of the snap-hooks B B and strap C, substantially as described."

No. 278856.

(William F. Benedict, New York, N.Y.; patented June 5, 1883; basket. See Plate CXIX.)

To strengthen and protect baskets used for carrying heavy matter, such as coal and oysters, they are provided underneath with perforate or imperforate metallic bottoms, and at their sides may also be provided with metallic strips which turn down over the brim. Requisite metallic handles are fastened to opposite strips, and pass over the basket handles. The bottom and strips are bolted to the basket or splint body.

CLAIMS.

"1. In combination with the basket A and handle a^2, the strip F, covering the said handle, cross-strip d', riveted to the ends *f* of the said strip F, and the side strip D, secured to the said cross-strip d' and connected by its lower end to the bottom of the basket, substantially as and for the purpose hereinbefore set forth.

"2. The combination of the basket A, the metallic bottom-protector B, the rim surrounding side strip C, the handle a^2, the metallic strip F, the cross-strip d', and side strip D, all constructed and connected together substantially as and for the purpose hereinbefore set forth."

No. 257597.

(Samuel N. Long, West Harwich, Mass.; patented May 9, 1882; fishing apparatus. See Plate CXX.)

This invention relates to that class of fishing apparatus in which a bag or pocket is attached to the side of the vessel, into which the catch may be discharged from the seine and kept until wanted.

Booms attached to the rail support the bag or pocket. Guys are attached to the outer ends of the booms, and have their inner ends secured adjustably to the side of the rail to enable the booms to be adjusted horizontally. Coiled springs are secured to the masts of the vessel by ropes, which pass through and are firmly attached to both ends thereof. When the springs are compressed the ropes which pass through them are slack. When the springs are expanded the ropes are tightened, but then prevent further expansion of the springs. The ropes are reeved through blocks attached to the outer ends of the booms, thence up through blocks or dead-eyes at the lower ends of the springs, thence through blocks attached to the rail of the vessel at the inner ends of the booms, and finally are attached to fastenings on the deck. By this tackle the outer ends of the booms may be adjusted vertically. The object of the springs is to relieve the masts in case the vessel rolls and the pocket is heavy with fish. Around the sides and ends of the pocket is passed a stout rope, which strengthens and enables it to support the weight of the fish. Ropes are attached to the outer ends of the booms and reeved through the ends of the pocket, passing under the same through suitable rings or eyes. The inner free ends of the ropes may be made fast upon the deck of the vessel.

In operation the ropes are slackened until the outer edge of the pocket comes below the water-line. The end of the seine has been previously attached to the edge of the pocket, and the men in the seine-boat then commence hauling in the seine, thus forcing the fish from the latter into the pocket. When the seine has been hauled in and its entire contents discharged it is detached from the pocket, and the outer edge of the latter is then, by pulling the ropes, hoisted to the desired height above the water-line, thus preventing the escape of the fish.

When the fish are to be removed from the pocket the latter may be gradually pursed up by means of the ropes under it.

CLAIMS.

"1. The combination of the booms C, the bag or pocket D, the blocks I T U, ropes H, and coiled springs F, all arranged and operating substantially as and for the purpose set forth.

"2. The combination, with the vessel A, of the booms C, the bag or pocket D, attached to said booms and to the side of the vessel, and having rings or eyes M, and the ropes L, attached to the outer ends of the booms, reeved through the eyes M, and having their inner ends secured adjustably to the deck of the vessel, as set forth."

No. 268558.

(Michael S. Small, Cape Elizabeth, Me.; patented December 5, 1882; fish-sack. See Plate CXXI.)

A floating fish-sack to be attached to the side of a vessel for holding the fish that have been caught in the large seines. Suspended from the side of a fishing vessel by ropes is a square sack of heavy twine netting secured to a line which runs around its top and from which it hangs. Above the hanging-line on two sides of the sack are two flexible cylindrical floats. These floats are composed of a series of small cork seine-floats, arranged contiguously along a lace-line, and so closely placed as to make one long cylindrical float. They are fastened to the hanging-line by the ends of the lace-line, and the lace-line and hanging-line are further held together by seizings. The cylindrical float is sufficiently flexible to bend and turn to the undulations of the waves. No matter how much the vessel may roll, the sack will not "churn," but only rise and fall with the surface of the water. Fastened to the hanging-line at the outer side of the sack are the looped seine-line for attachment of the seine, seizings, and stop-lines. Projecting over the side of the vessel is a boom, and running through a block, *a*, the end of the boom is a painter-line. This line is represented as hooking into one of the loops at the outer corners of the sack. When in the water the inner ends of the floats rest against the vessel's hull, and projecting outward at right angles keep the mouth of the sack extended. If there is a tendency of the floats to drift in against the vessel's side, the painter-line can be hooked into one of the loops and drawn inboard with sufficient tautness to keep the float extended under the boom. As soon as a school of fish have been caught in a large seine it is brought alongside the fishing vessel and the sack is lowered over the side, the suspending ropes being made fast to some point along the vessel's rail. The seine is then attached to the sack by taking a number of the floats on the hanging-line of the seine, gathering them into a compact bundle, and passing this through one of the loops of the seine-line. The stop-line is then passed over the seine-line and tightly tied. This operation is repeated until all the loops across the front of the sack contain a bundle of seine buoys. Thus the seine and sack are securely fastened together.

The fish can then be easily transferred from the seine to the sack. After the fish have all been transferred the stop-lines are unbound and the seine is taken away. In order that the weight of fish contained in the sack shall not sink it far below the surface of the water and permit the contained fish to escape as fast as a stop is untied and a bundle of seine-floats is withdrawn, a movable buoy or float is substituted, so that when the seine is taken away there will be a series of buoys attached to the hanging-line along the front of the sack, having sufficient buoyancy to keep the sack floating. The sack can readily be taken from the water folded into a compact mass.

CLAIMS.

"1. A floating fish sack or pocket provided with the flexible buoy or float D, consisting of a series of small floats, *d d*, arranged contiguously upon a lace, *f*, and seized to the hanging-line C at intervals, as shown, substantially as and for the purposes set forth.

"2. A floating fish pocket or sack consisting of a box-shaped netted receptacle, B, suspended from the hanging-line C, the flexible buoys or floats D, made as described, centrally pierced by the lace-line *f* and securely fastened to said hanging-line C by means of the lace-line *f* and seizings *h h*, the seine-line H, made secure to the hanging-line by seizings *g g* and the stop-lines *n n*, for the purpose of binding a bundle of seine-floats into the loops between said seine-line and said hanging-line, all constructed and arranged substantially as set forth."

No. 292123.

(Richard A. Lindsay, Baltimore, Md.; patented January 15, 1884; live-box for fish. See Plate CXXII.)

The top is buoyant, and has a door for introduction of the fish. The bottom is non-buoyant, and is of perforated metal or of wire-work, or may be imperforate. The top and bottom are connected by cord-netting, which forms the sides and ends, and permits the top and bottom to be brought close together, so that the device will occupy a greatly reduced space in transportation.

CLAIM.

"In a fisherman's live-box, the combination of a rigid buoyant top having an opening for the introduction of fish and a hinged door to close the said opening, a rigid non-buoyant bottom, and cord-netting sides, substantially as and for the purpose specified."

No. 265544.

(Diedrich Schmidt, New York, N. Y.; patented October 3, 1882; fish-safe. See Plate CXXIII.)

The object is to prevent salted fish from losing in weight by the evaporation of the water in the same. A case is provided with a slatted floor for receiving a box containing salted fish, and below the slatted floor there is a water-pan, which fills the case with moisture and prevents the rapid evaporation of the water in the salted fish. There is a second slatted floor above the first, above which upper floor the sides of the case and the upper door are provided with glass panels. The smoked fish on the upper slatted floor will be exposed to view by the glass. The upper floor, E, can be made solid, in place of being made of slats.

CLAIMS.

"1. In a fish-safe, the combination, with the box A, of the doors C and D, the slatted floors E and F, and the water-pan G, substantially as herein shown and described, and for the purpose set forth.

"2. In a fish-safe, the combination, with the box A, of the doors C and D, the slatted floors E and F, the glass panels J, and the water-pan G, substantially as herein shown and described, and for the purpose set forth."

No. 291195.

(Ralph S. Jennings, Boston, Mass.; patented January 1, 1884; fish package. See Plates CXXIV and CXXV.)

The claims describe the package and fully set forth the invention believed to be involved in the case. Fig. 2 of the drawing exhibits a supposed course or movement of air.

CLAIMS.

"1. The herein-described portable package for transporting fish, it having a tight top and bottom and tight sides, except that one side has an air-aperture at or near the bottom, and the other side has another air-aperture at or near the top, in combination with partitions or shelves formed of narrow cross-bars constructed to allow large air spaces between them, and arranged, substantially as set forth, to compel the air which enters the lower aperture through the side of the package to move in a broken or circuitous passage to the upper aperture, substantially as set forth.

"2. The herein-described portable package for transporting fish, it consisting of an outside casing and interior partitions or shelves constructed of strips or supporting-pieces arranged to allow a free passage of air between them, and each arranged to project part way across the side of the package opposite to the side from which the adjacent partitions or shelves project, and air apertures through the sides of the casing, substantially as set forth.

"3. In a portable package for transporting fish, the combination of the external casing and the interior partitions or supports, each having at one edge a cut-away portion or passage for air, and means, substantially as set forth, to prevent the fish from moving over said passage."

No. 295517.

(Charles A. Bergtold, New York, N. Y.; patented March 25, 1884; fish-box. See Plate CXXVI.)

The outer or main part of a double box is provided with a removable cover, at one extremity whereof is placed a block whereon the fish are dressed. A door or cover shuts over the inner box, and is provided with a glazed panel. This cover is hinged to the first named, and, when opened, rests against two supports at its back. At one extremity of the main box are located a towel-holder and a receptacle for the knife used in preparing the fish for use. The inner box is supported upon cleats vertically located at each corner against the wall of the outer box, extending to the bottom thereof, serving to support the inner box and strengthening the outer one. At the bottom of the inner box is a trap, through which the space between the bottoms of the two boxes may be reached, as the upper box is much less in depth than the outer, the trap being provided with handles for removal. Across the bottom of the main box extend two cleats cut away in the center. The walls of the inner box are perforated with small holes, and the top of the cover to the main box is perforated in like manner. In using this fish-preserving box a sponge or woolen cloth saturated with water, wherein salt and alum have been dissolved, is placed in the open space between the bottoms of the two boxes and the fish are put into the inner box. The evaporating moisture from the sponge or cloth charges the air between the two boxes, and that in the inner box, keeping the fish fresh, and any deleterious oders that, if confined, would hasten decay of the fish, pass out through the perforations in the cover.

CLAIM.

"A fish receptacle and preserving device consisting of main box A, having handles D, towel-holder B, knife support C, removable top G, having depending edges g, perforations g', and dressing-block L, inner box I, having lip I′, handles i, trap J, and perforations g', the main box being provided with cleats E and F, and the whole combined and arranged to operate substantially as shown and described."

No. 300061.

(Spencer Lee Fraser and William A. Brigham, Toledo, Ohio; patented June 10, 1884; oyster refrigerator. See Plate CXXVII.)

The refrigerator-box is divided horizontally at or near its middle by a perforated partition, upon which the ice is placed. This partition has a central opening, through which is inserted a receptacle, into which the articles are placed. This receptacle rests upon the bottom of the box, and is retained in a proper central position by a partition. The box is provided with a cover, which has a central opening, which, when the cover is in position, is directly over the mouth of the receptacle.

The receptacle extends upward so far that it is closely surrounded by the cover, which thus assists the partition in retaining the receptacle in proper central position, and also closes the box entirely, while leaving the receptacle open. An independent cover is provided for the receptacle, the ice in the box remaining thus at all times covered and unexposed to the air at any time. The ice on the shelf, by direct contact, cools the upper portion of the receptacle, and the drip-water and cold air which settle in the lower compartment of the box keep the lower portion equally cool. Only the upper half of the receptacle is surrounded by ice. In addition, the shelf acts as a partition to keep the drip-water from collecting around the ice. The drip-water may be removed by a faucet in the lower part of the box. A pipe, which is shown as extending upward from the lower compartment of the box and communicating with the external air, is provided for purposes of ventilation.

CLAIMS.

"1. A refrigerator-box and a food-receptacle contained therein, in combination with a cover for said box, provided with an opening adapted to encircle the top of said receptacle, whereby access may be had to the receptacle without exposing the contents of the box, substantially as set forth.

"2. The refrigerator-box *a*, the perforated shelf *d*, and the receptacle B, in combination with the box-cover F, provided with a central opening, E, adapted to encircle the top of the receptacle B, and the cover G of said receptacle, substantially as set forth."

No. 259442.

(William West, Keene, Ontario, Canada; patented June 13, 1882; can-filling apparatus. See Plates CXXVIII to CXXX, inclusive.)

The invention is an improvement upon an apparatus patented to John West and R. D. Hume, October 19, 1880, No. 233449, and consists in certain details of construction by which the material is delivered beneath the vertical plunger in a better manner, the operation of the cutting-knives is more perfect, and the knives are less liable to become dulled. A is the main shaft, having fixed to it the spur-gear wheel B, which meshes with the pinion C upon the driving-shaft D, by which it is rotated. Upon the shaft A is a cam which actuates a vertical rod, F, having guides and an anti-friction roller. This rod has its upper end connected with a horizontal lever-arm, G, one end of which is pivoted to a standard on the table or frame which supports the mechanism, and the other end is connected by a rod or link, H, with the plunger I, so that the rotation of the cam will cause this plunger to be elevated, and its weight, or, if desired, a spring, will carry it down when released. This plunger is guided, as shown, and moves in a corresponding chute, J, to force the fish down into the compression cylinder below, after the fish has been placed beneath the plunger by a reciprocating carrier, K, which moves in a trough, L, and is operated by a peculiarly-shaped lever-arm, M, notched or forked at M′, so as to be driven from the vertically-reciprocating bar N. A horizontal lever, O, actuated by a spring, P, and a cam, Q, on the end of the shaft A, moves the bar N up and down. The upper end of this bar has a rack, R, formed upon it, which engages with teeth S, circularly placed upon one side of a hinged swinging plate, T, and by the vertical reciprocation of this rack the plate T is caused to swing up to admit the forward movement of the carrier K, with the fish which has been placed before it, and after the carrier has been withdrawn it swings down, so as to complete the movement of forcing the fish into the chute, and also to form a wall at that side while the plunger passes down. The compression-cylinder into which the fish is forced by the plunger I is placed at the bottom of the chute, similarly to the one shown in the patent referred to; but the knife V, by which the fish is cut and shaped, is a single one, working entirely in one direction. This knife is in the form of a cylinder, having an opening cut out of one side equal in its dimensions to the size of the chute through which the fish is forced down, and as this cylindrical knife has its open side uppermost when the plunger I is forcing the fish down it receives enough to fill it. The knife then rotates upon its axis sufficiently to cut off the cylinder full and at the same time close it off from the chute. A horizontal knife, 2, is so placed that its edge is opposite to and assists the cylindrical knife. This knife V has a flange, W, upon one end, the flange having notches X X upon opposite sides of its periphery, as shown, and these notches are engaged successively by the point *y* of a curved cam-shaped lever, Z, which is pivoted to a disk, *i*, on the side of the eccentric-gear wheel *a* and rotates with it. A spring, *b*, holds the point *y* in contact with the periphery of the flange W, and when, in the rotation of the gear-wheel, it reaches one of the notches X it will fall into it and carry the knife along until the point *y* is lifted out of the notch by the action of a stationary pin, *c*, on the back of the cam-lever Z, the pin being fixed to the outside of the chute. When this occurs the knife remains stationary until the point *y* engages the next notch X and again moves the knife. By this action the knife is left stationary when its open side is uppermost and in line with the chute, so as to receive the fish, and again when in the opposite position and while the fish is being forced out of the compression and forming cylinder into the can. The knife is driven at a varying rate of speed by means of the two eccentric gears *a a′*, one of which carries the actuating cam-lever, as before described, while the other, *a′*, which is the driver, is mounted upon a shaft, this shaft carrying a bevel-pinion, *d*, and the bevel-gear wheel *e* upon the main shaft A meshes with and drives it. The disk *i* upon the side of the eccentric gear *a* is held and adjusted so as to regulate the movements of the knife by means of a screw, *f*, which passes through slots in the gear *a*, so that it may be moved around the axis, and thus change the position of the cam-lever Z relative to the flange W. The knife is moved slowly when its open side and cutting-edge are downward, and it is moved at its greatest speed when the open side is upward and the inclined cutting-edge is moving across the chute to cut off the supply. The piston *g* moves through the center of the cylindrical knife and forces the fish from it into the extension *h*, upon which the can fits, as described in the former patent above referred to. The movement of this piston is effected by means of a pin, *i*, projecting from the disk *j* on the end of the shaft A, this pin striking an arm, *k*, which projects downward from the guide extending in rear of the pistons. A bent arm, *l*, pivoted to the frame below, has a pin projecting in front of the arm *k*, and the arm *l* is acted upon by the pin upon the disk, so as to return the piston after it has been forced forward, in the same manner as shown in former patent. A vertically-sliding knife or plate, *m*, is formed across the space between the cylindrical forming-knife and the rear part of the extension *h* upon which the can fits, as soon as the piston has been withdrawn past that point, and thus closes the end of the cylindrical knife and former for the introduction of another charge by the plunger moving in the chute. The sliding knife *m* has a stem projecting downward, and a spiral or other spring, *n*, acts against a pin or shoulder to return the knife after it has been drawn down and then released. The knife is drawn down out of the cylinder by means of an arm, *o*, one end of which is connected with the stem of the knife, while the opposite end is curved and brought into such a position relative to a cam, *p*, upon the main shaft that as the shaft rotates the cam acts upon the lever, moving it about its fulcrum until the knife is drawn down, and then releases it, so that the spring throws it back again. When the supply of fish within the vertical chute is sufficient the swinging gate T is prevented from opening by a latch, *r*, a notch in which engages one of the pins or teeth S (by which and the rack R it is operated), and thus holds it against the action of the spring P until the latch is tripped and the gear released. As long as the chute contains a quantity of fish the plunger I will not descend very low; but as soon as the quantity diminishes to a certain point an arm, *t*, which is secured to the upper part of the plunger and moves with it, passing down outside the chute, will strike the rear end of the latch *r*, and thus disengage it, so that the gate can operate. The cam which moves the lever by which the plunger is actuated may be turned upon the shaft, so as to regulate the movement of the plunger, by means of a screw, E′, passing through a slot in a disk upon the main shaft, the cam lying in contact with the disk.

CLAIMS.

"1. In a can-filling apparatus, and in combination with the vertical fish-receiving chute J and the vertically-reciprocating plunger I, guided as shown, the cam E, adjustable upon the driving-shaft, the vertical rod F, the lever-arm G, and the connecting rod or link H, substantially as and for the purpose herein described.

"2. The horizontal trough L, opening into the upper part of the chute J, in combination with the reciprocating carrier K, moving in said trough, so as to transfer the fish into the vertical chute, substantially as herein described.

"3. In combination with carrier K, moving in the trough L, the lever-arm M, connected with the carrier by a link, and having the fork or notch M′, in combination with the vertically-reciprocating bar N, substantially as herein described.

"4. The hinged swinging-gate T, opening or closing the passage between the trough L and chute J, and having the toothed segment S, in combination with the reciprocating bar N, with its rack R, engaging said segment, substantially as herein described.

"5. The bar N, moving in guides, as shown in combination with the lever O, cam Q, and spring P, substantially as and for the purpose herein described.

"6. The cylindrical receiver, having one side open and the edge forming a knife, V, so that a supply of fish may be forced through the opening from the chute J, and cut off and formed to enter the can by the rotation of the knife, substantially as herein described.

"7. The cylindrical knife and shaper V, turning within the chute J, and provided with the flange W, in combination with the curved lever Z and rotating gear-wheel *a*, substantially as herein described.

"8. In combination with the cylindrical knife and shaper V, with its notched flange W, and curved operating-lever Z, the disk *i*, supporting the lever, and adjustable upon the gear *a* by slots and screws *f*, so as to regulate the movements of the knife, substantially as herein described.

"9. The cylindrical knife and shaper V, with its notched flange, and the curved pivoted lever Z, and spring *b*, rotated by the gear-wheel *a*, in combination with the stationary pin *c*, whereby the pawl *y* is disengaged at each semi-revolution of the knife, substantially as herein described.

"10. In combination with the hollow rotating knife and former V, operating within the chute J, as shown, the eccentric gears *a a′*, meshing with each other to drive the knife with a variable speed, substantially as herein described.

"11. In combination with the hollow intermittently-rotating cylindrical knife and former V and the eccentric driving gears *a a′*, the piston *g*, reciprocating through the cylindrical knife and the sleeve upon which the gear *a* turns, and the stem or extension *h*, operating lever and cam, substantially as herein described.

"12. The hinged swinging-gate T, toothed segments S, and vertically-moving bar N and rack R, in combination with the latch *r* and the arm *f*, connected with the plunger, substantially as and for the purpose herein described."

No. 262575.

(Augustine Crosby, Benton, Me.; patented August 15, 1882; machine for filling cans with meat, fish, &c. See Plates CXXXI and CXXXII.)

In some can-filling machines apair of semi-cylindrical knives or cutters rotating about a longitudinal axis, one within the other, in concentric circles, have been employed to cut the meat, fish, &c., delivered thereto from the chute or hopper and properly shape it to fit into the can to be filled. These cutters, when opened to their full extent by rotating them on their axis, so that one will lie snugly within the other, form a semi-cylindrical chamber or receptacle of a size and shape adapted to contain only one-half of the contents of the can to be filled, the meat or fish in the chute above being forcibly pressed directly down into the receptacle, and extending up above the upper edges of the cutters, which, as they are rotated, cut off a portion of suitable size and shape to fit the can to be filled, and as the meat or fish is soft and elastic, the mass of material above the cutters must be held down while they are operating, in order that a sufficient quantity may be cut off to properly fill the can. It is declared that to effect this pressure requires the expenditure of considerable power, while the mechanism employed within the chute to produce this pressure is in the way and interferes with the proper sorting and arranging by hand of the pieces of meat or fish before they reach the cutters, while the juices are expressed and escape at various points, thus running to waste, whereby the quality of the meat or fish is injuriously affected; that furthermore, as the cutters fit one within the other when opened, they do not form a true circle when closed up to make the cut, and it therefore becomes impossible to make the cylindrical plunger employed to force the substance into the can fit accurately within the chamber formed by the closed cutters, the space thus left between the plunger and the interior of the cutters affording an opportunity for tough fish skins and sinews to catch between the edges of the cutters and become twisted or jammed, and hence not to be carried forward by the plunger, when they will accumulate and cause the machine to become clogged, while it frequently happens that one end of a long piece of skin or sinew will become caught while the other end is carried by the plunger into the can, and when the latter is removed from the machine its contents will be drawn out in consequence of one end of this piece of skin being still held fast in the machine, causing much delay and waste of time and material. Finally, in some machines the meat or fish is forced into a nearly circular die or receptacle and cut off by a straight knife; but this construction is declared to be objectionable, as the portion of meat or fish is not properly shaped to fit the can, being left flat on one side, and a great pressure has to be exerted to force the meat or fish into the die, while all of the machines heretofore constructed for filling cans employ springs, and are, it is said, generally complicated and liable to get out of order on account of the great variety of irregular movements necessarily imparted to the different portions of the mechanism. This invention has for its object to overcome all of these difficulties; and it consists in the combination, with the chute, of a pair of semi-cylindrical knives or cutters so pivoted together as to open and close in the arc of a circle having its center in or near the line of their circumference, whereby they are adapted, when open, to receive the material from the chute, and when closing or advancing toward each other to gather together, cut off, and firmly compress the material received from the chute and properly shape it to fit the can to be filled, thus dispensing with the heavy pressure heretofore required to force the material from the chute to the cutters; also in the combination, with the chute and a pair of semi-cylindrical shaping and compressing cutters, constructed and operating as described, of levers secured to said cutters and actuated by cams; also in the combination, with a pair of semi-cylindrical shaping and compressing cutters so pivoted or hinged together as to open and close in the arc of a circle having its center in or near the line of their circumference, and form when closed a true cylinder, of a reciprocating piston or plunger adapted to accurately fit within the space or chamber formed by the said cutters when closed, and thereby insure the discharge of the entire contents of the chamber, whereby the machine is prevented from becoming clogged by the introduction of any portion of the material in the chamber between the piston and the inner surfaces of the cutters; also in providing the piston or plunger with an automatic vacuum-valve for admitting air into the chamber in which the meat or fish is compressed, for the purpose of preventing the formation of a vacuum therein on the withdrawal of the piston; also in the combination, with the semi-cylindrical shaping and compressing cutters, constructed and operating as described, and the casing and chute, of a reciprocating piston or plunger actuated by certain mechanism, as hereinafter set forth, whereby the machine is simplified and rendered more durable and effective in its operation; also in the combination, with the reciprocating piston and its actuating mechanism, of certain mechanism for operating the semi-cylindrical cutters, so constructed and connected as to cause the cutters to be entirely closed to form a true cylinder before or immediately after the piston reaches them on its forward stroke; also in supporting the can upon a series of bars of U or V shape in cross-section, so arranged as to form exit-passages for the escape of the air from the can while it is being filled; also in securing the can-supporting bars to a removable ring attached to the front of the casing, said ring forming a guide for the sliding-gate, which closes one end of the chamber in which the meat or fish is compressed,

CLAIMS.

"1. In a can-filling machine, the combination, with the chute C, of a pair of semi-cylindrical cutters, G, so pivoted or hinged together as to open and close in the arc of a circle having its center in or near the line of their circumference, whereby they are adapted, when open, to receive the material from the chute, and when closing or advancing toward each other to gather together, cut off, and firmly compress the said material received from the chute and properly shape it to fit the can to be filled, substantially as set forth.

"2. In a can-filling machine, the semi-cylindrical shaping and compressing cutters G, adapted to receive the material from the chute, and so pivoted or hinged together as to open and close in the arc of a circle having its center in or near the line of their circumference, in combination with the chute C and the levers *d*, actuated by the cams *w a'* on the shaft T or other suitable operating mechanism, substantially as described.

"3. In a can-filling machine, the combination, with a pair of semi-cylindrical shaping and compressing cutters, G, so pivoted or hinged together as to open and close in the arc of a circle having its center in or near the line of their circumference, and form when closed a true cylinder, of a reciprocating piston or plunger, I, adapted to accurately fit within the space or chamber formed by the said cutters when closed, and thereby insure the discharge of the entire contents of the chamber, whereby the machine is prevented from becoming clogged by the introduction of any portion of the material in the chamber between the piston and the inner surfaces of the cutters, substantially as set forth.

"4. In a can-filling machine, the combination, with the semi-cylindrical shaping and compressing cutters G, of the reciprocating hollow piston I, having a head, *i*, provided with an automatic vacuum-valve, *n*, adapted to admit air into the chamber E in front of the piston as it is withdrawn, substantially as and for the purpose described.

"5. In a can-filling machine, the combination, with the semi-cylindrical shaping and compressing cutters G, operating as described, and the casing B and chute C, of the reciprocating piston or plunger I, with its connecting-rod L, lever M, rock-shaft *p*, slotted lever *q*, connecting-rod N, and actuating-disk P, all constructed to co-operate substantially in the manner and for the purpose set forth.

"6. In a can-filling machine, the combination, with the reciprocating piston I and its actuating mechanism, of the shaft T and mechanism connected therewith for operating the semi-cylindrical cutters G, so connected as to cause the cutters to be entirely closed, to form a true cylinder, before or immediately after the piston reaches them on its forward stroke, substantially as described.

"7. In a can-filling machine, the combination, with the casing B, the shaping and compressing cutters G, and the reciprocating piston I, of the can-supporting bars *l*, made of U or V form in cross-section, and arranged with their open sides outward to form outlets or exit-passages for the escape of the air from the can as it is being filled, substantially as set forth.

"8. In a can-filling machine, the can-supporting bars *l*, secured to a removable ring, 25, attached to the front of the casing B, said ring forming a guide for the sliding gate H, substantially as described."

No. 265137.

(Charles L. Pond, Buffalo, N. Y.; patented September 26, 1882; package for oysters, &c. See Plate CXXXIII.)

The invention relates to the construction of the removable head of barrels, tubs, or other vessels in which oysters and other similar perishable articles are packed, and has for its object so to construct the removable head that it can be readily applied and removed, and that when applied it is sufficiently tight to prevent the escape of the contents of the package, and that it can be readily sealed, and that it has no projecting parts which would interfere with the handling and stowing of the package in transportation. At the upper head are two segmental side pieces. These are fixed within the barrel upon an inner hoop, there being a groove on the curved edge of each piece which fits upon the hoop, and nails being driven from the exterior of the barrel through the hoop into the side pieces. Between the parallel sides of the side pieces is the removable portion of the head, which consists of two parts hinged together below. The outer ends are grooved to fit over the rest of the hoop. Each removable part has at its side a packed offset which rests upon an offset on the corresponding side piece. Two clamps pivoted to the side pieces opposite the hinged edges of the removable portion overlap the adjacent parts and secure them in place. Each clamp consists of two wings, respectively, on the upper and lower sides of the cover, and secured to the same by a vertical pivot which turns in the side piece. The upper wing has an arm which projects rearward, and turns upon a plate secured to the top of the side piece. The plate has two upward-projecting stops to limit the movement of the arm to a quarter-circle. One of the stops and the arm resting upon it is perforated, so that the wire of a seal may be drawn through both perforations, thereby preventing the clamp from being turned without breaking the seal. The upper wing and the arm are in one piece with a hub, the exterior surface of which is hexagonal, turned by a wrench. One of the removable parts is provided with a removable handle shaped to serve, when removed, as a wrench to turn the clamps. The wrench end of the handle is attached to the cover by a metallic strap, which is secured to the upper side of the cover, leaving sufficient space between the under side and the upper side of the cover to permit this end of the handle to be inserted under the strap. The cover is provided with depressions for the reception of the ends of the handle. The opposite end of the handle is inserted under a similar strap and bears with its end against a spring seated in an inclined socket in the cover, whereby the handle is pressed toward the strap. Upon pressing the handle toward the spring until the opposite is withdrawn from under the strap, the handle is released. The handle is reattached in an obvious manner.

CLAIMS.

"1. The combination, with the body A, provided on its inner side with a hoop, *d*, of the grooved stationary end pieces, B, hinged cover C C′, provided with grooves in its ends, and ledges *e e′*, formed respectively on the stationary end pieces, and hinged cover, substantially as set forth.

"2. The combination, with the body A, having end pieces, B, of the hinged cover C C′ and clamps F, whereby the hinged cover is secured in place, substantially as set forth.

"3. The clamp F, composed of two lips, *f*, secured to a pivot, *f′*, which is provided with a head, *h*, adapted to be seized by a wrench, substantially as set forth.

"4. The combination, with the side pieces, B B, and the hinged cover C C′, of one or more clamps, F, each provided with two lips, *f*, arranged respectively on the upper and lower sides of the cover, substantially as set forth.

"5. The combination, with the side pieces, B B, and a hinged cover, C C′, of one or more clamps, F, provided with lips *f*, adapted to engage over the adjacent portions of the cover, an arm, *g*, formed on the clamp, a fixed plate, *g′*, provided with stops g^2 g^3, and means whereby the arm *g* can be locked to one of the stops, substantially as set forth.

"6. The combination, with the cover, of a removable handle, I, straps *k k′*, and spring *l*, substantially as set forth."

No. 296023.

(Thomas Levi, New Westminster, British Columbia, Canada; patented April 1, 1884; device for keeping fish, meat, fruit, and other preserving cans clean while being filled. See Plate CXXXIV.)

A tin case or cylinder to fit over fish, meat, fruit, or other preserving cans while being filled. The tin case or cylinder is made one size larger in circumference at the top, increasing in size to the bottom, and a size shorter in length than the preserving-can, with a rim at the top turned inward and downward. When the preserving-can is filled, it is lifted by the pressure of the fingers and thumb on the case or cylinder, the object being to keep the can while being filled clean, and to enable the person filling the preserving can to remove it after it has been filled without touching it with his hands, thereby keeping it clean and saving labor.

The inventor says:

"I make no claim to the preserving-can A."

CLAIM.

"The combination of the case or cylinder B with the preserving-can A, when applied as shown in the Fig. C, substantially as described."

No. 299710.

(Julius Wolff, New York, N. Y.; patented June 3, 1884; sardine-can. See Plate CXXXV.)

A sardine-can having its top or bottom, or both, concave. In canning sardines as heretofore practiced the cans are made with flat or slightly convexed tops and bottoms. The fish are packed into the cans and oil is poured over them until the body of the can is filled with oil. The tops of the cans are then soldered on, and heat is applied by water or steam a sufficient time to preserve the fish. The cans are then removed, and if the soldering was properly done, the top and bottom of the cans are convex from the expansion of the inclosed air by the heat. The cans are then punched to allow the air to escape, and the puncture is thereupon closed with solder. In this process, when the cans are punched to allow the air to escape, the escaping air carries a portion of the oil with it, so that when the cans are opened the fish are found to be only partly covered with oil, and consequently not in a state of perfect preservation. To avoid this the inventor here makes a sardine-can with the top or bottom, or both, concave. The depression of the middle parts of the tops of the cans then causes the air in the cans to collect around the edges of the tops, and the heat of the soldering-tool heats the air and oil along the edges, and causes the air to expand and escape in front of it as it passes along the edges, so that when the soldering is completed the air will be sufficiently expelled. The filled cans are then subjected to heat in the ordinary manner, and if the soldering has been properly done, the expansion of the small quantity of air left in the cans will have expanded the concaved top and bottoms into an approximately level or horizontal position, and the cans are ready to be cooled and stored for market. In case the tops and bottoms of the cans, when the boiling operation has been completed, have not been expanded into level positions, it shows that the soldering was not properly done, and that the inclosed air and part of the oil have escaped during the boiling operation. Such cans have to be resoldered, punched in two or more places and placed in hot oil until they are again filled with oil. The punctures are then filled with solder and the sardines are marketed as seconds.

CLAIMS.

"1. A sardine-can having its top or bottom concaved and secured within the body of the can, as and for the purpose set forth.

"2. In a sardine-can, the combination, with the body A, provided with the offsets *a*, of the concave top B, provided with a flange *b* and bead *c*, substantially as herein shown and described."

No. 288106.

(Freeman Payzant, Lockeport, Nova Scotia; patented November 6, 1883; process of and apparatus for extracting oil from fish liver and blubber. See Plate CXXXVI.)

The furnace has a water-jacket and a pipe for conducting air into the furnace below the grate; the pipe has at its upper end an adjustable hood for catching the air. The furnace is put into a tank or vat containing fish livers and blubber. The oil rises to the surface, and the livers and blubber sink to the bottom.

CLAIMS.

"1. The method herein described of preventing the discoloration and injury of the oil, which consists in interposing a stratum of water between the oil-yielding substance and the furnace, substantially as described, and for the purpose set forth.

"2. The combination, with the oil-holding receptacle, of a water-jacketed furnace, substantially as shown and described.

"3. The combination, with the furnace A B C, provided with an air-pipe, D, and adapted to be supported in a tank, of the water-jacket F, surrounding the furnace and extending from below the grate nearly to the upper end of the furnace."

No. 294940.

(Peter C. Vogellus, Gloucester, Mass.; patented March 11, 1884; process of extracting oils and fats from fish. No drawing.)

In extracting oil from fish, fish-livers, or fish-heads where solvents are employed as the extracting agent, to obviate the difficulty experienced by the presence of water, this is first removed by subjecting the fish whole or cut up and raw, but preferably while being heated or cooked, to the action of a substance, such as plaster-of-paris, which will absorb the water without taking up the oil.

CLAIMS.

"1. The improved process of extracting oils from fish, consisting in subjecting the fish to the action of plaster-of-paris or some similar water-absorbing agent, whereby the water is removed therefrom, and then mingling the fish with a suitable solvent, whereby the oil in the fish is dissolved, substantially as described.

"2. The improved process of extracting oils from fish, consisting in heating the fish, subjecting the same to water-absorbing agents, and then to the dissolving action of solvents, substantially as described.

"3. In the process of extracting oil from fish, the subjection of the latter to the water-absorbing action of plaster-of-paris or equivalent absorbents, substantially as specified."

No. 259140.

(Frank L. Harris, Harrisonburg, Va.; patented June 6, 1882; manufacture of fertilizing material. See Plate CXXXVII.)

Bone, horn, or hoof is subjected to pressure while immersed in water heated above the boiling point for the required length of time, which will be until the water reaches the temperature of about 250° or 300° Fahrenheit. The pressure is produced by heating the water in which the bones are immersed in an air-tight vessel. The bone thus treated is then removed and allowed to dry. The water remains in the vessel, and a fresh charge of bone is introduced into the same, and the operation is repeated. After a succession of operations the water is drawn off, and the dried bone is allowed to soak in the water thus enriched with gelatine until the bone has absorbed most of it. The bone is then again dried, and finally is pulverized for market.

The drawing shows a furnace and a closed vessel surrounded by a jacket, and placed upon the furnace. The closed vessel has a steam-tight cap, and the flame and heat from the furnace enter the space between the jacket and the closed vessel rapidly to heat the latter. An ordinary gage indicates the pressure and a chain that can be connected with a crane serves to lift the apparatus from the furnace when desired.

CLAIMS.

"The herein-described process of producing a fertilizer, consisting in immersing bones, horns, or hoofs in water within an air-tight vessel, and while so immersed and confined subjecting the article to pressure by heating the water above the boiling point, removing and drying the charge, and introducing into the same water a fresh charge, and treating it in a similar manner, next allowing a quantity of the article thus treated and dried to soak in the water, so as to absorb the gelatine contained therein, and finally drying and pulverizing the article."

No. 263322.

(Azariah F. Crowell, Wood's Holl, Mass.; patented August 29, 1882; manufacture of fertilizers. No drawing.)

Instead of first pressing the fish to extract therefrom the oil and gelatinous and nitrogenous liquid, and afterward mixing with the latter a superphosphate, as described in a patent to this inventor, dated September 24, 1878, No. 208224, the fish (dogfish, menhaden, &c.) and superphosphate are mixed together and cooked by steam or otherwise, whereby a greater amount of the gelatinous and nitrogenous matters and oil are obtained, and the soluble parts of the superphosphate are combined to better advantage with the gelatinous and nitrogenous matters, the oil being subsequently separated from such matters and the soluble parts of the superphosphate by skimming, and the cooked mass being pressed to squeeze out liquor and oil. Furthermore, by the present procedure, the insoluble parts of the superphosphate are at the same time mixed with the fish scrap or pomace, whereas by the former patented process this mixture had to be effected at another time and at an increased expense.

The inventor says:

"Consequently I do not herein claim to first press from the fish the oil and gelatinous and nitrogenous liquid, and afterward mix with the said liquid a superphosphate, and remove from the mixture the insoluble substance or substances, and evaporate the remainder to the necessary consistency. My new process involves the employment of heat and the cooking of the fish mixed with the superphosphate, such not constituting a part of my former or patented process."

CLAIM.

"In the manufacture of liquid fertilizer, the process of obtaining from fish its gelatinous and nitrogenous properties, combined with the soluble parts of a superphosphate, such consisting in mixing together the fish and superphosphate and cooking the mixture by heat and subsequently subjecting it to pressure, so as to expel from it the oily, nitrogenous, and phosphatic liquid."

No. 251772.

(John Eckart, Munich, Bavaria, Germany; patented January 3, 1882; compound for preserving meats and fish. No drawing.)

Instead of the solution mentioned in the patent granted this inventor August 28, 1877, No 194550, in which half a pound of salicylic acid to 100 pounds of water was used for preserving animal or vegetable matter, a mixture of 50 per cent. of common salt, 47½ per cent. of chemically pure boracic acid, 2 per cent. of tartaric acid, and ½ per cent. of salicylic acid, is employed. The flesh of fishes immediately after they are caught is separated from the skin and bones. The composition is then applied to it in the proportions of about twenty grams of the composition to one kilogram of flesh. The flesh is afterward filled into gut or artificial cases of parchment. These cases are then packed into casks, after which the casks are filled with a gelatine solution, made up of about 50 grams of gelatine and 20 grams of the preserving mixture to every 1,000 grams of water, and submitted to pressure in the following manner: The casks being strong and tight, their interior is put into communication with the pressure-pipe of a pump and hermetically closed; more of the solution is pumped into the cask until the pressure-gauge with which it is supplied shows a pressure up to twelve atmospheres or more. This pressure is maintained from fifteen to thirty minutes, more or less, according to the requirements of the case, until the contents are completely saturated. Then an air-valve is opened and the pressure is relieved, the cover is removed and the contents are taken out. The gut cases may then be strewn over with more of the preserving mixture in a dry condition and be stored in vessels for shipment. They may also then be covered with a solution of the preserving-salt in water.

The inventor says:

"I do not herein claim the gelatine solution, as I propose to make it the subject of a separate application for patent."

CLAIMS.

"1. The preserving-salt, composed of chloride of sodium and boracic acid with the smaller quantities of tartaric and salicylic acid, substantially as herein specified.

"2. The sausage described, having a filling of meat saturated with the preserving-solution, as herein specified."

No. 255017.

(Charles L. Pond, Buffalo, N. Y.; patented March 14, 1882; package for oysters. See Plate CXXXVIII.)

The lower head of the barrel is fixed. Upon the inside of this head is a rim which forms a recess in which rests the bottom of a can, the can being stayed at the top by a ring secured to the inside of the barrel. The upper head of the barrel bears upon the upper end of the can and prevents it being displaced vertically. The upper head is removable and rests upon a rim fixed in a recess at the upper end of the barrel. Where it rests upon the rim the head has a projecting edge, which is provided on its under side with a packing ring fixed in a groove in the head, being there secured by a metallic hoop, which also serves to prevent the head from warping. Two sliding bolts arranged in recesses on the inner side of the removable head are connected at their ends to a lever which extends outward through an opening in the head. On one end of the lever to which the bolts are attached is a disk nearly circular, and the bolts are so connected to this disk on opposite sides of its center, that by swinging the outer end of the lever in one or the other direction the bolts will be extended or retracted. A casing of metal or wood secured to the under side of the removable head incloses the sliding bolts, the ends of the casing being provided with openings through which the sliding bolts protrude. One sliding bolt, that shown to the left of Fig. 2, is provided with an upward projecting tongue, and the lever has an opening which permits the tongue to project through it, when the lever is closed down upon the head. The head has upon its upper side a recess in which the lever rests when it is thus closed down. When the bolts are retracted the head can be inserted into the open end of the barrel with the packed edge resting upon the rim. By pushing the lever down upon the head the sliding bolts are projected under the rim, thereby drawing the edge of the head tightly against the outer side of the rim and locking it in the barrel. A wire is then drawn through the opening in the end of the tongue above the lever, and its ends are connected by a metallic seal whereby the lever is firmly secured in place at a quarter circle from the insertion of the bolts, and on the under side of the head are two turn-buttons to engage against the under side of the rim. The buttons are each attached to a bolt, which projects upward through the removable head, and is provided with a knob or head having a nose. This knob turns on a plate which is seated in a recess formed in the head, whereby it is prevented from turning. The plate has two projecting stops at right angles to each other, and the nose of the knob swings between them, and the movement of the turn button is limited by the stops to a quarter turn. The buttons are to furnish an additional fastening. The nose, and the stop against which it rests when the turn-button is projected under the rim, are provided with perforations through which a wire can be drawn for the purpose of attaching a seal.

CLAIMS.

"1. The combination, with a barrel or tub, A, of a ring, *c*, composed of a strip of wood made of uniform cross-section throughout its length, and sprung into a recess of suitable shape formed in the barrel or tub near its end, substantially as set forth.

"2. The combination, with a barrel or tub, A, provided on its inner surface, near its end, with a projecting ring, *c*, of a removable head, B, resting upon the ring *c*, and fastening devices applied to the under side of the head and adapted to be projected under the ring *c* for securing the head and to be retracted for releasing the head, substantially as set forth.

"3. The combination, with a barrel or tub, A, provided with a ring or shoulder, *c*, of a removable head, B, provided with sliding bolts $f f'$, attached to the under side of the head and adapted to engage with their outer ends under the ring *c*, and a lever, F, to which the inner ends of the bolts $f f'$ are connected and whereby both bolts are moved in opposite directions, substantially as set forth.

"4. The combination, with the removable head B, of the sliding bolts $f f'$, one of which is provided with a projecting tongue, *h*, and the lever F, having an opening, h', substantially as set forth.

"5. The combination, with the removable cover B, constructed with a projecting rim, *b*, of a packing-ring, *d*, applied to the under side of the rim *b*, and a hoop, *c*, which surrounds the lower contracted portion of the cover, and bears with its upper edge against the packing-ring *d*, and secures the latter in place, substantially as set forth.

"6. The combination, with the cover B, of a turn-button, L, secured to a bolt, *l*, having a head, M, provided with a nose, *m*, and a plate, N, secured to the cover B, and provided with stops, *n*, between which the nose *m* swings, substantially as set forth."

No. 261984.

(James H. Baxter, Portland, Me., assignor to himself and Charles A. Dyer and David L. Fernald, both of same place; patented August 1, 1882; apparatus for packing dried fish. See Plate CXXXIX.)

Molds which are made in two longitudinal sections hinged together, and of cylindrical contour on their interior, are constructed with a series of grooves for insertion of the binding-cords, and with fastenings for keeping the molds closed and locked when removing them from the ordinary screw press employed, and until the binding-strings are tied, during which operation other molds may be successively inserted in the press for a repetition of the process.

CLAIM.

"The fish-compressing mold C, constructed of two longitudinal sections hinged together on their one side, and of cylindrical contour on their interior, with a series of transverse grooves, *c c'*, in and through them for the reception of binding strings or cords, in combination with one or more hooks and fastenings, *e f*, for holding the molds locked with the fish under pressure, substantially as and for the purposes herein set forth."

No. 265735.

(James H. Baxter, Portland, Me., assignor to himself and Charles A. Dyer and David L. Fernald, both of same place; patented October 10, 1882; putting up dried fish. See Plate CXL.)

Fish is compressed into a compact mass in a mold under a press and held firmly together by binding strings applied at different points in its length and tied while the fish is under pressure. This bound package is then inclosed in a wrapper of waxed paper, after which the whole is inclosed in an outer wrapper of manilla paper. These wrappers exclude the air, and this fact, with the expulsion of the air from between the fish while in the press, prevents the fish spoiling in hot weather or on long voyages or from losing weight. On the exterior of the outer wrapper is inscribed a series of marks which enables the dealer to cut the package into the desired smaller parts without weighing, and this without objectionable exposure of the fish by removing the wrapper and without handling it.

CLAIMS.

"1. A package of boneless fish bound at intervals with strings and incased in wrapping-papers, one of which wrappers is marked to indicate where said package may be cut across to separate it into divisions of one pound each, or of any other unit of weight.

"2. A package of boneless fish pressed into a solid mass of uniform size throughout its length and incased in a wrapper which is marked into equal divisions indicating where the package may be cut across to separate it into multiplies of the whole package, as one-half, one-third, one-fourth, &c., as shown and described."

No. 267685.

(Anderson Fowler, New York, N. Y.; patented November 21, 1882; apparatus for preserving meats. See Plate CXLI.)

The invention is designed to provide an apparatus for carrying into rapid, cheap, and effective operation the process of preserving and curing meats, fats, fish, &c., by subjecting the same simultaneously to the action of a current of electricity, and of a preservative substance, as set forth in an application by this inventor for patent filed October 30, 1880, serial No. 19806; but the invention here may be employed with advantage wherever it is desirable to subject substances of the character indicated to the pervasive or permeating action of electricity. The meats, fats, fish, or similar organic substance to be preserved, should be packed in the cases or smaller boxes B, and surrounded by a suitable preservative agent, such as salt, saltpeter, or salicylic acid. During the operation of the apparatus the dynamo-electric machine F is in operation to generate the desired electric current, and simultaneous therewith the disks C are caused to rotate in opposite directions by the revolution of the fast pulleys on their respective shafts *b*. The cases B, being closed, and having the substance to be acted upon to be cured or preserved packed therein, are passed longitudinally through the box or tube A and between the disks C. As each box B passes into the space between the disks C the electric current is caused to pass through the conducting sides of the box and through the contents thereof. Inasmuch as the said boxes may be very rapidly passed one after another through the box or tube A and between the disks C, the operation of subjecting the contents of each box to the action of the electricity is rapid, and from the rotation in opposite directions of the disks C, and the intensity of the current derived from the dynamo-electric machine, a powerful effect of the character indicated in the aforesaid application filed October 30, 1880, is to be produced.

CLAIMS.

"1. In an apparatus for subjecting organic substances to the action of electricity, the combination of the oblong box or tube A, the disks C, connected with suitable means for generating and maintaining a current of electricity, and one or more cases or boxes, B, adapted to pass lengthwise of the box A and between the disks C, and to contain the substance to be treated, all substantially as and for the purpose herein set forth.

"2. In an apparatus for subjecting organic substances to the action of electricity, the combination of the disks C, arranged to rotate in opposite directions, the box or tube A, one or more cases or boxes, B, constructed to pass through the box A and between the disks C, and wires or conductors adapted to connect the same with a source of electricity, arranged to pass a current of electricity from one to the other of the disks C, and through the contents of a case or box, B, as the latter is passed through the box or tube A, all substantially as and for the purpose herein set forth.

"3. In an apparatus for subjecting organic substances to the action of electricity, the combination of the insulated bearings *a* and insulated pulleys *c c'* with the shafts *b*, the disks C, the box or tube A, and one or more cases or boxes, B, adapted to be passed through the box A and between the disks C, all substantially as and for the purpose herein set forth.

"4. In an apparatus for subjecting organic substances to the action of electricity, the combination of one or more cases or boxes, B, having sides capable of conducting electricity, and non-conducting ends, top, and bottom, the box or tube A, the disks C, and wires or conductors adapted to connect the apparatus with a source of electricity in order to maintain a current of electricity from one of the disks C to the other, the conducting sides of the cases or boxes B, and the contents of said cases or boxes, all substantially as and for the purpose herein set forth."

No. 275973.

(Oscar Andrews, Gloucester, Mass.: patented April 17, 1883; preparing salt fish for market. See Plate CXLII.)

Salt fish is made into bars or cakes, each cake weighing one, two, or more pounds. The layers of fish are held together in compact form by thread or twine sewed through them.

CLAIMS.

"1. The method of preparing salt fish for the market, consisting of first making the layers of fish into a bar or cake, and then applying a fastening material interiorly to the bar or cake by passing said fastening material through the layers of fish constituting said bar or cake, substantially as and for the purpose set forth.

"2. As an improved article of manufacture, a bar or cake of salt fish, the layers of fish which constitute said bar or cake being held together compactly by means of fastening material passed through said layers, substantially as and for the purpose described."

No. 276868.

(Frederick B. Nichols and Cathcart Thomson, of Halifax, Nova Scotia, Canada, said Nichols assignor to said Thomson; patented May 1, 1883; process of manufacturing fish-meal. No drawing.)

The fish are headed and split and a portion of the backbone is removed in the same manner as for making the ordinary dry salted fish. The pieces are then washed and all bloody portions removed. Very little salt should, it is said, be used in curing, as heavy salting makes an inferior meal, even when the excess is removed by water previous to drying. For some qualities of meal it is preferred to dry without salt. In this state the fish would soon spoil, and very rapid drying must be resorted to in order to save them. The immediate application of currents of hot air would accomplish this, but would render the skin so friable as to defeat the after process, and in other respects injure it for making meal, and open-air drying would not be speedy enough to keep the fish from tainting. In order to obviate these difficulties, the fish-drying house and apparatus of the patent granted this inventor December 6, 1881, No. 260382, is employed. The drying must be more thorough than for ordinary dried fish, in order to make the fish hard and crisp. The hard-dried fish are made small enough to be fed into the hopper of a mill to be coarsely ground. Almost any kind of grinding mill may be used, provided it is not too sharp, and is set high for coarse grinding for the first run. This run should be bolted through sieves having about one hundred and forty-four meshes to the square inch. About 75 per cent. of it should pass through the bolt. The remainder, which is too coarse to pass, consists of the bones and the skin with considerable fish flesh adhering to it. In order to utilize this, it is reground with the mill set closer, and again passed through the bolt. If on examination much fish adheres to the skin, it should be subjected to another grinding with a still closer set of the mill, and again passed through the bolt. The residue from this, consisting principally of skin, bones, and scales, should not amount to more than 10 per cent. of the weight of the dried fish. This residue can be utilized as manure. The product of the last grindings contain considerable of the white portion of the skin with fragments of bone and enough of the black skin to give a coarse dirty appearance to the meal. In order to remedy this, it should be again ground in a sharper and closer set mill to reduce it to a fine meal, and this, being passed through a bolt having about four hundred meshes to the square inch, gives a fine product, and contains the most nourishing portion of the fish. The last product can be either used alone or incorporated with the first by uniform mixing.

The inventors say:

"We are aware that fish-meal has been previously made; but in all previous processes, so far as we are aware, the fish used have been so salt as to require soaking the meal to remove the excess of salt before cooking, and the skin, fins, tail, and larger bones removed before grinding. We propose to use fish dried with little or no salt, and to grind them without removing either skin, bones, or other refuse contained in fins or tail, and to separate them by bolting."

CLAIM.

"The process of manufacturing fish-meal from dried fish, which consists in first heading and splitting the fish, then removing the backbone, then washing and drying, then chopping, grinding, and bolting through sieves, substantially as specified."

No. 273074.

(Ralph S. Jennings, Baltimore, Md.; patented February 27, 1883; process of preserving fish. No drawing.)

In this process salted fish is subjected to the action of superheated steam or hot air to destroy the organic life in the salt with which it is cured. It is stated that in salt procured by the evaporation of sea water by solar heat, there frequently exist spores of algæ, which are liable at certain seasons and under certain conditions to impart a red color to or cause decomposition of the fish cured with such salt. An endless woven wire apron hung on rollers and having within it a narrow box with a foraminous top, may be employed. Into this box heated air at 450° Fahrenheit may be forced, and be discharged from it against the fish which have been placed on the endless apron. Instead of such box there may be placed within or underneath the apron a foraminous pipe, through which superheated steam or hot air at a temperature of 400° Fahrenheit is discharged against the fish, while the apron is revolved at such speed as will expose each fish for about two seconds to the action.

The inventor says:

"I do not claim boiling salted fish, nor smoking nor drying such, as usually heretofore practiced, by means of air or products of combustion, for the purpose of curing or drying them; nor do I claim merely singeing an animal or article of food, such not being productive of a result or results attainable by my invention."

CLAIM.

"The process, substantially as described, of treating salted fish for the destruction or killing of the alga germs contained in the salt of such fish, such process consisting in rapidly passing, at or about at a speed as hereinbefore mentioned, the fish over a sufficiently-heated surface, or through or in contact with heated air or superheated steam at or about a temperature of 400° Fahrenheit, so as to superficially heat the fish to an extent required to kill the said germs, without heating the interior of the fish to the injury thereof."

No. 261623.

(Hubert W. Morgan, Westfield, Mass., assignor to himself and Edwin R. Lay, of same place, and James T. Morgan, of Winsted, Conn.; patented July 25, 1882; preparation of whalebone. No drawing.)

A strong solution of an alkali, such as potash, is heated and in this, whalebone, in the proportion of half a pound of whalebone to a quart of the solution, more or less, according to the consistency desired in the resulting mixture, is dissolved. If this solution be applied in coats to flexible but comparatively inelastic substances, they will be rendered permanently elastic thereby. Whips are instanced. A highly elastic body may be produced by making the whalebone preparation of a much thicker consistency—of that of a thick paste—and of a somewhat plastic character by adding a larger quantity of the whalebone cuttings or shavings to the given quantity of the potash solution, and then adding thereto fine cuttings of leather or leather ground up into a pulp, so that the whole mixture may be sufficiently tough and hard to take the form of a die, and then molding it. Waste whalebone in cuttings, shavings, or waste pieces, is used. This solution of whalebone may have added to it any desired water-proof substance, such as gum-shellac or other desired substance of similar nature, so that when applied it will resist the action of moisture or dampness.

CLAIM.

"A new compound or liquid preparation of whalebone, consisting of whalebone dissolved in an alkali, substantially as hereinbefore described."

No. 299515.

(Reuben Brooks, Gloucester, Mass.; patented June 3, 1884; process of treating the waste of salt fish. See Plate CXLIII.)

The object is to desalt fish-waste. The waste is first mechanically disintegrated or pulverized, is then subjected to the action of water until the salt is removed, or to that of very dilute sulphuric acid, or other antiseptic which will also prevent putrefaction, and finally the glue is extracted preferably in the manner described in patent No. 243713, granted LePage, July 5, 1881. The material, after being disintegrated, is placed in a perforated receptacle, which is itself suspended in a tank containing water, the water being changed from time to time until the desalting process is complete. From 1 to 3 per cent. of sulphuric acid may be mixed with the water, but the use of chemicals may be entirely dispensed with if the tanks are so situated as to permit a constant stream of water to flow in at the top over the material and percolate down through the mass. The liquid is discharged from the bottom, carrying the salt with it.

The inventor says:

"I am aware that tanks have heretofore been constructed for leaching chemicals, in which liquids flowing in at the top were drawn off from the bottom in a manner similar in many respects to that above described, and hence I make no claim to tanks so constructed in my present application."

CLAIMS.

"1. The process of preparing the waste portions of salt fish for the manufacture of glue, consisting in, first, crushing, tearing, or otherwise mechanically disintegrating the waste, and, secondly, removing the salt therefrom by the use of water or dilute sulphuric acid, substantially as set forth.

"2. The process of preparing the waste portions of salt fish for the manufacture of glue, consisting in, first, crushing, tearing, or otherwise mechanically disintegrating the waste, and, secondly, removing the salt therefrom by exposing the waste to the action of flowing water, substantially as set forth.

"3. The process of preparing the waste portions of salt fish for the manufacture of glue, consisting in, first, crushing, tearing, or otherwise mechanically disintegrating the waste, and, secondly, removing the salt therefrom by exposing the waste to the action of flowing water, said water passing downward through the mass, and leaving the material through which it has passed by the pressure of the water in the tank, substantially as set forth.

"4. The process of extracting glue from the waste of salt fish, consisting in, first, mechanically disintegrating the waste; secondly, removing the salt therefrom by the use of flowing water, or water with an antiseptic in solution; thirdly, cooking; fourthly, straining, and fifthly, evaporating, substantially as set forth.

"5. The process of extracting glue from the waste of salt fish, consisting in, first, mechanically disintegrating the waste; secondly, removing the salt therefrom by the action of flowing water or dilute sulphuric acid; thirdly, steaming the desalted mass; fourthly, straining, and fifthly, evaporating, substantially as set forth."

No. 260179.

(Henry F. Evans, New York, N. Y.; patented June 27, 1882; oleaginous compound used in manufacturing cordage. No drawing.)

In the manufacture of ropes, twines, and cords it is customary to treat the manila or other material with an oil. As a substitute for the oils commonly used, a mineral oil commercially known as amber-oil or Smith's Ferry oil, mixed with fish or whale oil in the proportion of fifty parts of fish or whale oil to fifty parts of Smith's Ferry oil is employed.

CLAIM.

"An oleaginous compound to be used in the manufacture of cordage, consisting essentially of an amber-oil and fish or whale oil, combined as specified."

No. 286869.

(C. W. Trammer, Great Falls, Md.; patented October 16, 1883; fishway. See Plate CXLIV.)

The invention relates to devices to enable fish to ascend a fall, or to so-called "fishways" or "fish-ladders."

An inclined chute widens upward, and has an enlarged or hopper-shaped fish inlet at its lower, and an outlet at its upper end, either or both of which may be provided with a sliding gate, and suitable means for operating the same, to regulate the flow of water. The diverging sides of the chute are straight, but the top and bottom are a series of inflected steps, which form enlarged communicating chambers, the entire space of which is filled by the water that enters the chute at the upper end or fish outlet. The water is retarded in its exit by the shape and the gradual narrowing of the chute, thus causing comparatively still water in the chambers, so that the fish will have no difficulty in working their way from the lower to the upper end of the chute, whence they emerge into the river or water-course above the dam or falls.

CLAIM.

"The improved fishway herein shown and described, having sides C C, top and bottom A and B, composed of inflected steps or sections *a* and *b*, forming gradually-enlarged chambers *c* inside of the chute, connected to one another by the narrowings *d*, enlarged fish-inlet D, and outlet E, substantially as and for the purpose herein shown and specified."

No. 301285.

(Christopher Schmitz, San Francisco, Cal.; patented July 1, 1884; apparatus for oyster-culture. See Plate CXLV.)

The oysters when near their spawning time are placed in a perforated vessel which is in the center of a basin containing sea-water. The proper time is when the two vesicles of the creature which contain the eggs and milk commence to swell, whereupon the membrane bursts and fertilization takes place, for soon after this the spat or spawn may be extracted by tne operator, or the oyster itself will expel the same. When this has occurred a very fine stream of sea-water is allowed to pass through a pipe from an elevated tank into the perforated vessel. Thence it passes through the perforated sides in innumerable small and gentle currents, widely spread, which carry out with them the spat into the basin. Thence the spat floats gently into compartments over end-gates until it finds stones and rubbish there placed to which it attaches itself. By the employment of the perforated vessel the spawn is held together until ready to float off. Then when it does go it follows the small and gentle currents flowing outward in all directions, and becomes well separated and distributed, giving each living young oyster a chance to find its lodgment. The end-gates of the compartments are vertically movable. The first set, namely, those nearest the entrance, are first closed, and a small flow of water is permitted over them into the compartments following. The young then coming down with the gentle current find such stones or rubbish as may be in that part of the canals and cling to them. The cock in the pipe from the tank is then turned to shut off the supply of water until as many of the young as possible settle down to their places. Then the first set of gates is raised and the next set is pushed down and the supply again turned on, and so on. The entire apparatus is housed, and has a general incline from the basin toward the last of the compartments.

CLAIMS.

"1. The combination, with the water-tank B, having the pipe *b* and cock *c*, of the basin C, provided in its center with a perforated annular vessel, D, a series of passages formed by the extended sides of the basin and divided by a central partition, and a series of vertically-adjustable gates, G, and canals, constructed as shown, and for the purpose herein set forth.

"2. The basin C, having outlets E, and the annular perforated vessel D, in combination with the canals F, having gates G, adjustable, and rocks or rubbish in their bottoms, and a means for supplying vessel D with a gentle flow of sea-water, substantially as herein described."

No. 263933.

(Marshall McDonald, Washington, D. C., assignor to himself and Stephen C. Brown, of the same place; patented September 5, 1882; method of and apparatus for hatching fish. See Plate CXLVI.)

The object is to provide a method of and apparatus for hatching fish, automatically agitating the eggs, eliminating the small fry as soon as hatched, and separating the bad eggs and old shells, and thereby avoiding the contamination of the sound ones. The eggs are agitated by a forced circulation of water in a closed chamber which is entirely filled with water, taking off the discharge-water and with it the bad eggs (or small fry, as the case may be), at a point central with respect to the body of the chamber, in contradistinction to taking off the bad eggs at the surface by overflow from an open jar. A pipe above supplies water under pressure and of a temperature between 50° and 80° (of what thermoneter scale is not stated). Beneath this are the hatching-jar and the receiver or collector, which together constitute a complete automatic apparatus, but there may be a series. Both the hatching-jar and the collector have two glass tubes. Of these tubes, one in the hatching-jar connects by a rubber tube with the water-supply, and extends to nearly the bottom of the jar, being held in a tubular sleeve in the cover of the jar, axially, but vertically adjustable to regulate and control the agitation of eggs and flow of water according to the necessities of the case, there being two classes of eggs to be operated upon, namely, those which are normally of greater, and those which are normally of less specific gravity than water. In the case of heavy eggs (as of the shad and the white fish), the central tube is pushed down to introduce a current of water at the bottom of the vessel, which buoys up the eggs, and filters through the mass, the dead eggs being, by degrees, carried to the surface and removed as above described. As shown in the drawings, the apparatus is arranged for operation upon eggs which are normally heavier than water. In the case of eggs that are normally lighter than water (as of salt-water fish, such as cod and mackerel), the tube is drawn up to introduce the current of water at the upper part of the vessel which passes out at the bottom, thus reversing the direction of the current. The tube is rendered water-tight in the sleeve by small stuffing-boxes at the top and bottom, which by frictional contact hold the tube to its adjustments against the pressure of the water. The other tube of the hatching-jar is the outlet tube for the water, the small fry, and the bad eggs when it is required to remove the latter. This tube is in a short sleeve in the cover, and which is also provided with a stuffing-box to render it tight, but which permits this tube to be deflected. In constructing the sleeve to permit this deflection, the sleeve and also the removable thimble of the stuffing-box are made of a larger diameter than the tube, and the packing in the stuffing-box is in the nature of a round rubber ring confined between the thimble and sleeve, and large enough to act as a fulcrum for the tube when it is to be deflected. The cover to the jar is held down by a screw-ring upon a gum gasket to form a perfectly tight closed jar. The receiving-jar is provided with a similar tight cover, and has similar tube connections for its tubes, one of which tubes is connected to a tube of jar A by a rubber pipe. The other is the discharge-pipe and opens into any suitable receiver for the waste water. Over the lower end of the discharge-tube is a large filtering bag distended over a cage, the object of which is to secure a discharge from this closed jar commensurate with the inflow without creating a violent suction through the filter, which would injure the young and delicate fish. The jars are preferably of glass. They are also of a cylindrical shape, with rounded or oval internal ends. In practice for heavy eggs, as shown, they are filled about three-fourths full of eggs that have been vitalized with the milt of the male, and the tubes are then adjusted to about the position shown. The constant flow of water under pressure into and out of the closed jar now gives the required movement to the eggs, and when the fish is freed from its shell it very soon is caught in the current of water passing up the tube, and is thereby transferred to the receiver, where it remains while the water passes out through the strainer. As the eggs are agitated by the current, the bad eggs and the shells, by reason of their less specific gravity, accumulate from time to time on the top of the strata of sound eggs. Now, to get rid of them the rubber tube is disconnected from its glass tube in the collector vessel and its glass tube in the hatching vessel, and is deflected till its end is near them, when the induction of water draws off these eggs, which are thrown away. After the jar has been purged, the pipe is again connected, and the fish are allowed to pass over again.

The inventor says:

"I am aware of the patents to Chase, August 16, 1881, and Wilmot, July 18, 1876, and I do not claim anything shown therein.

"My invention is distinctive with respect to processes described in the foregoing, and especially the Wilmot process, in that he uses an open vessel and separates the bad eggs, which are of less specific gravity, by overflow from an open vessel. I take advantage of the same principle of separating the bad from the good eggs through their different specific gravities. My process is, however, distinct in the following respects: The forced circulation in a closed vessel, and discharging the water from the vessel at a point more or less central to said chamber or below the surface of the water enable me to secure the following important results: First, I am enabled to effect the separation at any point in the jar without change in the water circulation, and thus can treat a very small quantity of eggs in the jar as well as if the jar were filled nearly to the top, as is necessary in Wilmot's invention; secondly, I avoid all slopping over of the water in the jar and avoid waste of eggs, thus permitting my process to be conducted on cars during transportation; thirdly, by taking off the discharging water in the forced circulation at a point more or less central to the jar, I avoid the spattering of the water and damage to the small fry involved in the fall from an overflowing vessel; and, fourthly, this mode of carrying off the water draws the eggs and small fry into its current with a gentle but positive suction whose influence is distributed throughout the jar, while a surface overflow has no effect in eliminating the bad eggs until they get upon the immediate surface.

CLAIMS.

"1. The improved process of automatically separating the bad eggs and small fry from fish-eggs during incubation, which consists in agitating them in a closed chamber filled full of water by means of a forced circulation of the same, and drawing off the discharge-water along with the bad eggs or small fry at a point below the surface of the water, or more or less central with respect to the jar, as described.

"2. A fish-hatching jar composed of closed glass vessel A, a detachable cover, and the inlet and outlet tubes A′ B′, one being adjustable in vertical direction and the other being deflectible, as shown and described.

"3. A collector for the small fry, consisting of a jar or vessel having an inlet-tube and an outlet-tube, with an enlarged or cage filter on its inner end immersed in said jar or vessel, as and for the purpose described.

"4. The combination of the closed hatching-jar A, having tubes A′ B′ for a forced circulation, and the collector B, having connecting-tubes B^2 and *f*, and a discharge-tube, A^2, with a cage-filter, as shown and described."

No. 277805.

(Livingston Stone, Charlestown, N. H.; patented May 15, 1883; fish-egg hatching trough. See Plate CXLVII.)

This device is analogous to the well known "Williamson hatching trough," but differs from it in construction, whereby it can be readily taken apart and folded into a small compass for package or transportation. Instead of having the sides and bottom of solid wood they are of light water-proof fabric or cloth stretched, laid, and fastened on longitudinal bars connecting the wooden ends and partitions of the trough, and confined thereto by cleats and screws. Each partition has a passage through it and is open laterally at top and bottom. Egg-hatching trays are placed in its several larger compartments. The water passing into the trough at one end flows from one compartment to the other and upward through each series of trays and escapes at the other end of the trough, which is notched, to allow the water to pass off at a proper level.

CLAIM.

"The fish-egg-hatching trough, substantially as described, composed of the notched end pieces, four connecting-bars, the series of notched transverse partitions, and the water-proof cloth or fabric and its fastening cleats and screws, arranged and adapted essentially as set forth."

No. 256240.

(Charles N. Orpen, New York, N. Y.; patented April 11, 1882; aquarium. See Plate CXLVIII.)

A tripod stand has a hook in its upper part from which the globe or aquarium is suspended. The globe is of glass and is for holding fish or water plants. It has a projecting threaded nipple on its top to which is screwed a thimble, which has on its upper part an eye by which the globe is suspended from the hook of the tripod stand. On each side of the thimble the top of the globe has oval openings through which a current of air is maintained upon the surface of the water, keeping it cool and pure. The openings also permit access to the interior of the globe for filling it with water and for the introduction of the fish or water plants. The upper portion of the stand may be provided with a vase for flowers.

CLAIMS.

"1. In an aquarium, a globe, B, provided with a threaded nipple, and with small openings D, in combination with a thimble, C, substantially as set forth.

"2. In an aquarium, the combination, with a stand, A, provided with a hook, *a*, of the globe B, having the thimble C and eye *c* and the oval openings D, substantially as and for the purposes set forth."

No. 265255.

(John H. Scott, jr., and Albert A. Freeman, Philadelphia, Pa.; patented October 3, 1882; method of preserving oysters and similar shell-fish. No drawing.)

The object is to make oysters and like shell-fish retain their liquors and juices in their shells, preserve them alive for a considerable time, and render them capable of transportation in natural and fresh condition, even without ice. This is to be attained by binding the shells firmly together while the oyster or other mollusk is fresh and alive, by wire made to embrace the shell, or by other clamping device.

The inventor says:

"We are aware of attempts having been made to accomplish the same purpose by dipping in paraffine, wax, &c.; but this fails from the fact that it makes them air-tight, the fact being overlooked that they must have air to be kept alive; also, the method of packing in barrels with concave shell underneath; but a turning of the barrel or package permits the liquor or juice to escape, and they soon die."

CLAIM.

"The method of preparing oysters and other shell-fish for preservation and shipment, which consists in holding the shells thereof firmly clamped together while the animals are in natural condition by means of a binding-wire secured around the same, or equivalent clamping device, substantially as and for the purposes set forth."

No. 295218.

(Fortonato Clemente Zanetti, Bryan, Tex.; patented March 18, 1884; aquarium. See Plates CXLIX and CL.)

The object is to produce an ornamental and attractive suspension aquarium in which the water may easily be renewed. A glass jar has one foot or more formed integral with it. The upper edge of the jar is provided with three thickened lugs perforated to receive hooks at the ends of chains by which the device may be suspended. The bottom between the legs or at the side is thickened and provided with a conical perforation through which the water may be drained off. For the perforation a ground plug or stopper is provided. This plug, which is of colored glass, porcelain, majolica, or other ornamental material contrasting with the white glass of which the jar is made, has an enlarged head which forms an interior ornament for the aquarium, and which may represent a man or woman, animal, plant, rock, house, or castle, or any desired ornamental object.

CLAIM.

"The herein-described improved aquarium, consisting of the vase or jar with a base support, and provided at its upper edge with the thickened perforated enlargements for the suspending-chains, and having a re-enforced bottom provided with an aperture, and a plug inserted from within the jar and provided with an interior enlarged ornamental head, as set forth."

Fig. 1

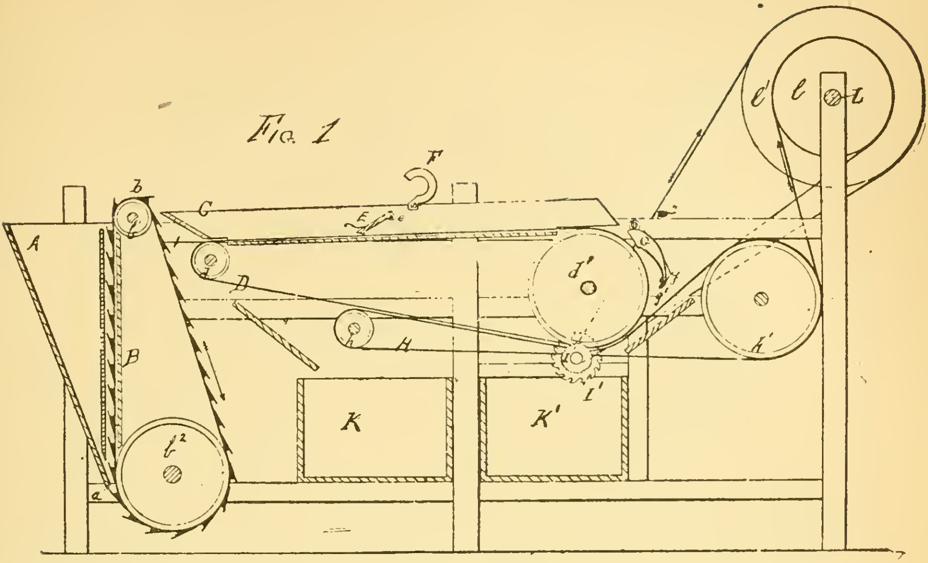
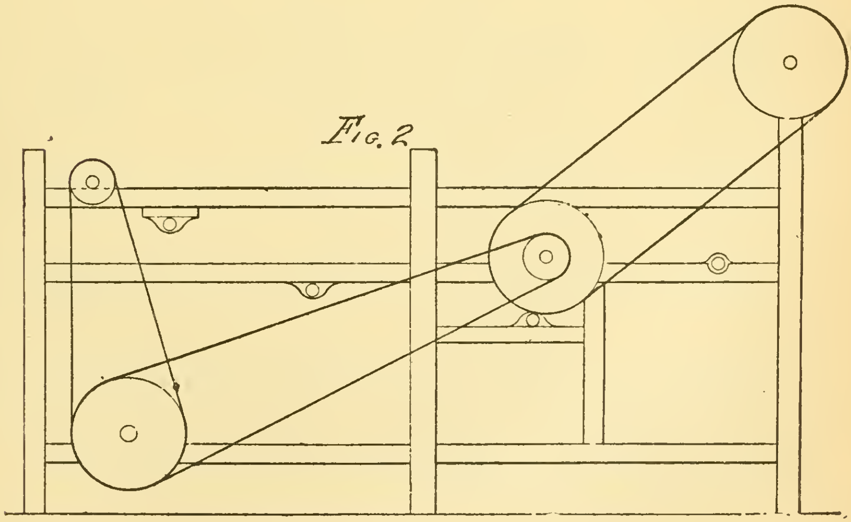


Fig. 2



No. 266,134. Fish-cutter, by James B. Grady. See p. [9].

Fig. 3

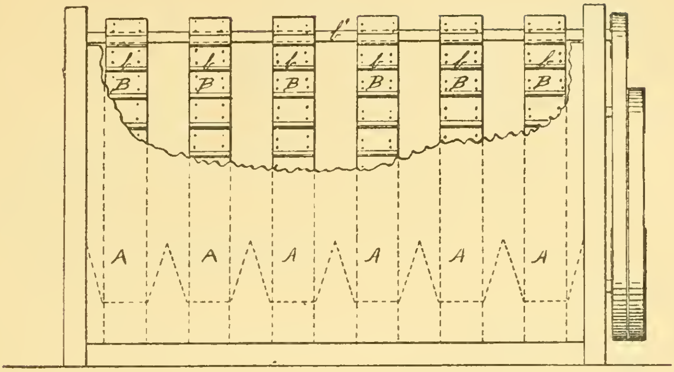
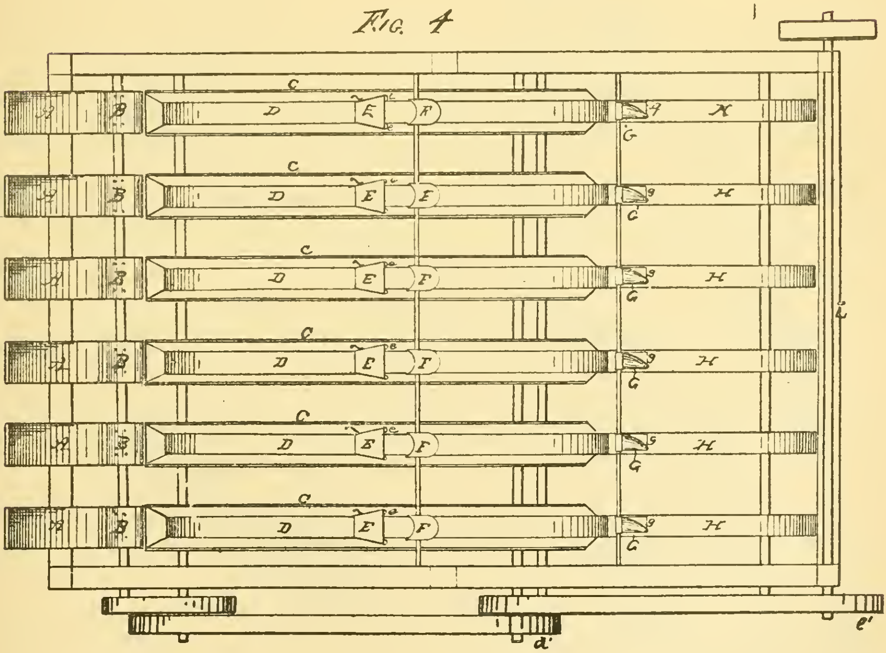


Fig. 4



No. 266,134. Fish-cutter, by James B. Grady. See p. [9].

Fig 5.

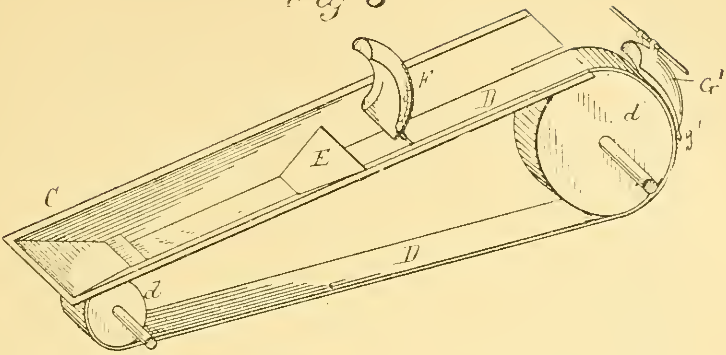
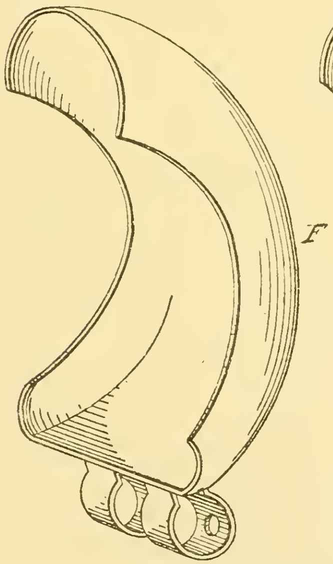
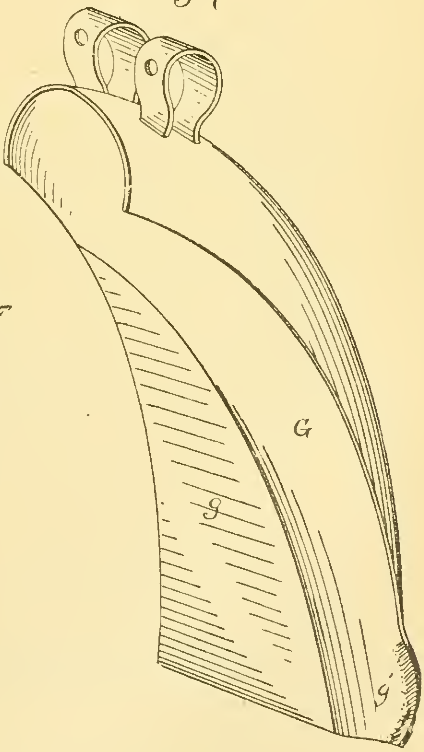


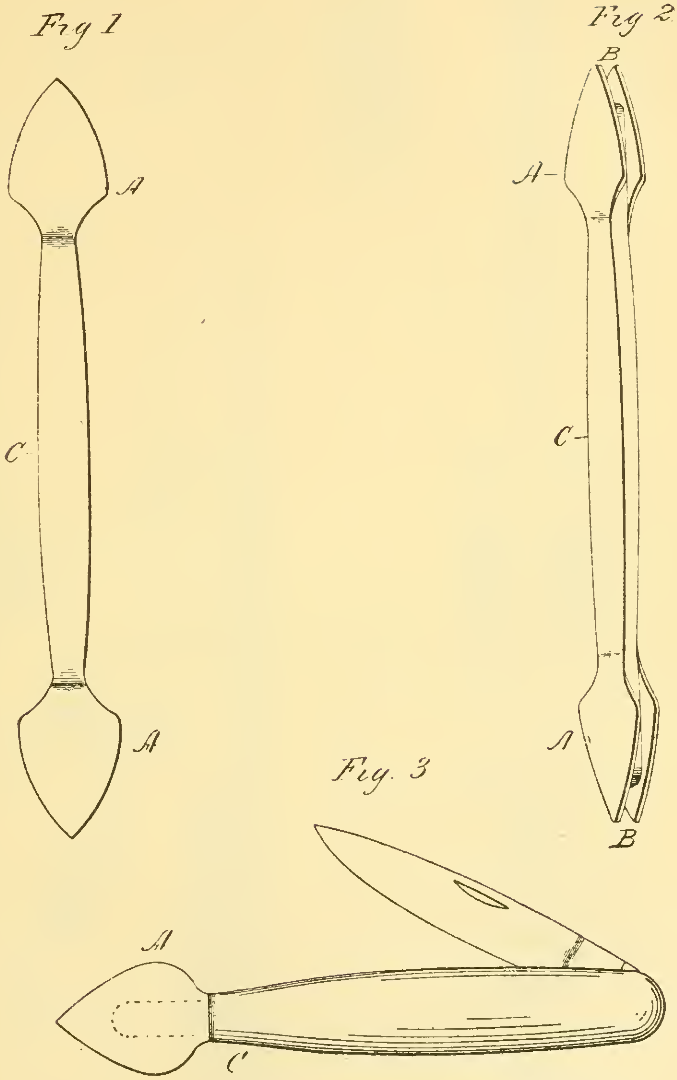
Fig. 7.

Fig. 6.

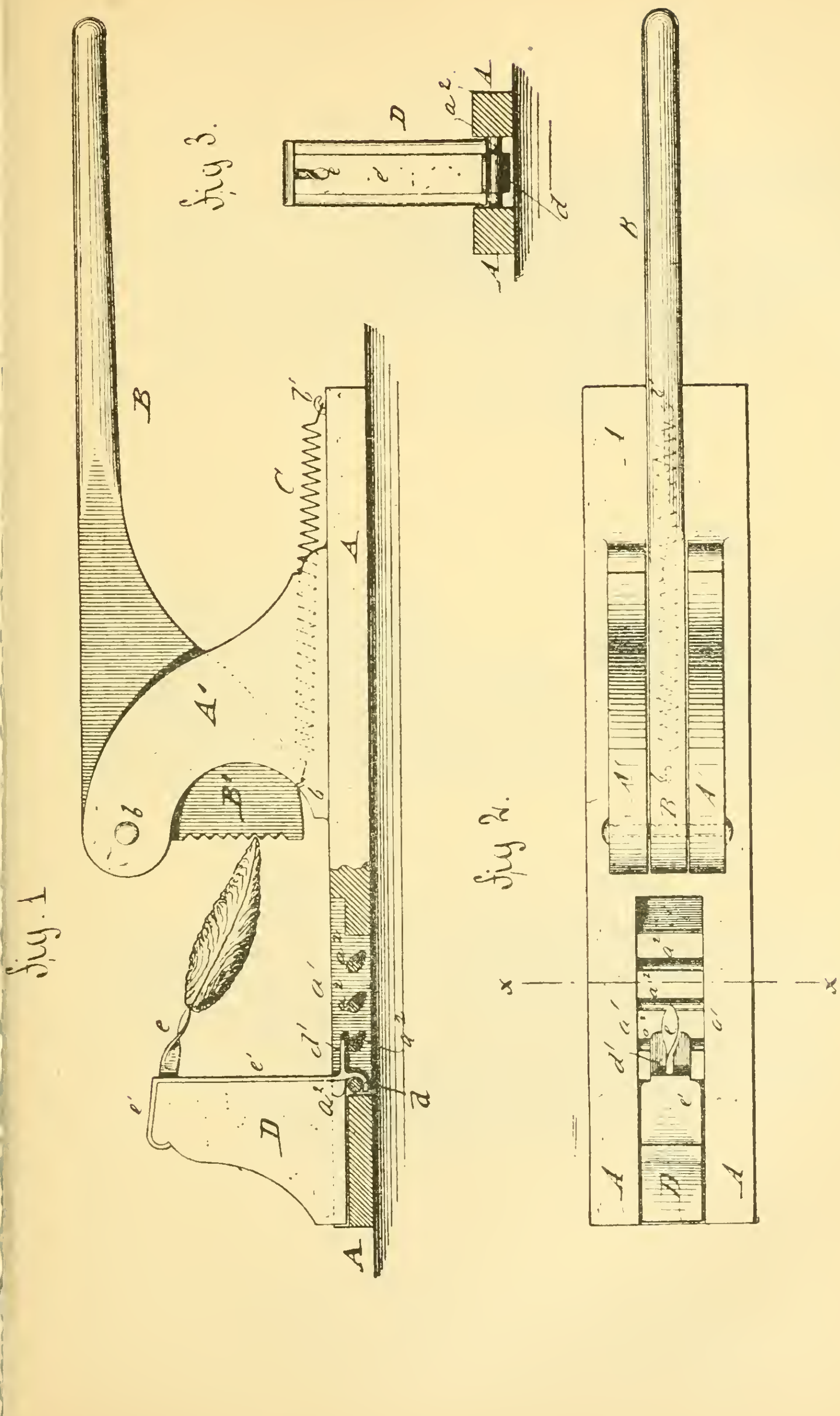




No. 266,134. Fish-cutter, by James B. Grady. See p. [9].



No. 253,363. Fish-hook Extractor, by J. W. Foard. See p. [11].



No. 295,611. Machine for Opening Oysters, by L. A. Amouroux. See p. [11].

Fig. 1.

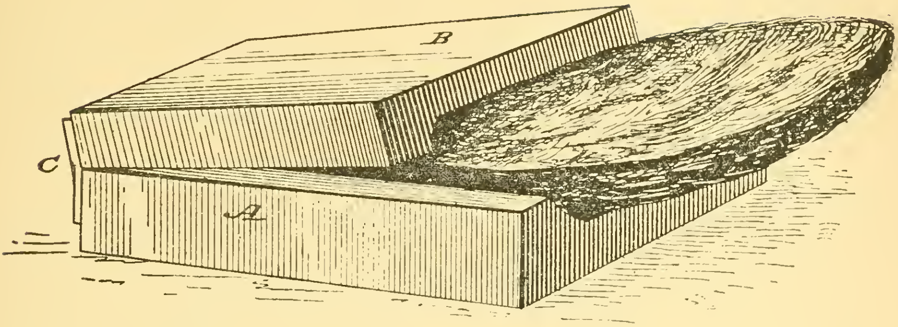


Fig. 2.

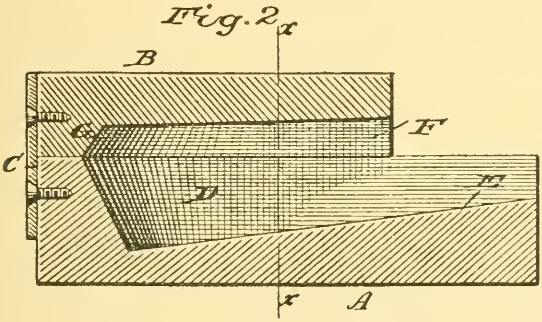


Fig. 3.

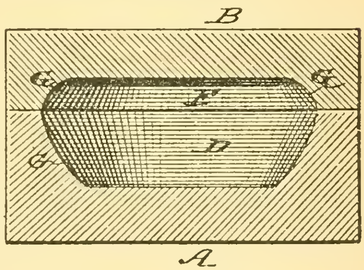
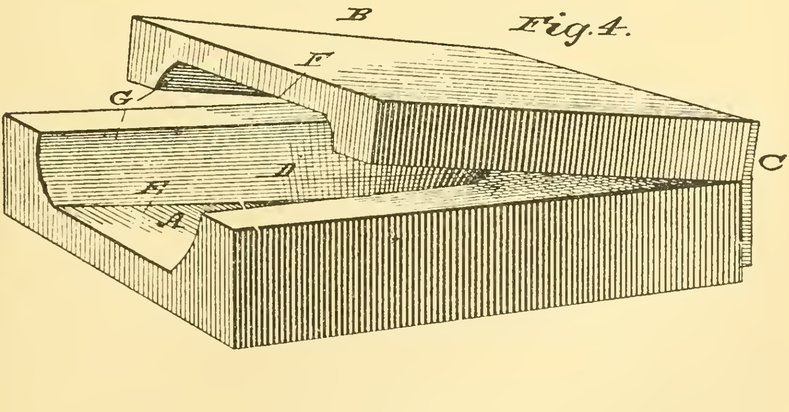


Fig. 4.



No. 299,756. Oyster-clamp, by C. Drake. See p. [12].

Fig 1

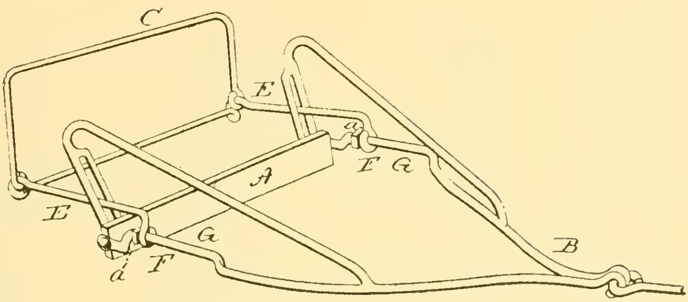
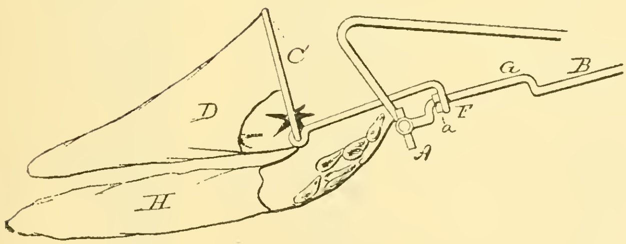
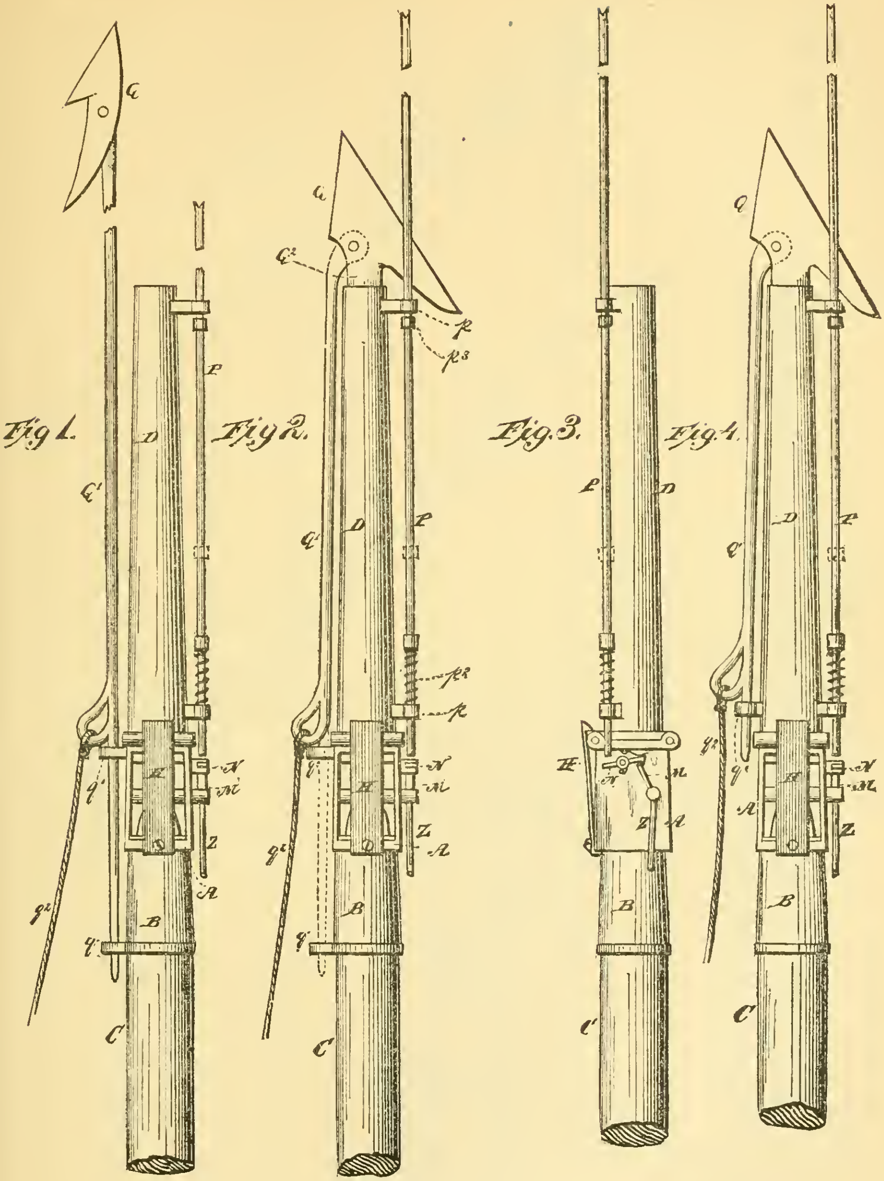


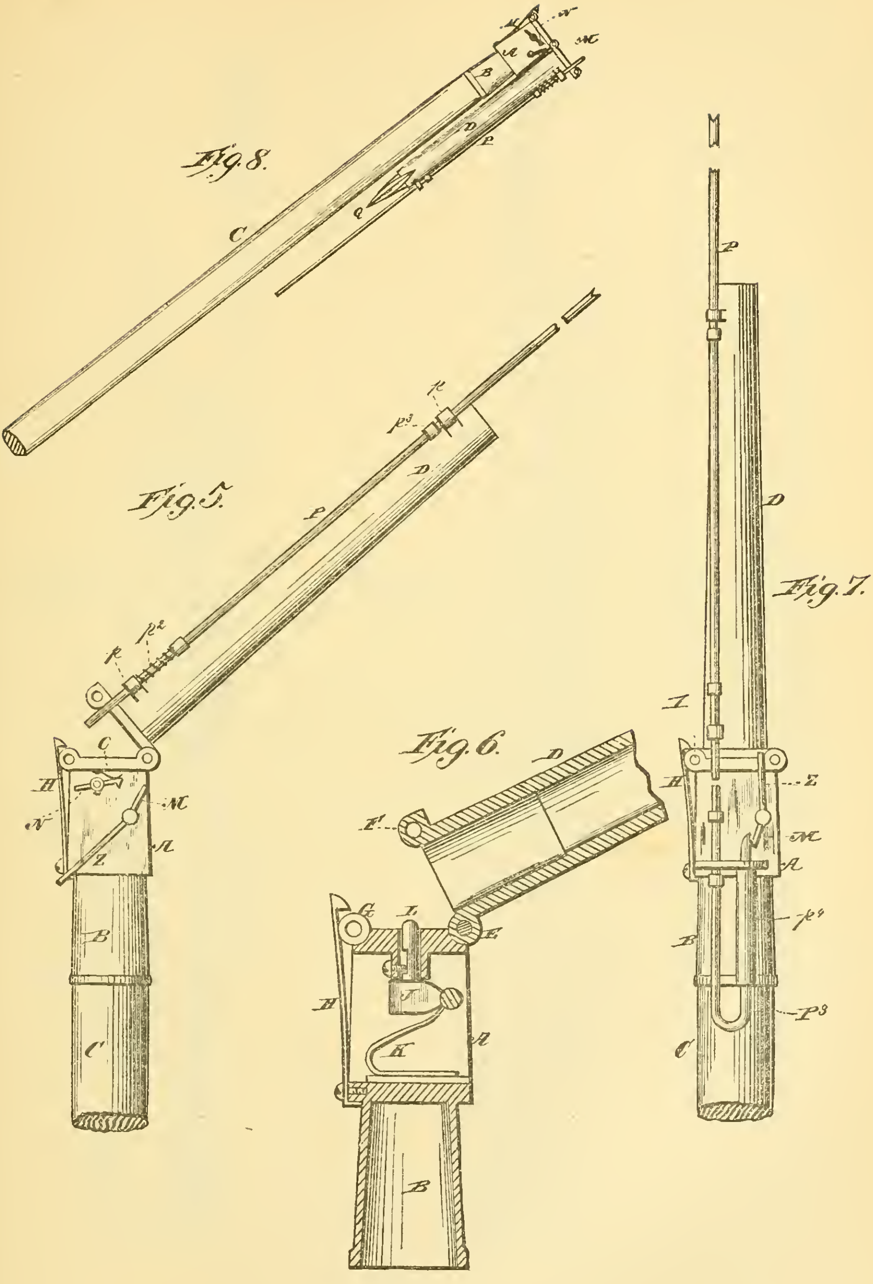
Fig 2



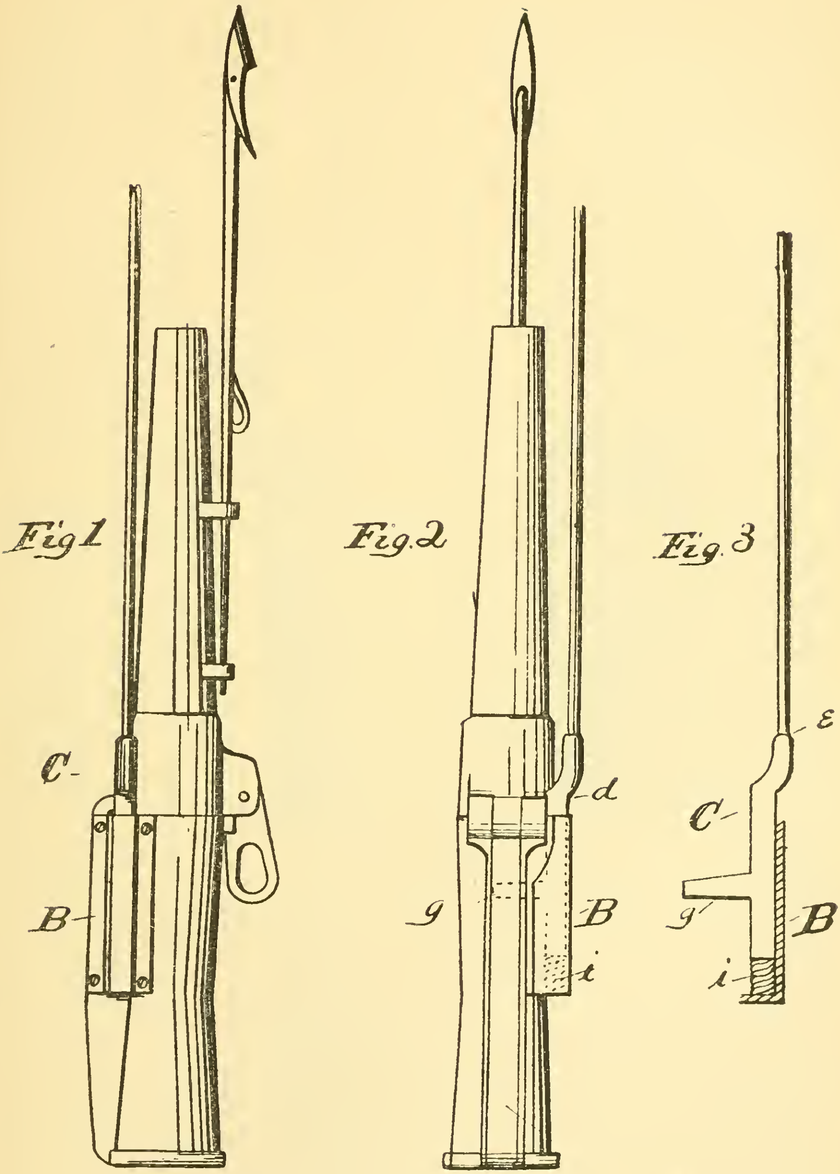
No. 297,079. Apparatus for Catching Starfish, by J. F. and F. L. Homan. See p. [12].



No. 256,041. Breech-loading Bomb-gun, by E. Pierce. See p. [13].



No. 256,041. Breech-loading Bomb-gun, by E. Pierce. See p. [13].



No. 256,548. Bomb-gun, by P. Cunningham. See p. [14].

Fig. 4

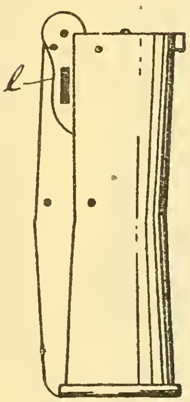
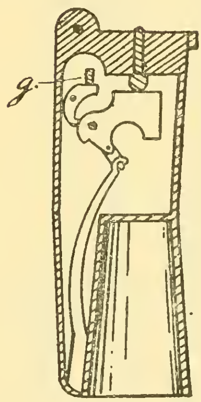
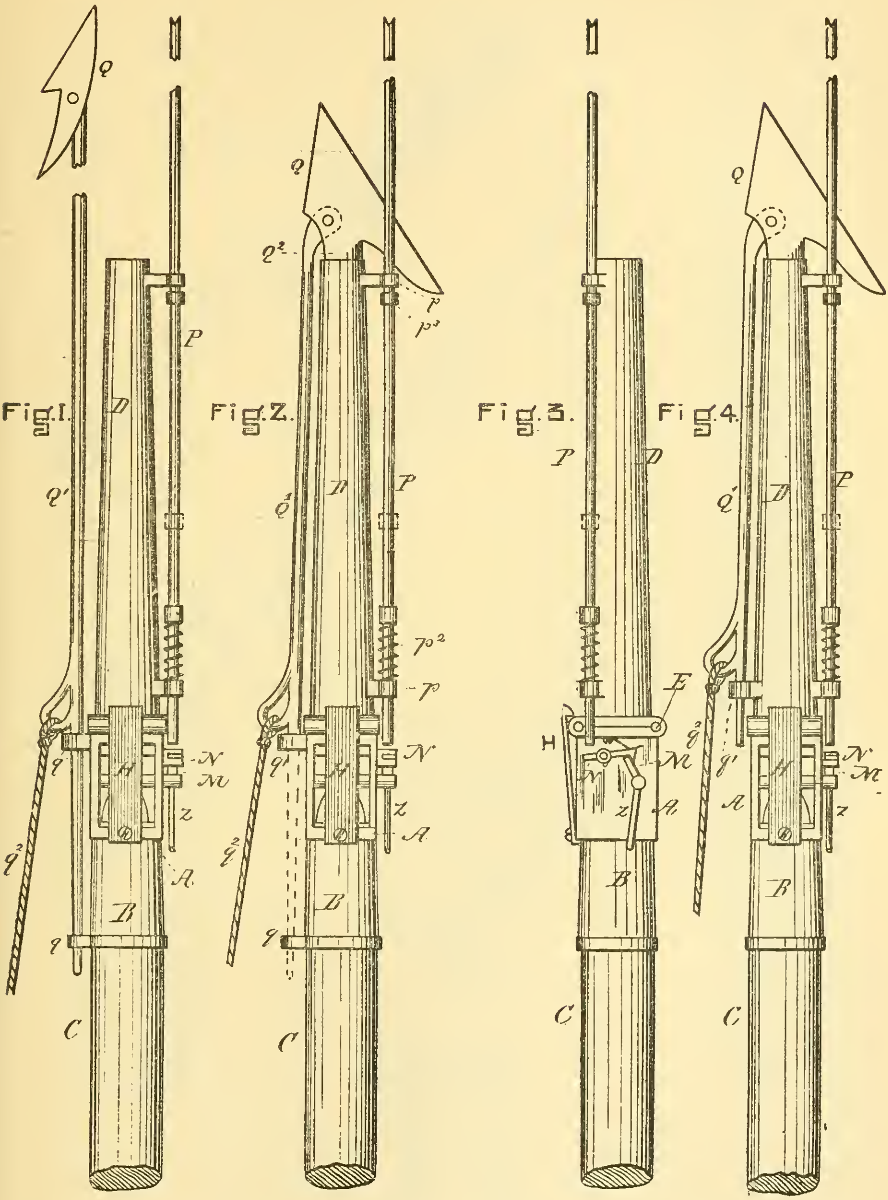


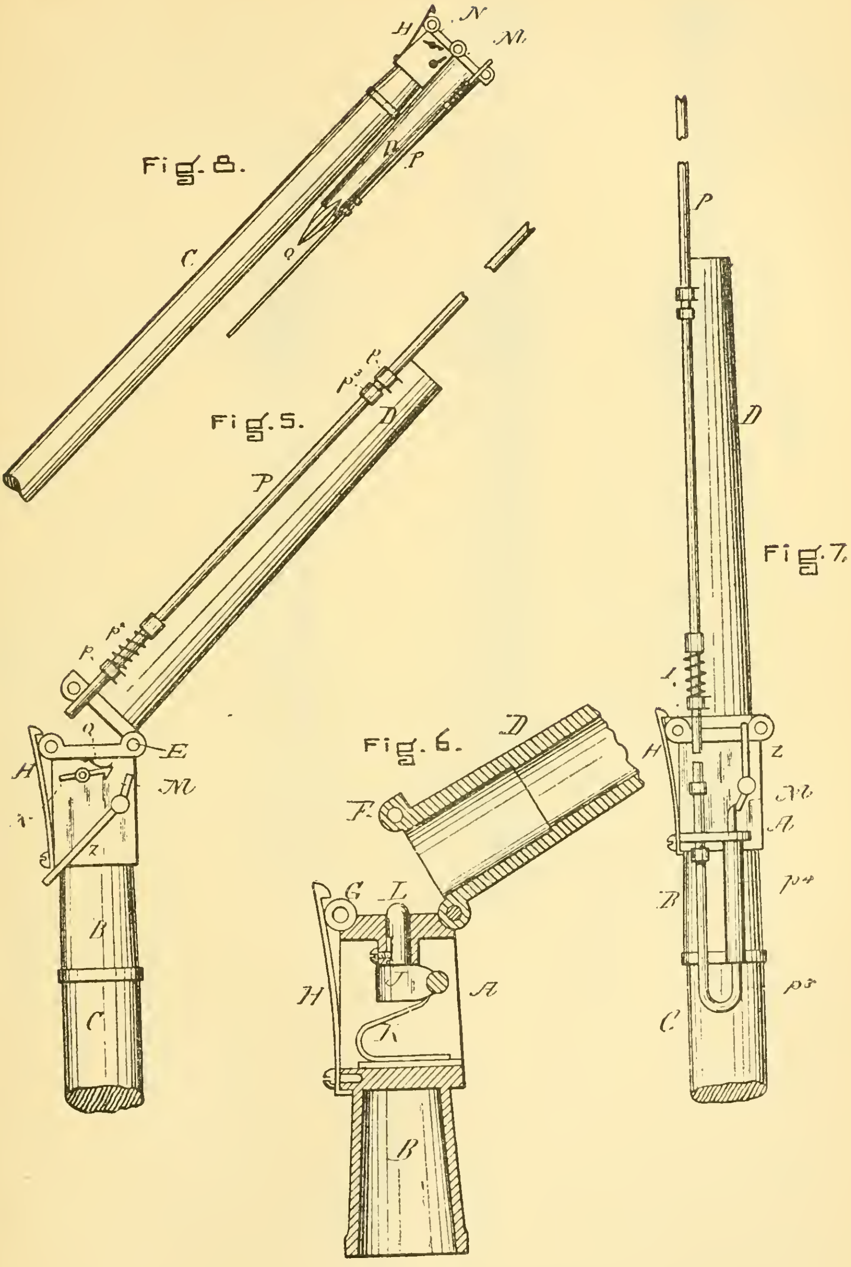
Fig. 5.



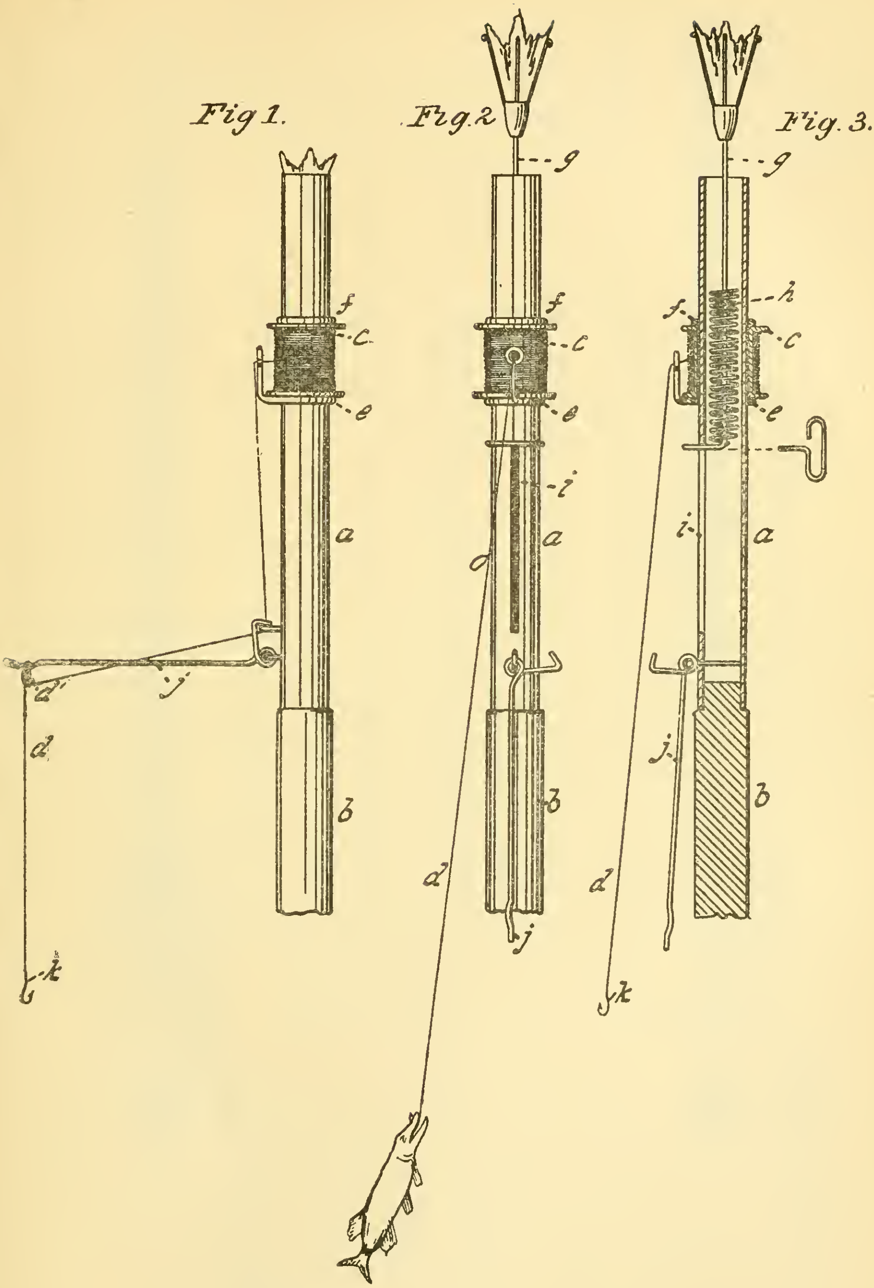
No. 256,548. Bomb-gun, by P. Cunningham. See p. [14].



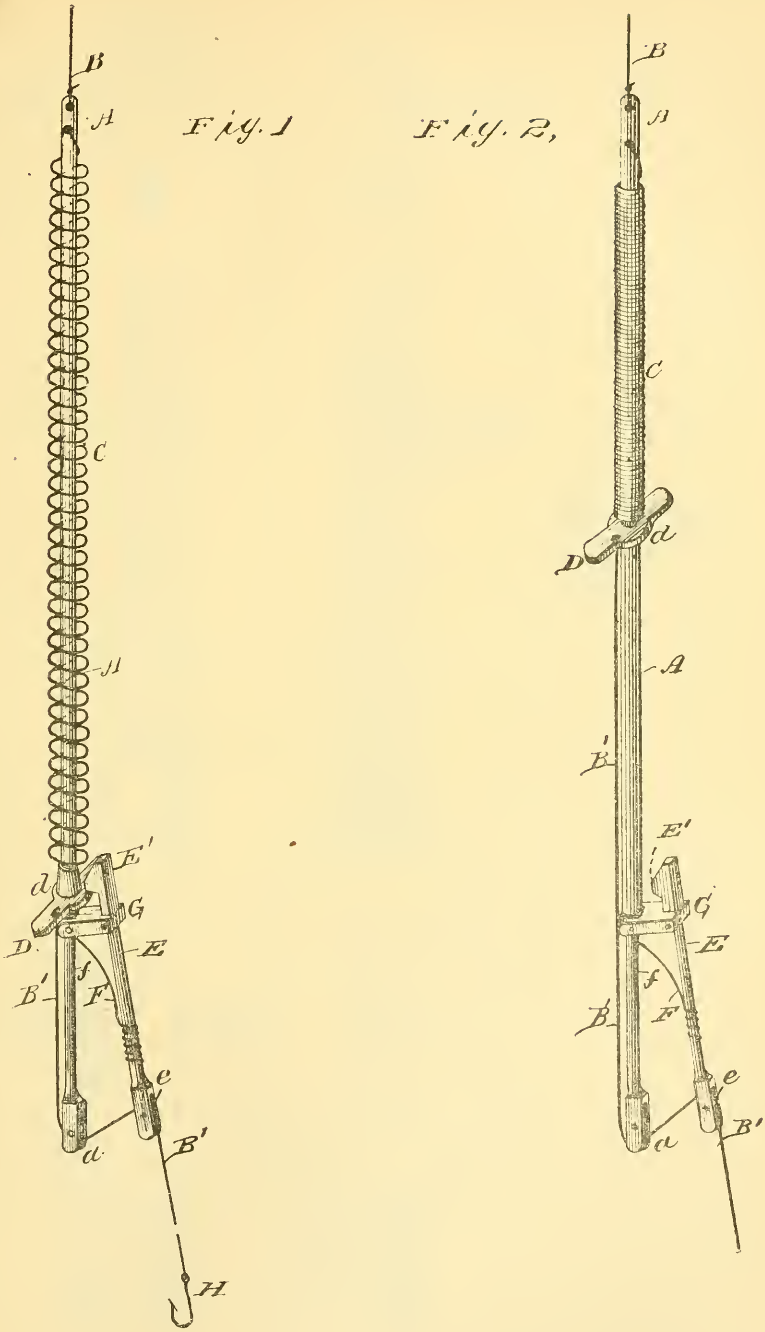
No. 10,392. Breech-loading Bomb-gun, by E. Pierce. See p. [15].



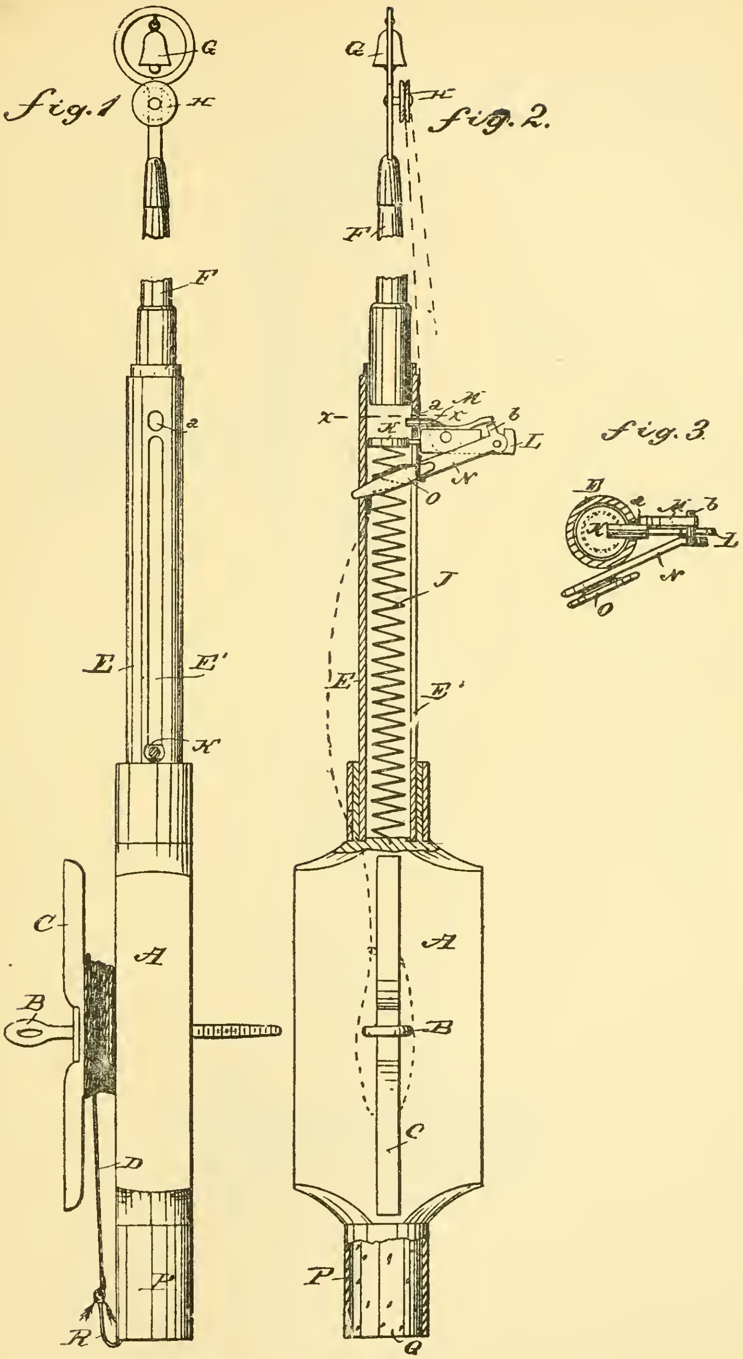
No. 10,392. Breech-loading Bomb-gun, by E. Pierce. See p. [15].



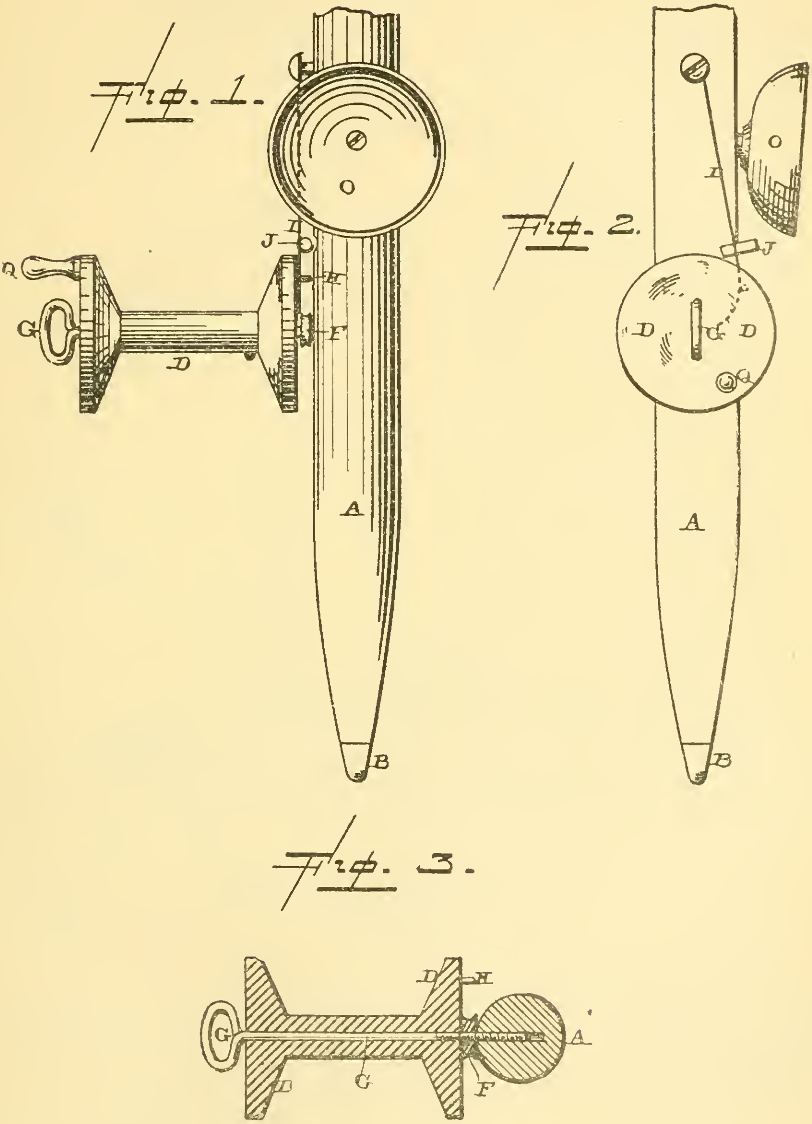
No. 253,456. Fishing Apparatus, by M. H. Whitcomb. See p. [15].



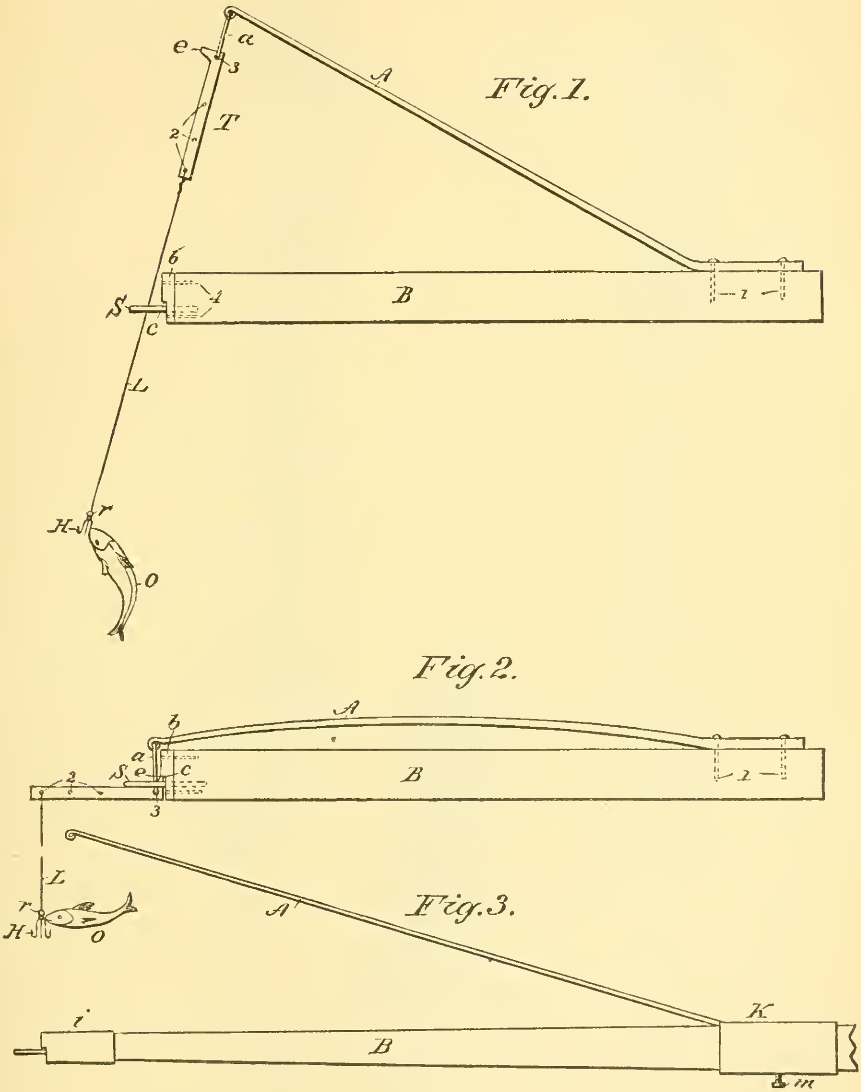
No. 263,638. Fish-trap, by R. A. Wentworth. See p. [16].



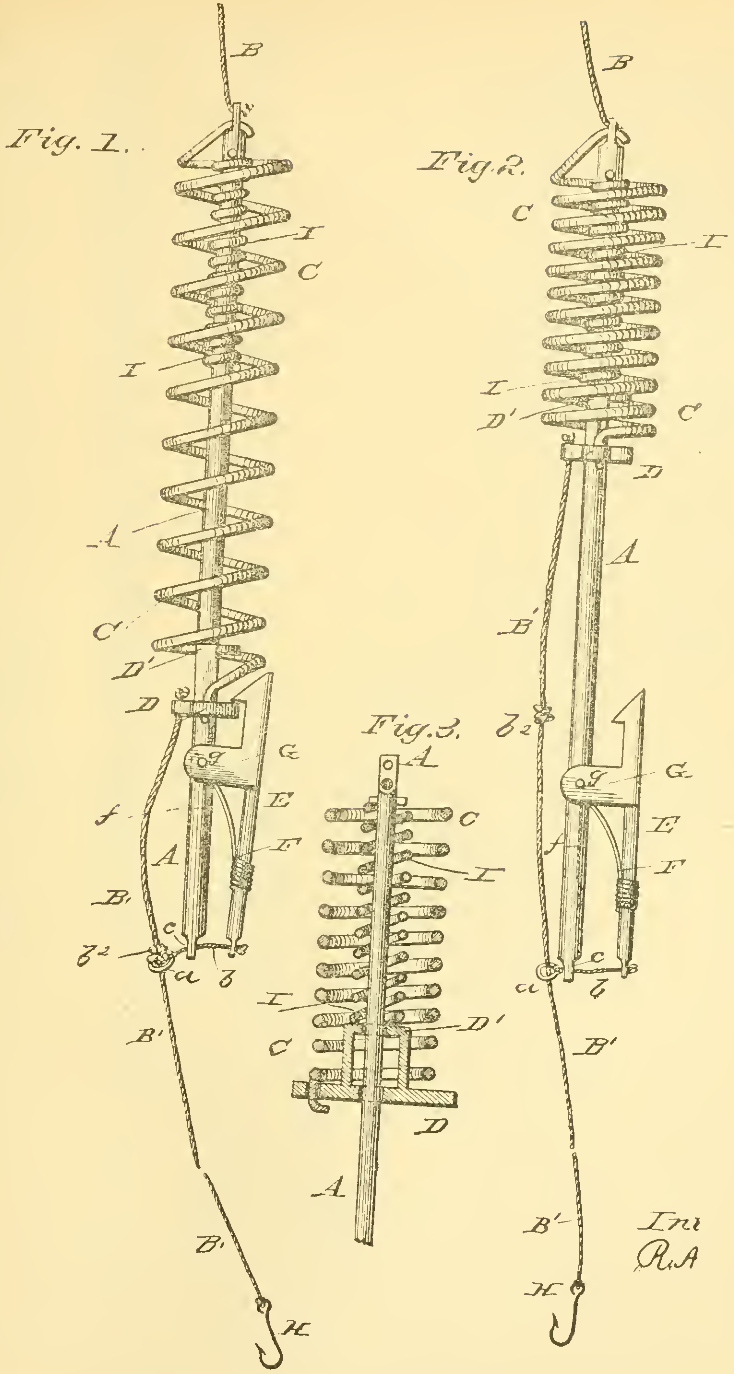
No. 272,232. Fishing Tackle, by C. J. B. Gaume. See p. [17].



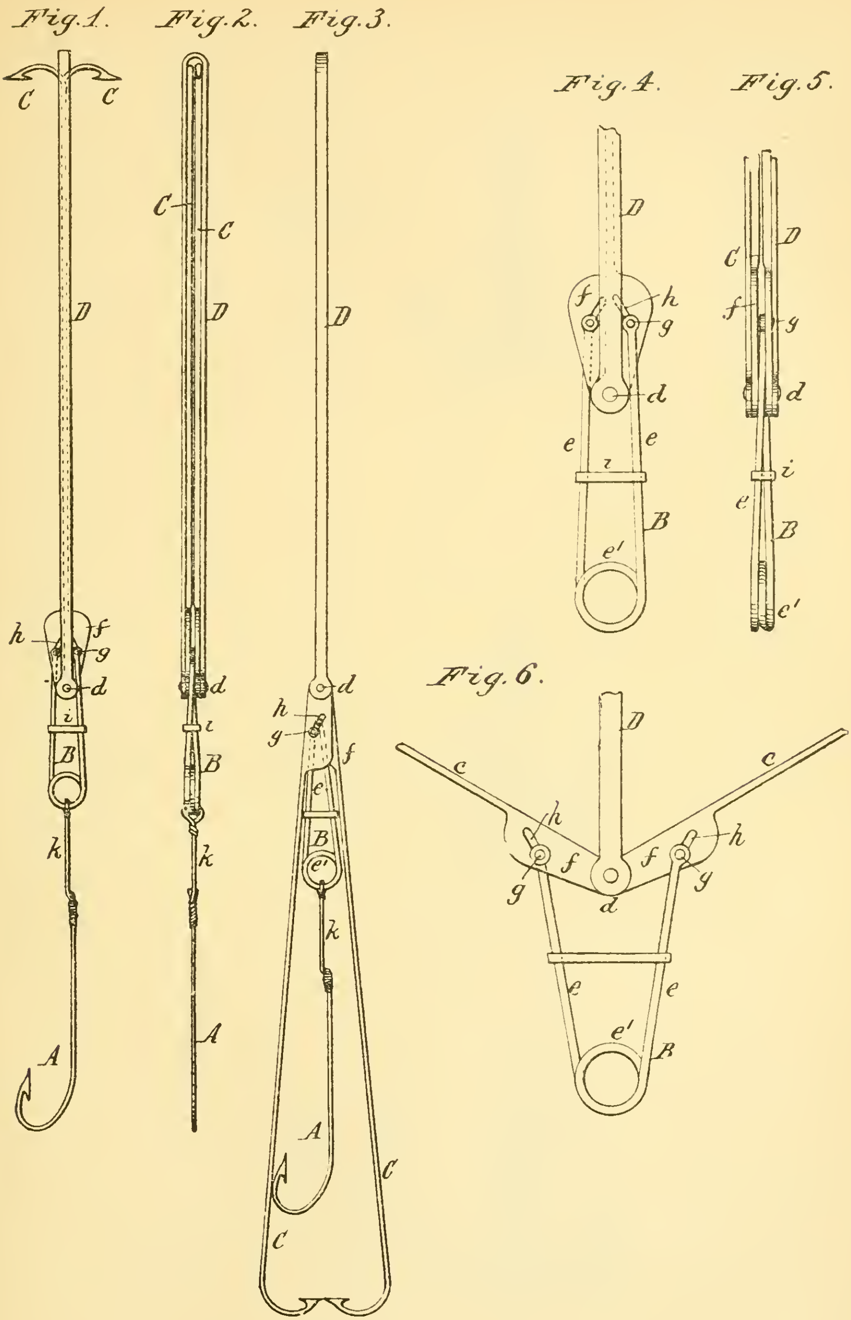
No. 279,508. Fishing Stake, by D. B. Tiffany. See p. [18].



No. 279,556. Fish-trap, by C. Fisher. See p. [18].



No. 283,444. Fish-trap or Spring-hook, by R. A. Wentworth. See p. [19].



No. 286,494. Fish Trap-hook, by M. R. Skinner. See p. [19].

Fig. 1.

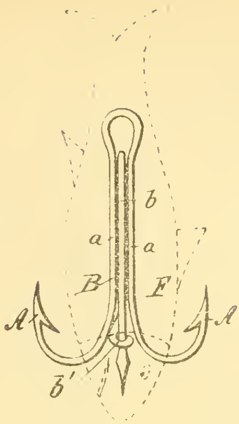


Fig 2

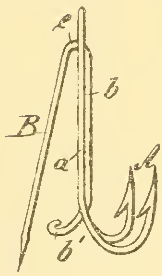
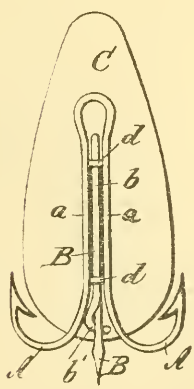


Fig 3.



No. 254,313. Fish-hook, by W. E. Hemming. See p. [20].

Fig. 1.

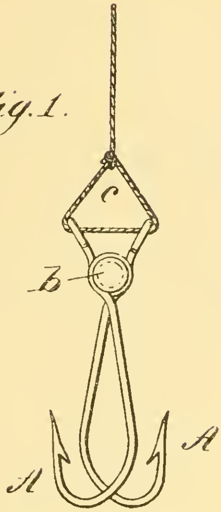
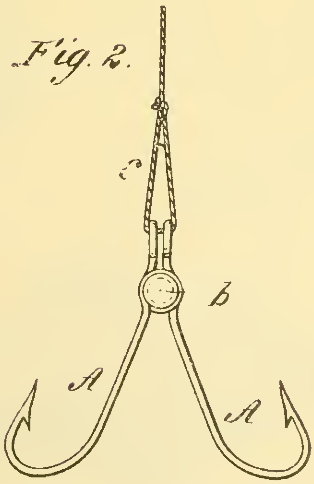
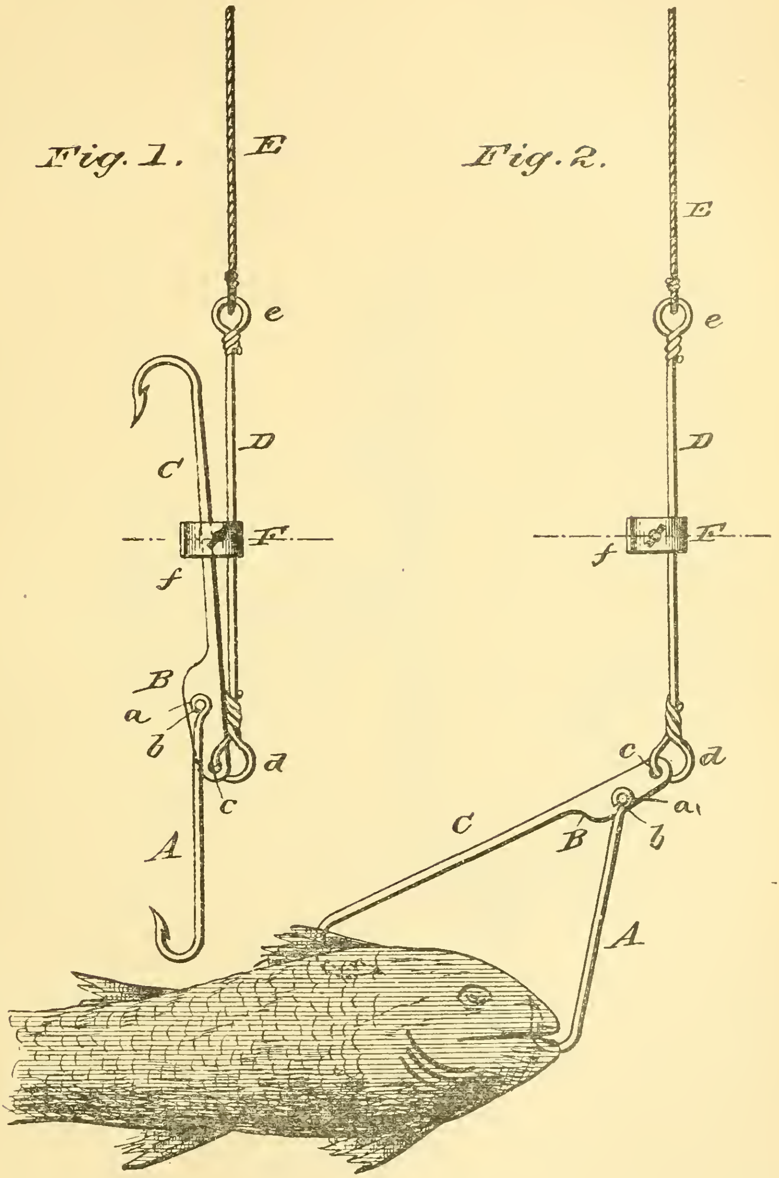


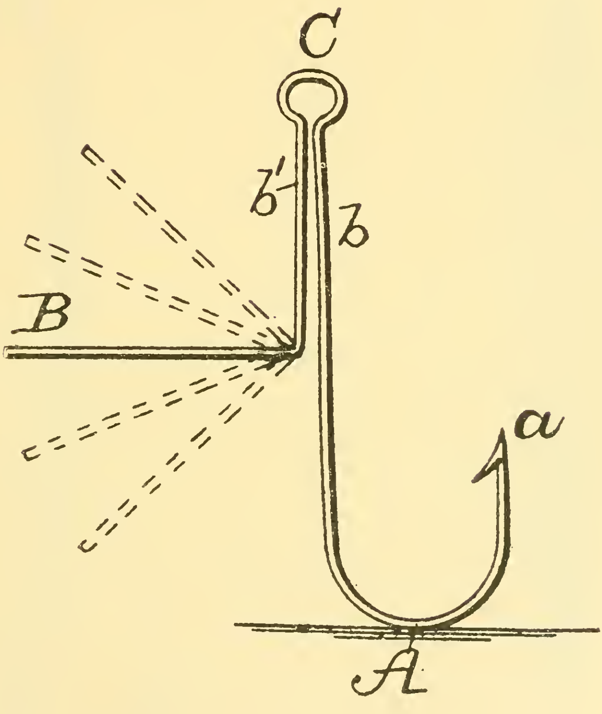
Fig. 2.



No. 264,256. Fish-hook, by F. DeForest. See p. [21].



No. 280,610. Fish Trap-hook, by W. N. Greer. See p. [21].



No. 310,118. Fish-hook, by W. C. Bower. See p. [22].

Fig 1

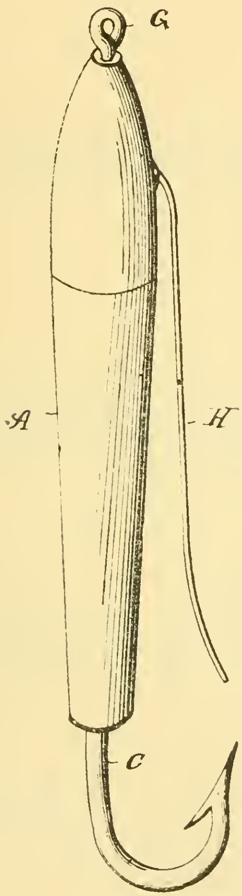
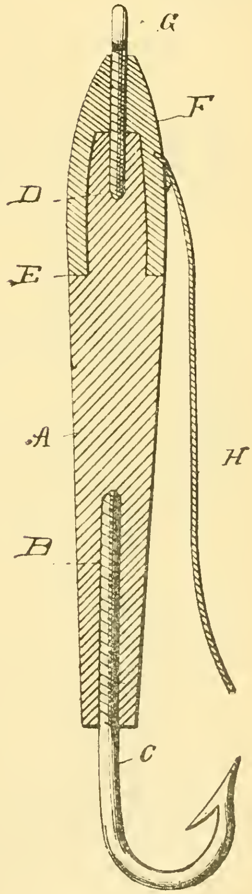
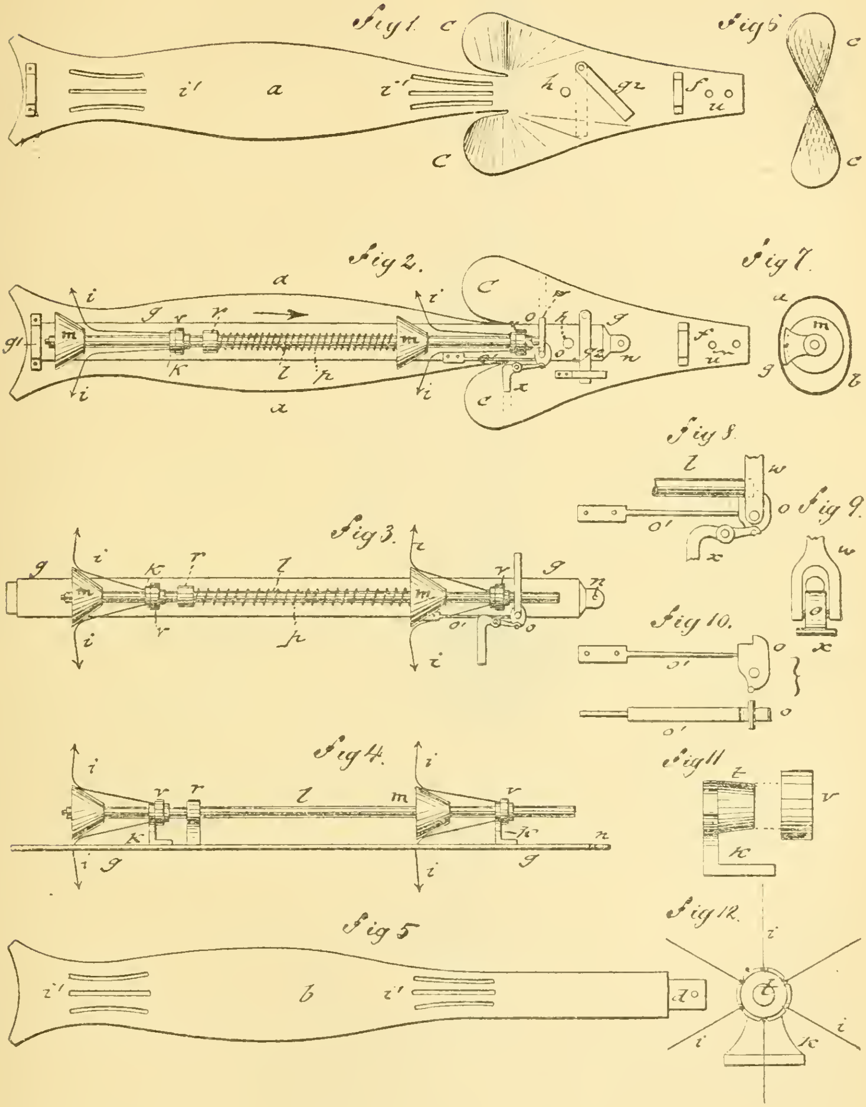


Fig 2



No. 295,369. Trolling-hook, by N. A. Dickinson. See p. [23].

PLATE XXVI.



No. 253,508. Bait-hook, by K. Müller. See p. [23].

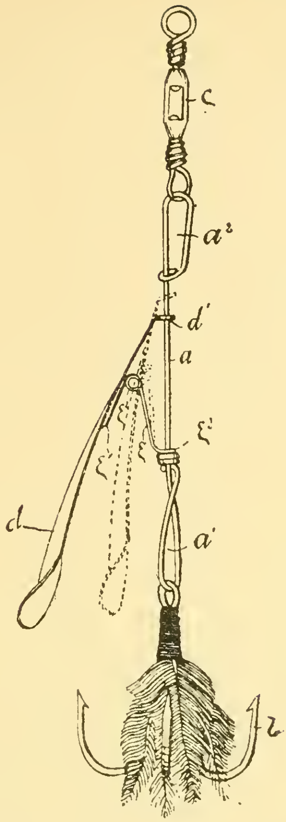


Fig 1

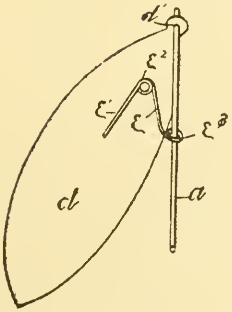


Fig 2

No. 256,843. Spoon-bait for Fishing, by W. T. J. Lowe. See p. [24].

Fig. 1.

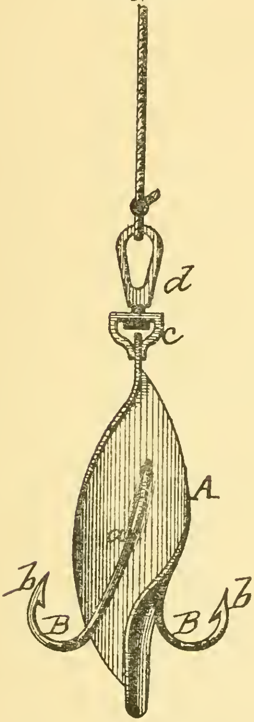
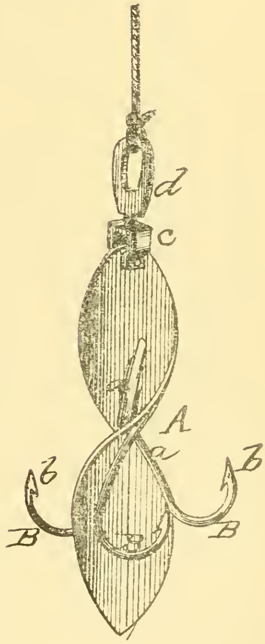
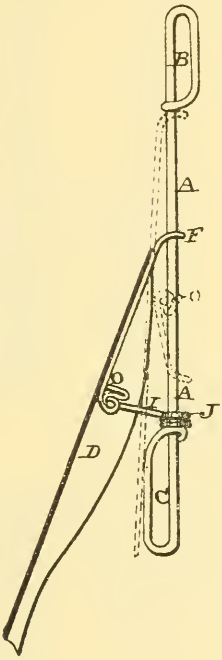


Fig. 2.

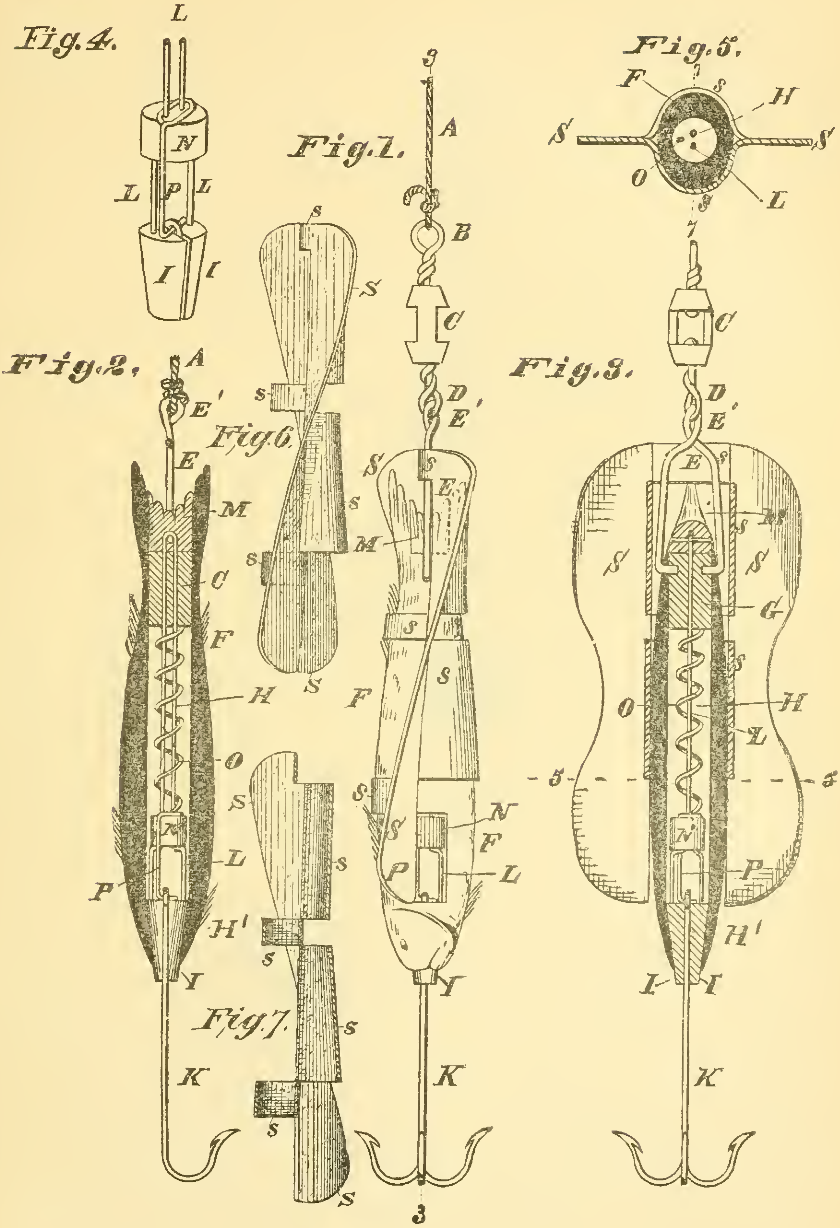


No. 261,194. Trolling-spoon, by L. C. Wylly. See p. [25].

Fig. 1.



No. 267,203. Spoon-bait, by L. S. Hill. See p. [26].



No. 273,996. Self-adjusting Fish-shaped Fish-hook Holder, by C. Hymers. See p. [26].

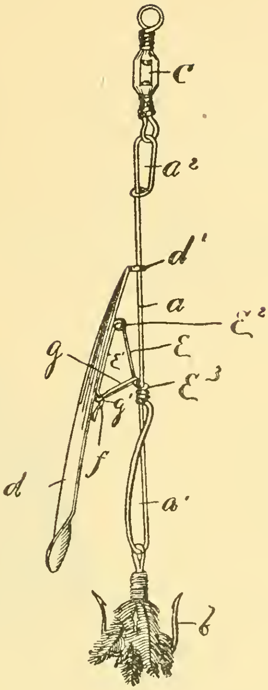


Fig 1

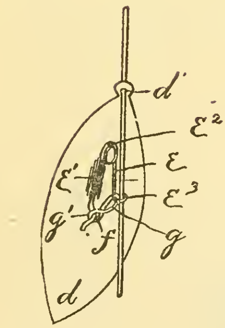


Fig 2

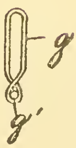
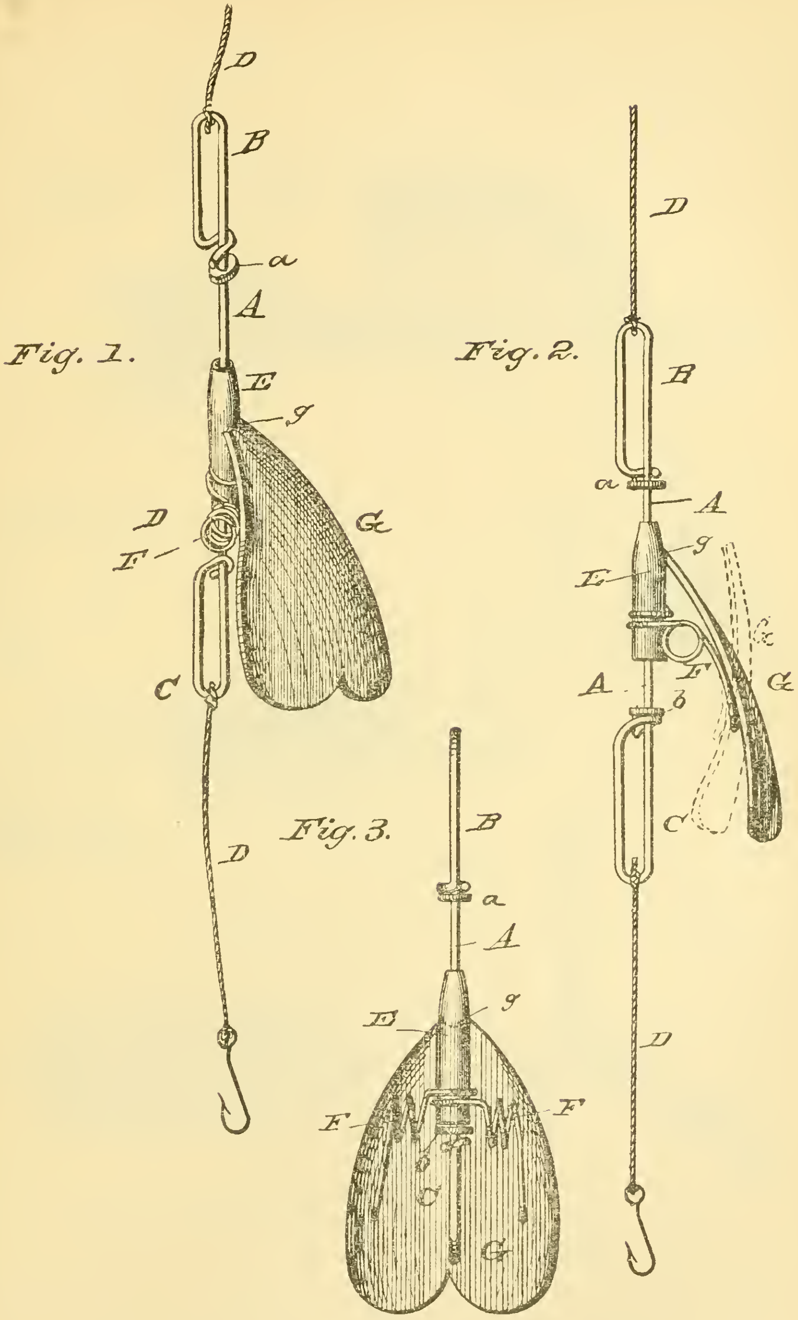
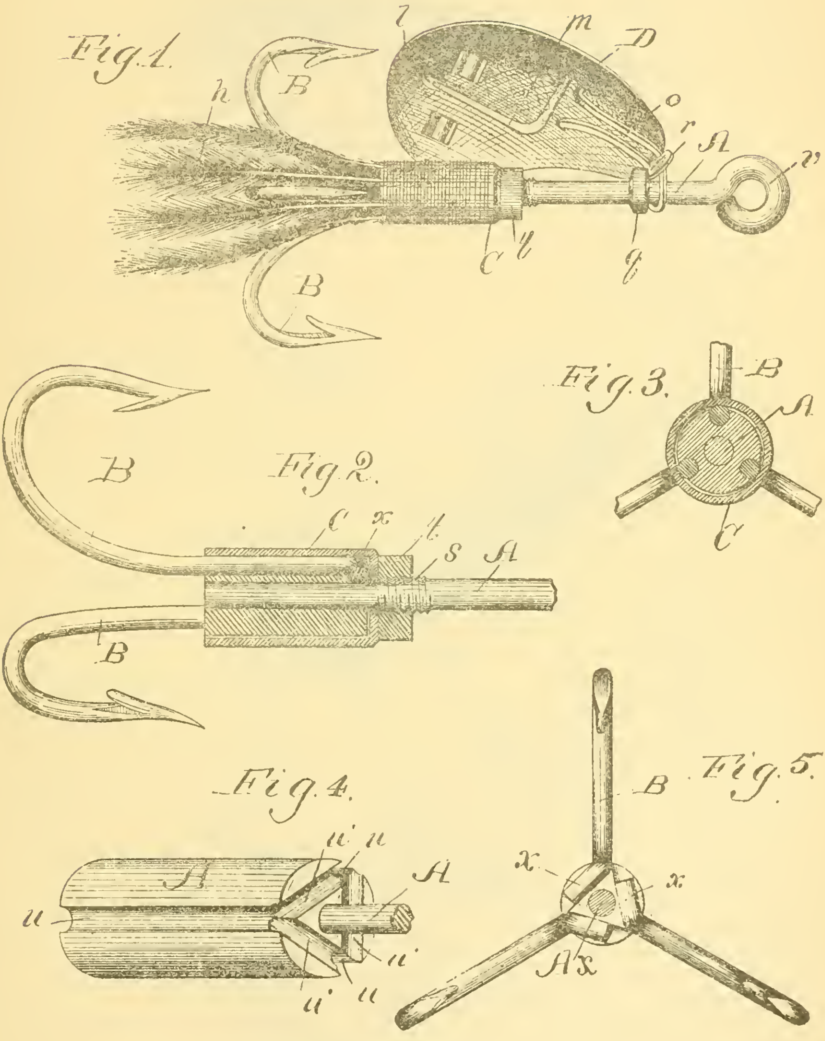


Fig 3

No. 276,055. Spoon-bait for Fishing, by W. T. J. Lowe. See p. [27].



No. 281,083. Fishing Apparatus, by L. Kessler. See p. [27].



No. 289,508. Fish-hook, by A. L. Dawson. See p. [28].

Fig. 6.

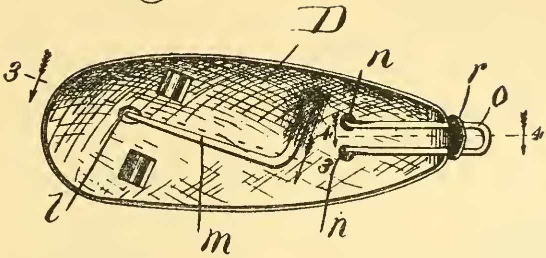


Fig. 7.

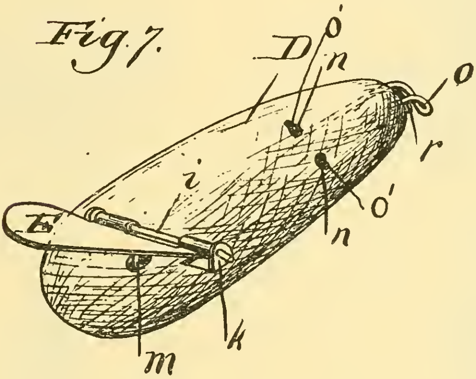


Fig. 8.

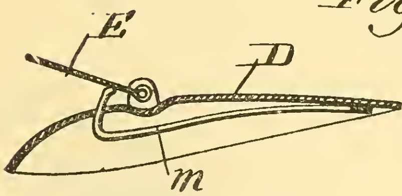
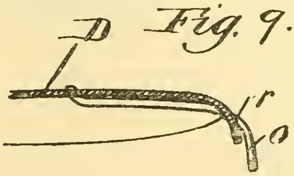


Fig. 9.



No. 289,508. Fish-hook, by A. L. Dawson. See p. [28].

Fig. 1.

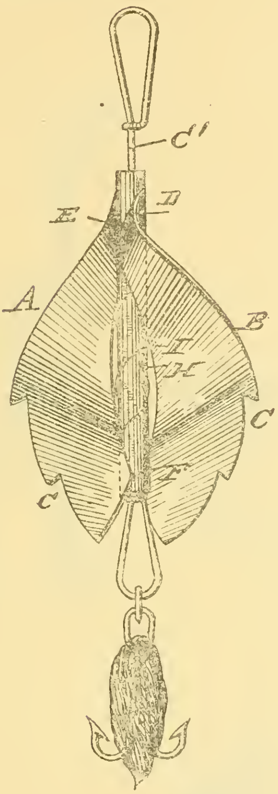


Fig. 2.

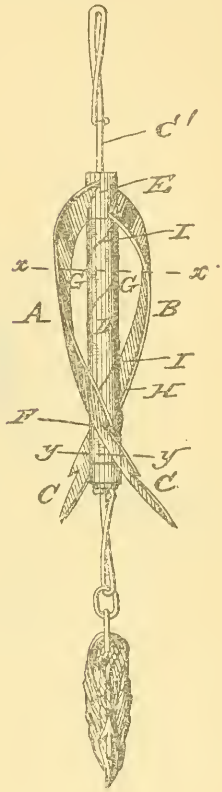


Fig. 3.

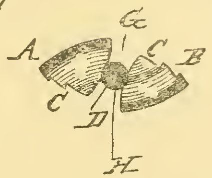
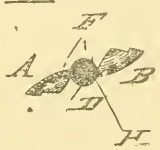
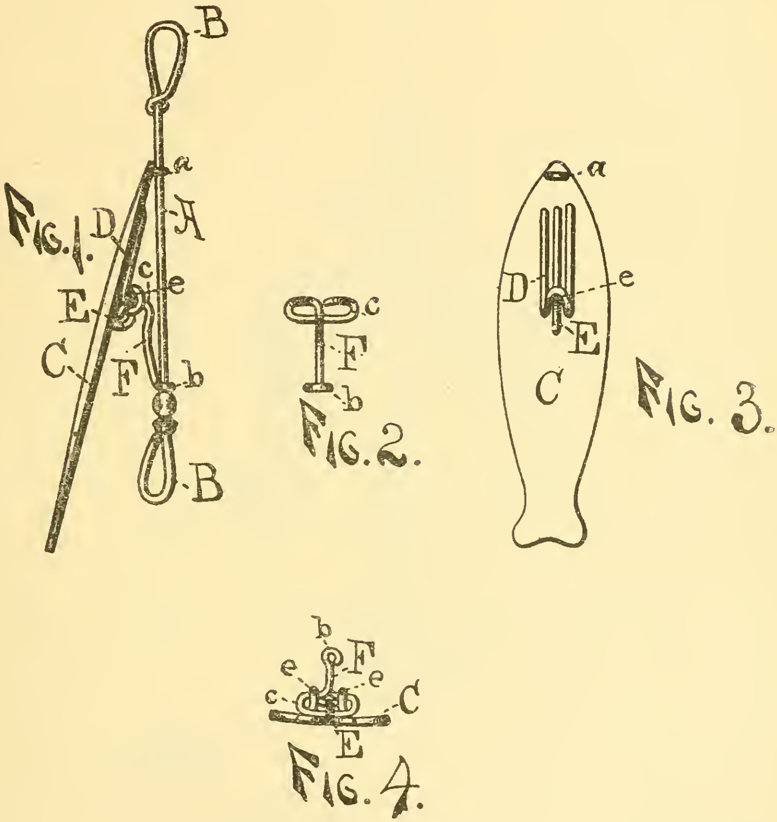


Fig. 4.



No. 295,350. Artificial Fish-bait, by W. D. Chapman. See p. [29].



No. 295,758. Spoon-bait, by C. B. Hibbard. See p. [30].

Fig. 1.

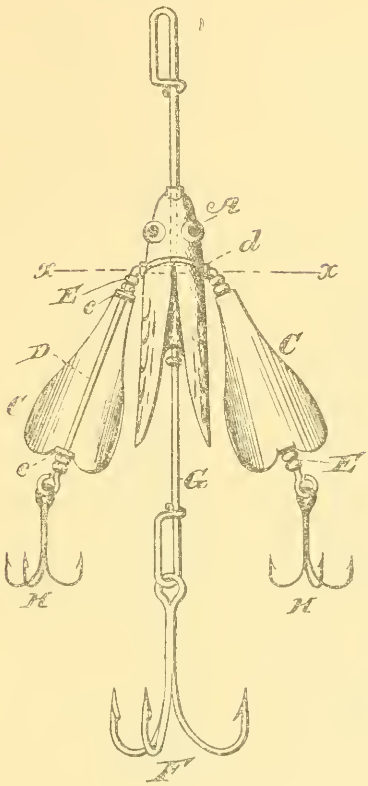


Fig. 2.

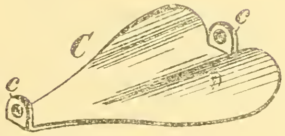
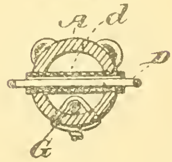
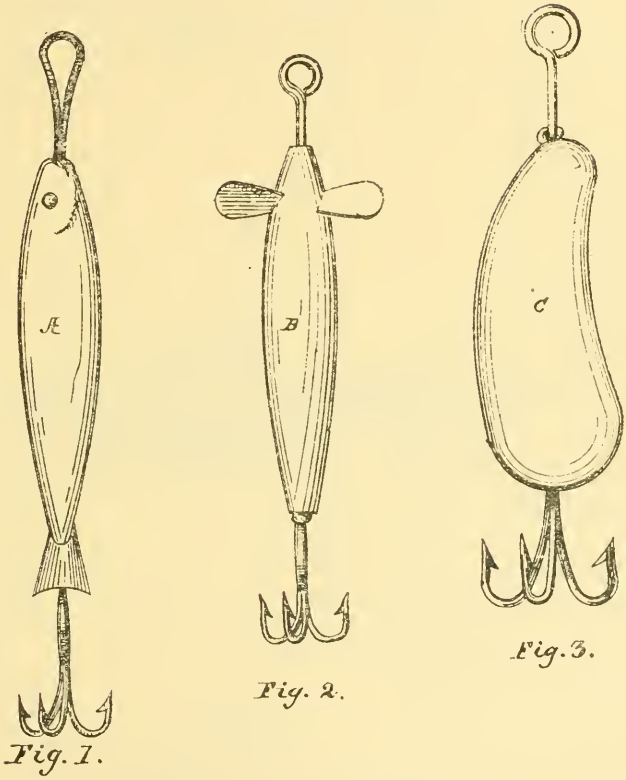


Fig. 3



No. 271,424. Artificial Bait, by H. Comstock. See p. [31].



No. 272,317. Artificial Fish-bait, by E. F. Pflueger. See p. [32].

Fig. 1.

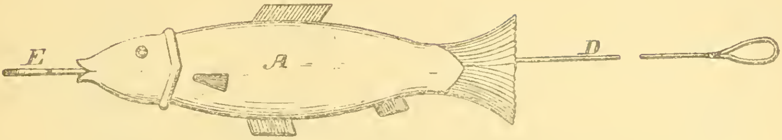


Fig. 2.

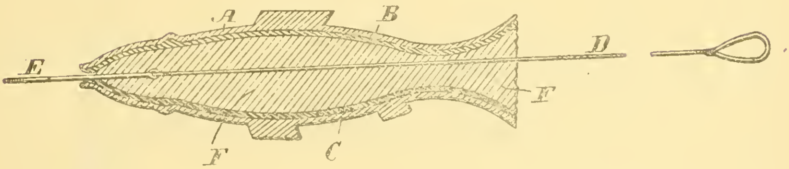
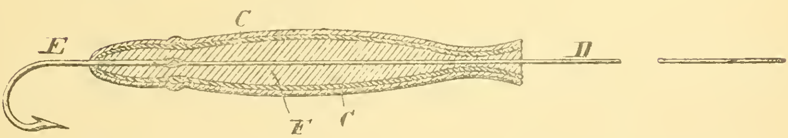
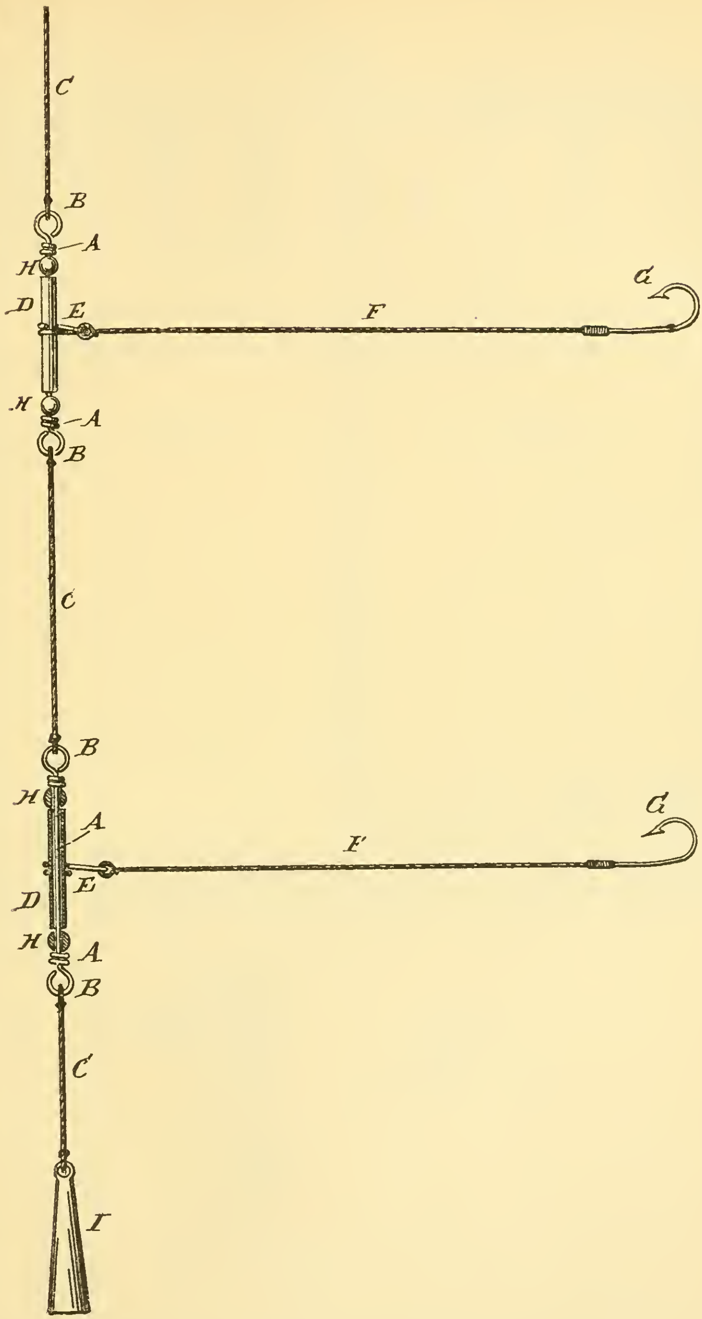


Fig. 3.



No. 284,056. Artificial Fish-bait, by E. F. Pflueger. See p. [32].



No. 289,612. Rotary Leader-link for Fishing-lines, by C. L. Bollermann. See p. [33]

Fig. 1

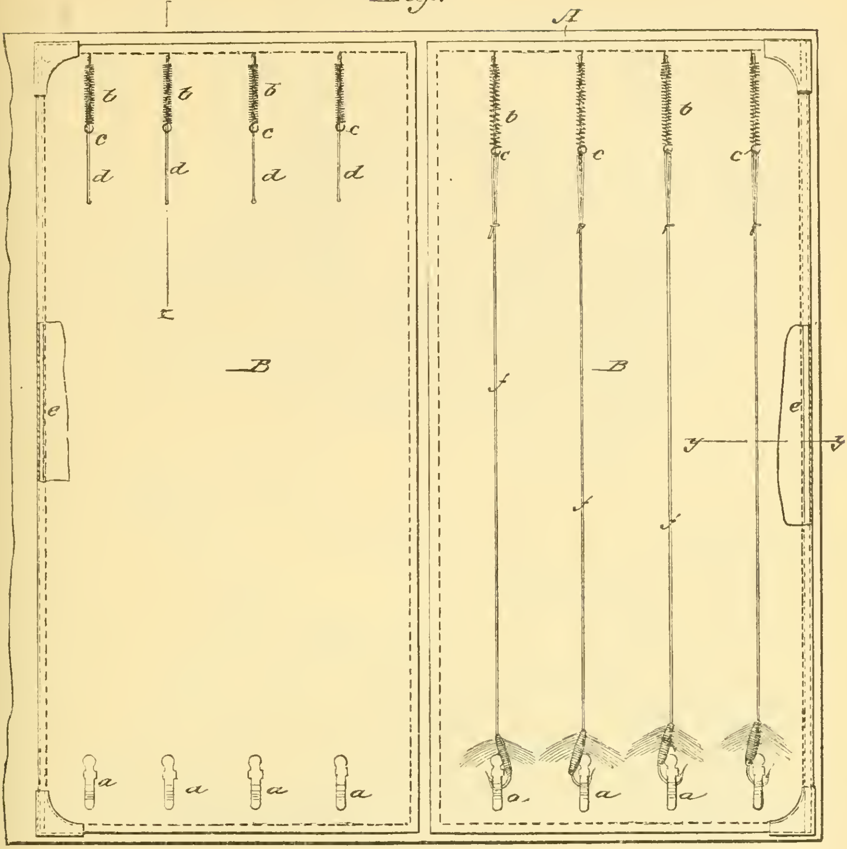
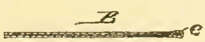


Fig. 2

Fig. 3



No. 258,393. Fly-book, by F. Endicott. See p. [34].

Fig. 1.

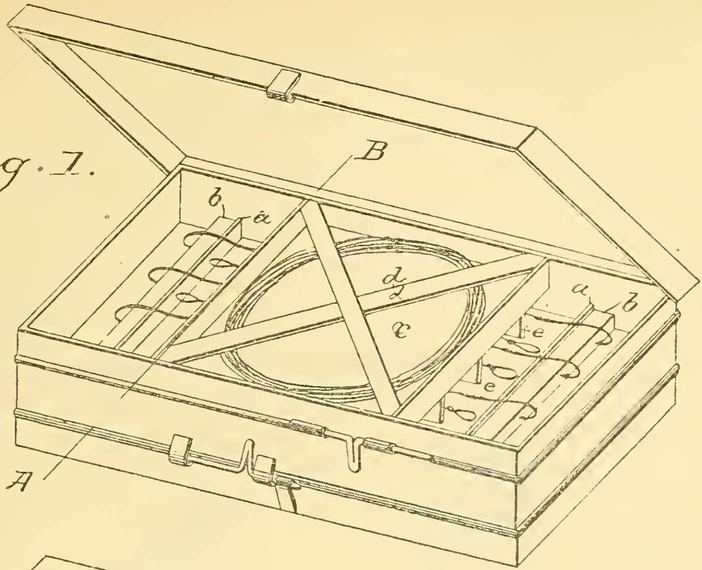


Fig. 2.

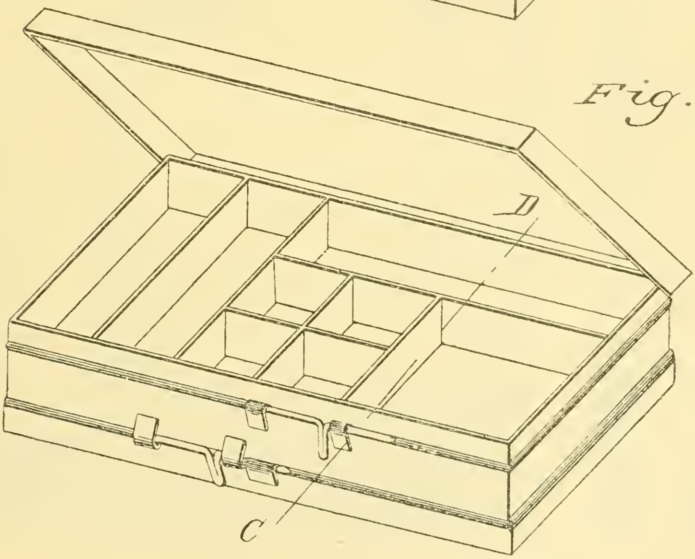
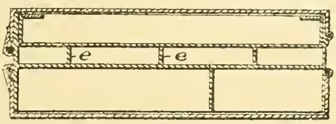
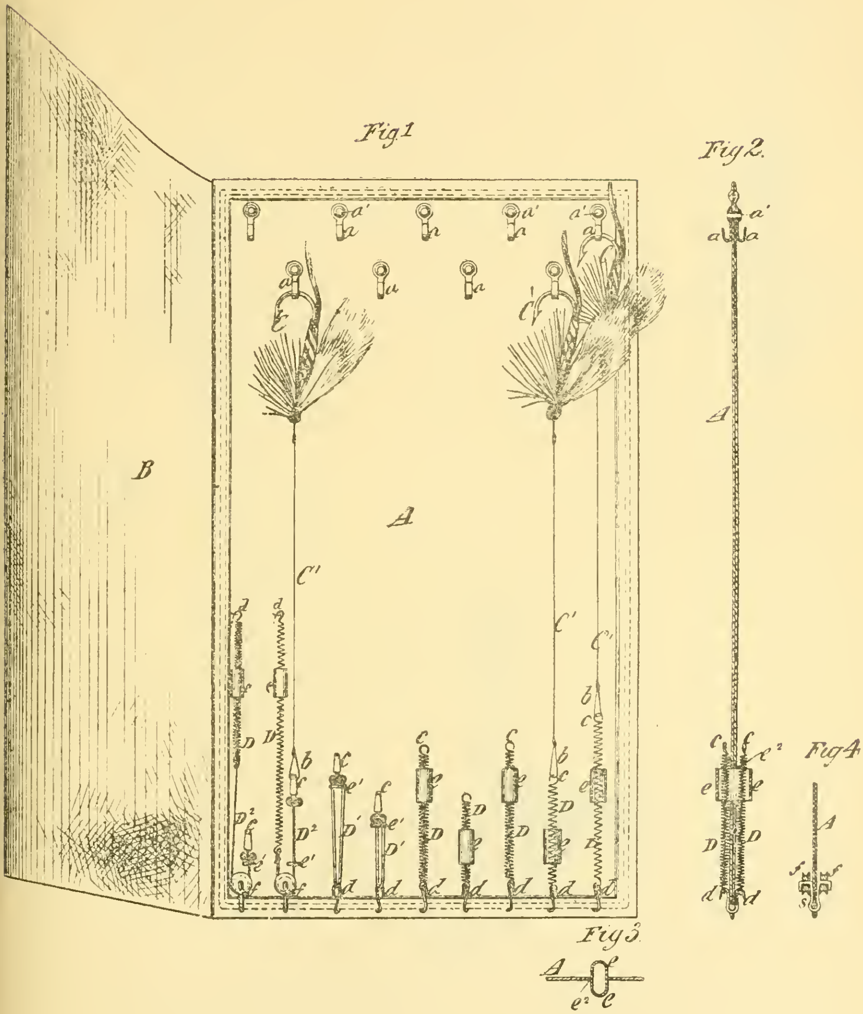


Fig. 3.



No. 275,703. Fishing-tackle Case, by H. F. Price. See p. [34].



No. 294,888. Fishing Fly-book, by C. G. Levison. See p. [35].

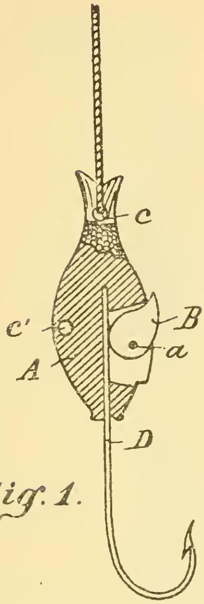


Fig. 1.

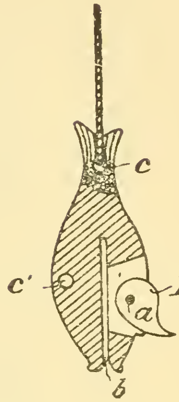


Fig. 2.

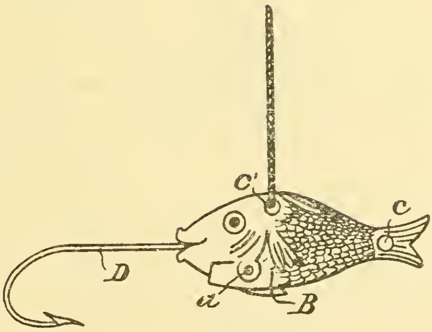
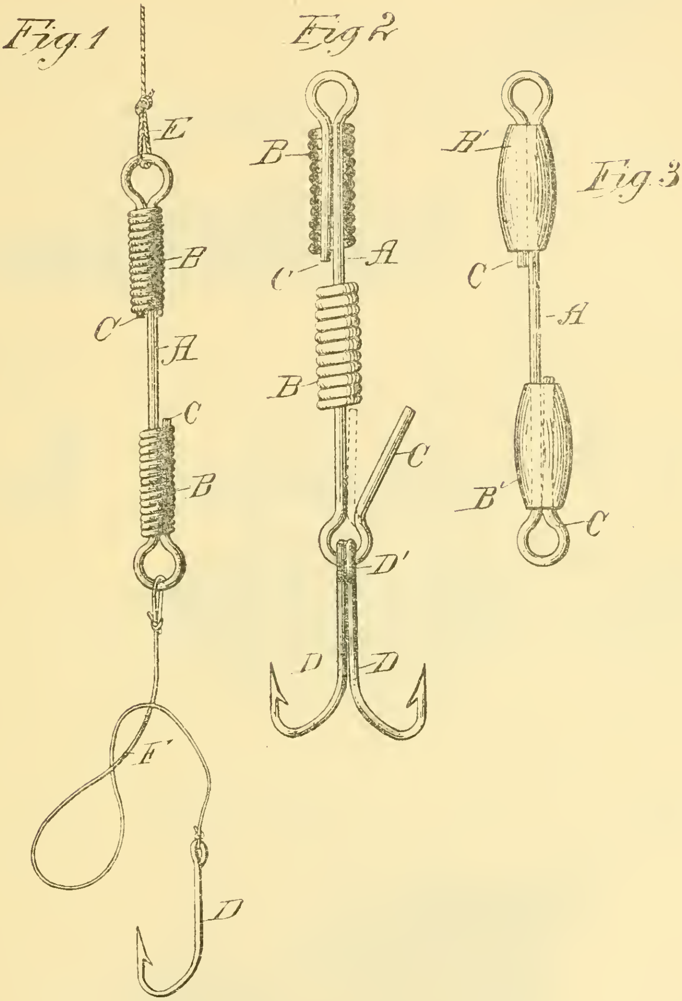
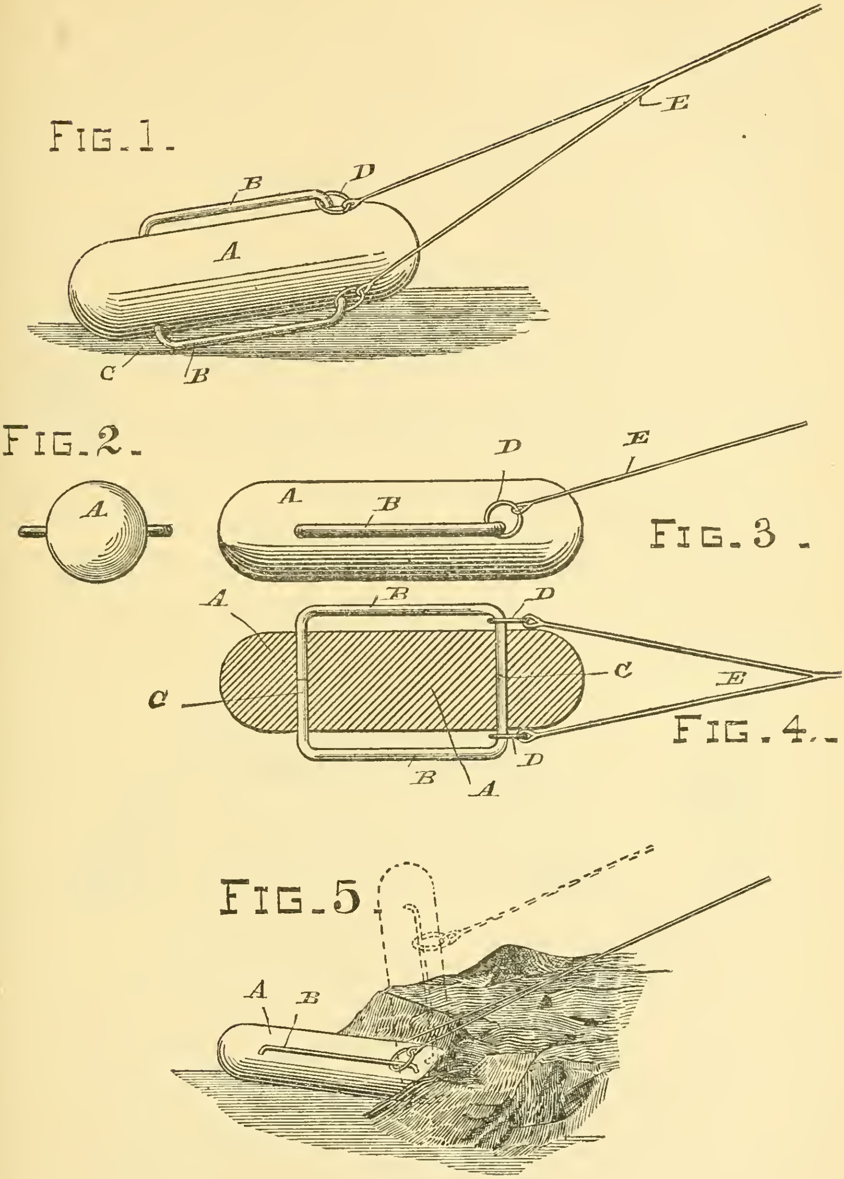


Fig. 3.

No. 252,628. Combined Sinker and Fish-hook Holder, by S. E. Smith. See p. [36].



No. 279,206. Fishing-tackle, by H. Van Altena. See p. [36].



No. 285,075. Sinker for Fishing-tackle, by H. Rix. See p. [37].

Fig. 1.

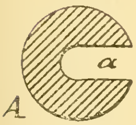


Fig. 2

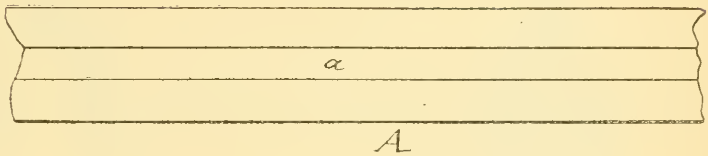


Fig. 3.

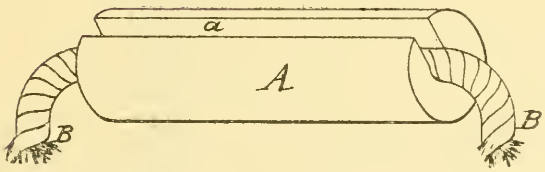
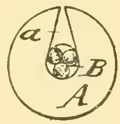


Fig. 4



No. 276,188. Sinker for Fish-nets, by D. Erickson. See p. [38].

Fig. 1.

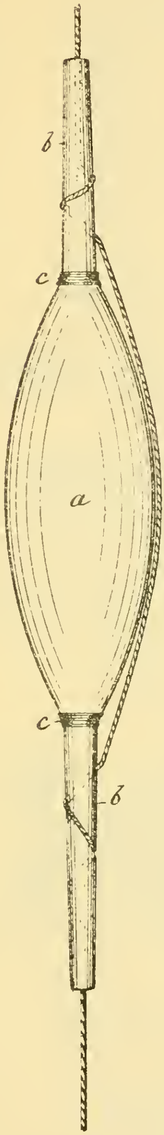
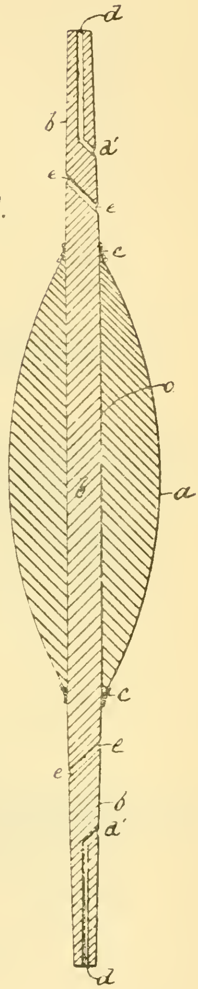


Fig. 2.



No. 261,505. Fishing-float, by O. G. Wilson. See p. [38].

Fig. 1.

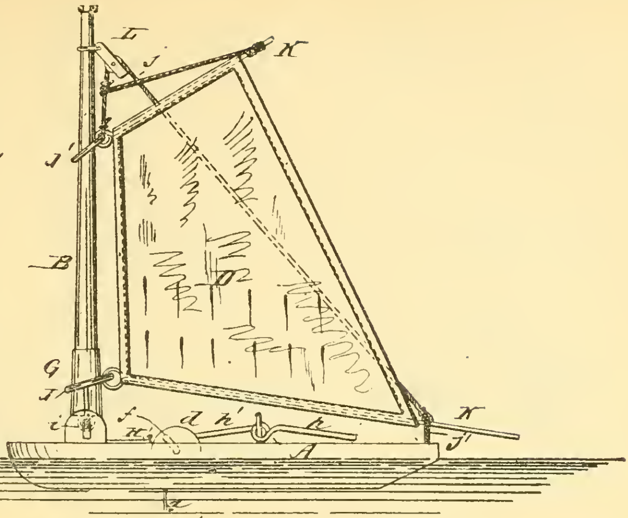


Fig. 2.

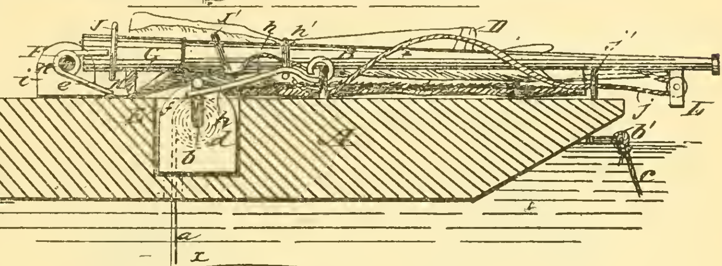


Fig. 3.

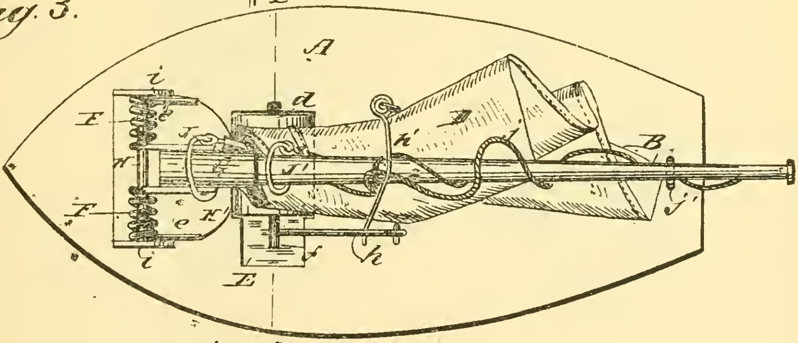
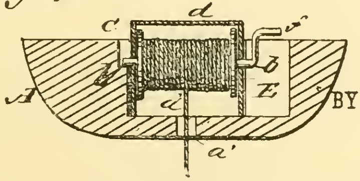
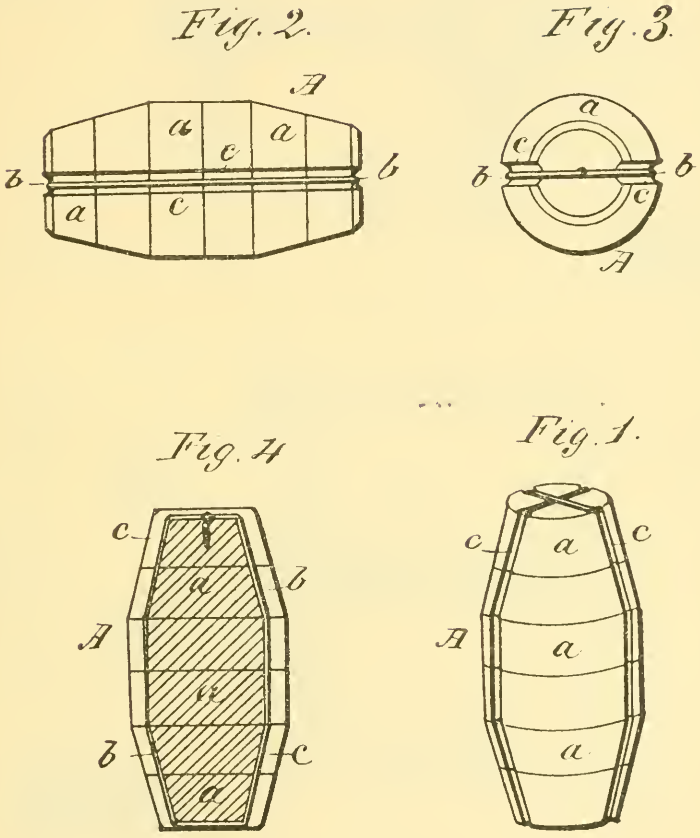


Fig. 4.



No. 270,358. Fishing-float, by R. W. E. Aldrich. See p. [39].



No. 290,154. Fishing-float and Method of Manufacturing the Same, by V. Vidal, jr.
See p. [40].

Fig. 1.

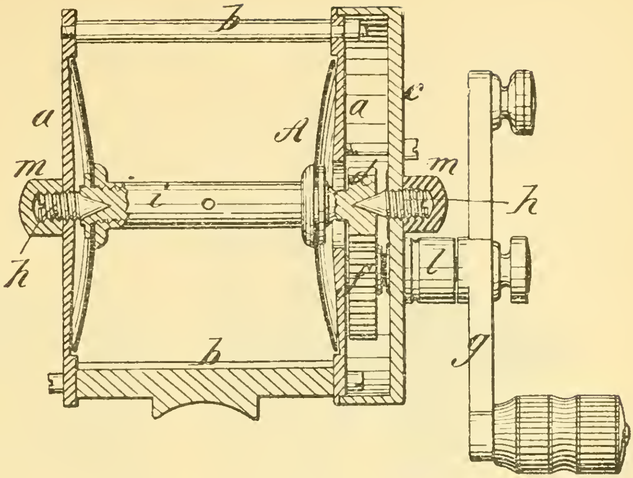


Fig. 2.

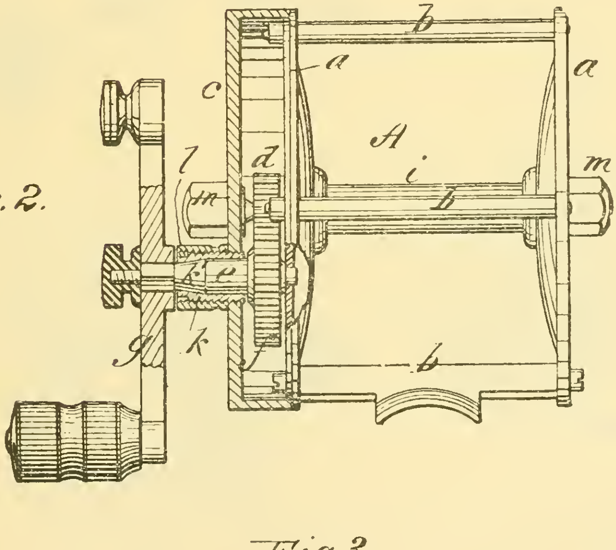


Fig. 3.

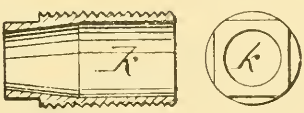
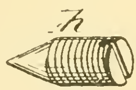


Fig. 4.



No. 252,554. Fishing-reel, by J. Vom Hofe. See p. [41].

Fig. 1.

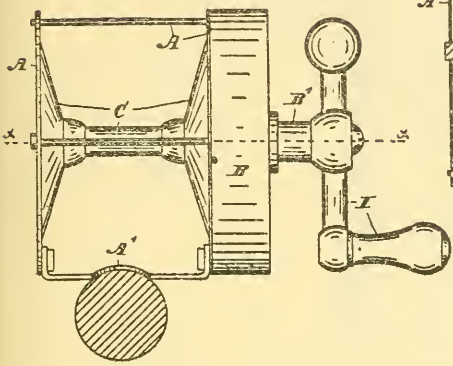


Fig. 2.

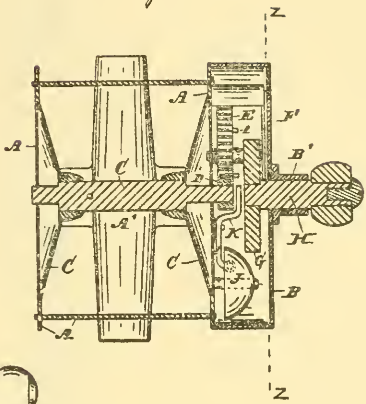


Fig. 3.

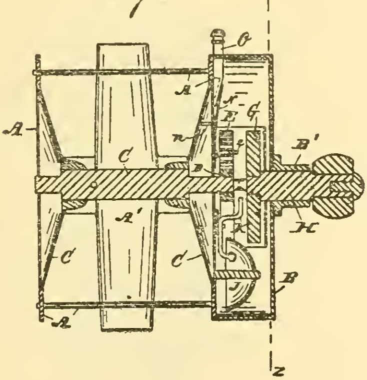
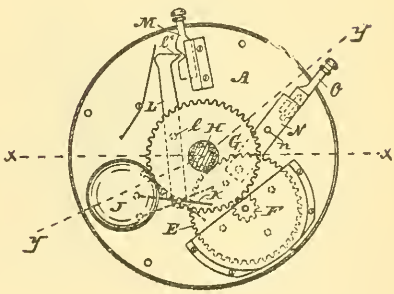
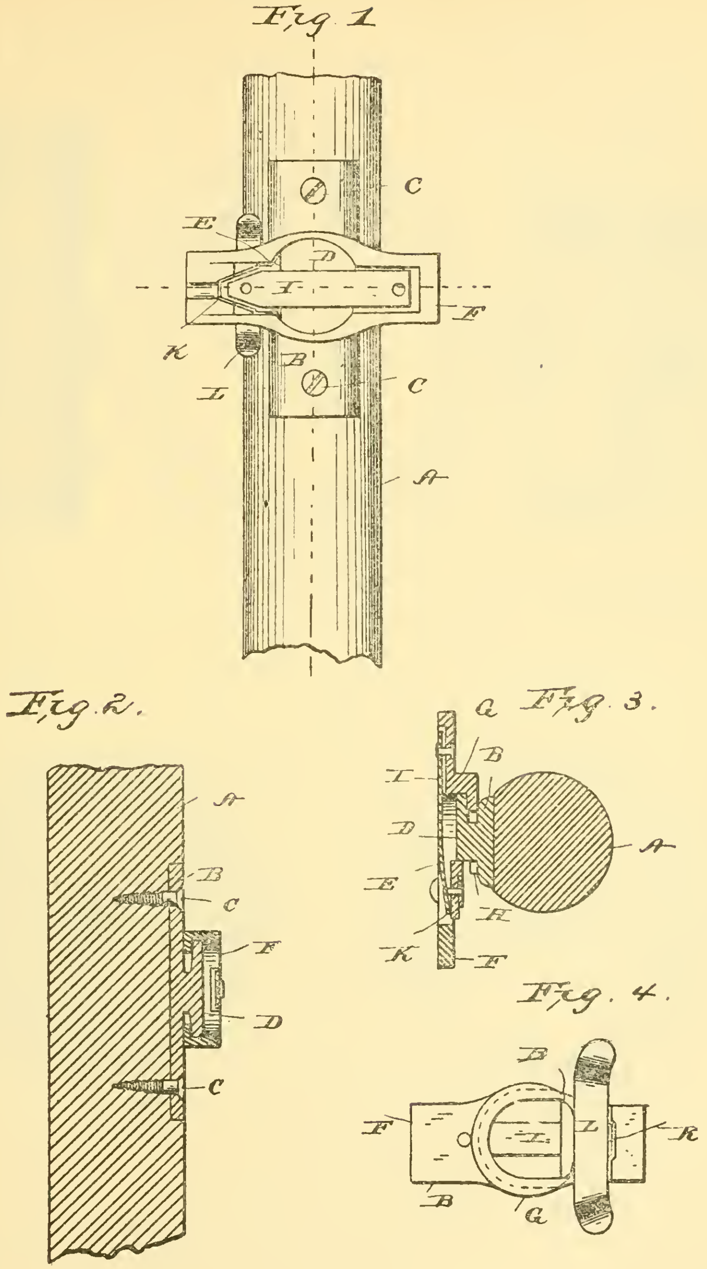


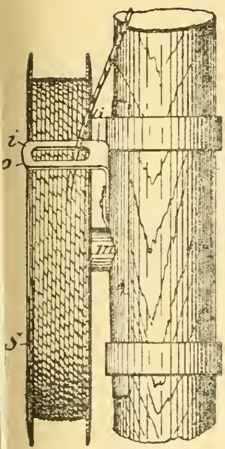
Fig. 4.



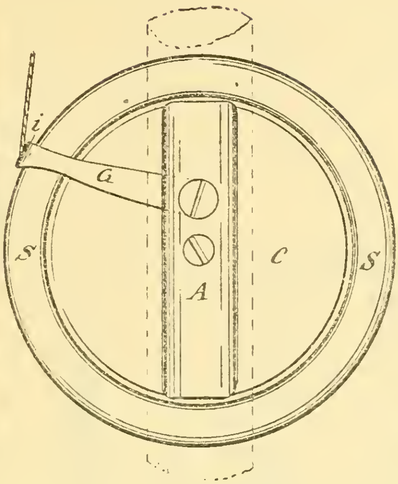
No. 253,090. Fishing-reel, by W. Ohaver and T. O'Bannon. See p. [41].



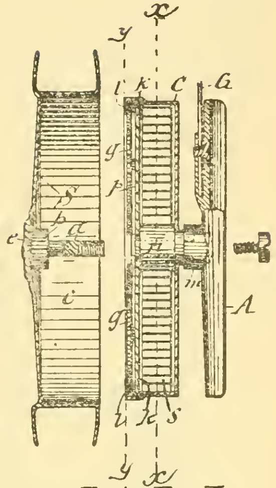
No. 254,025. Reel-lock, by L. A. Kiefer. See p. [42].



F I G - 1 -

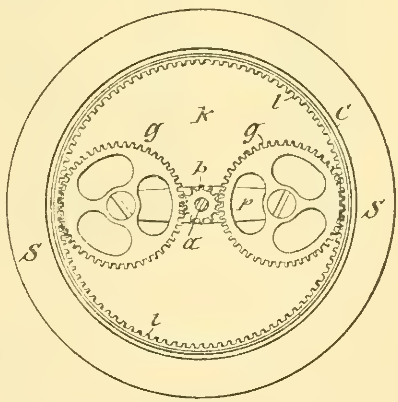


F I G - 2 -



F I G - 3 -

F I G - 4 -



F I G - 5 -

No. 259,935. Fisherman's Reel, by F. R. Smith. See p. [43].

FIG-6-

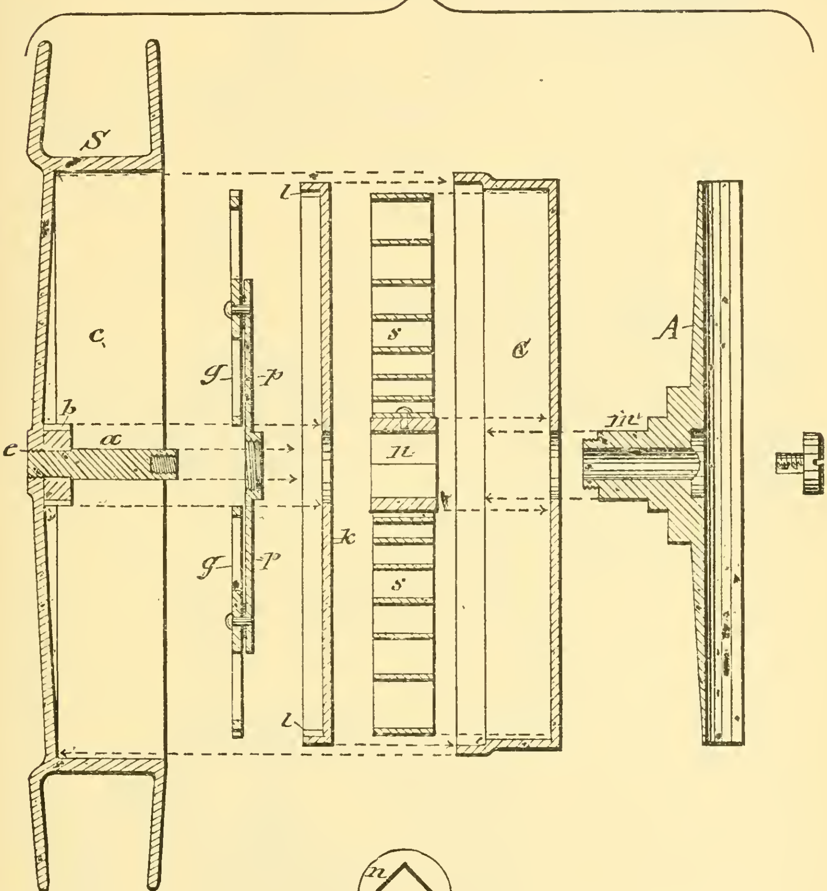
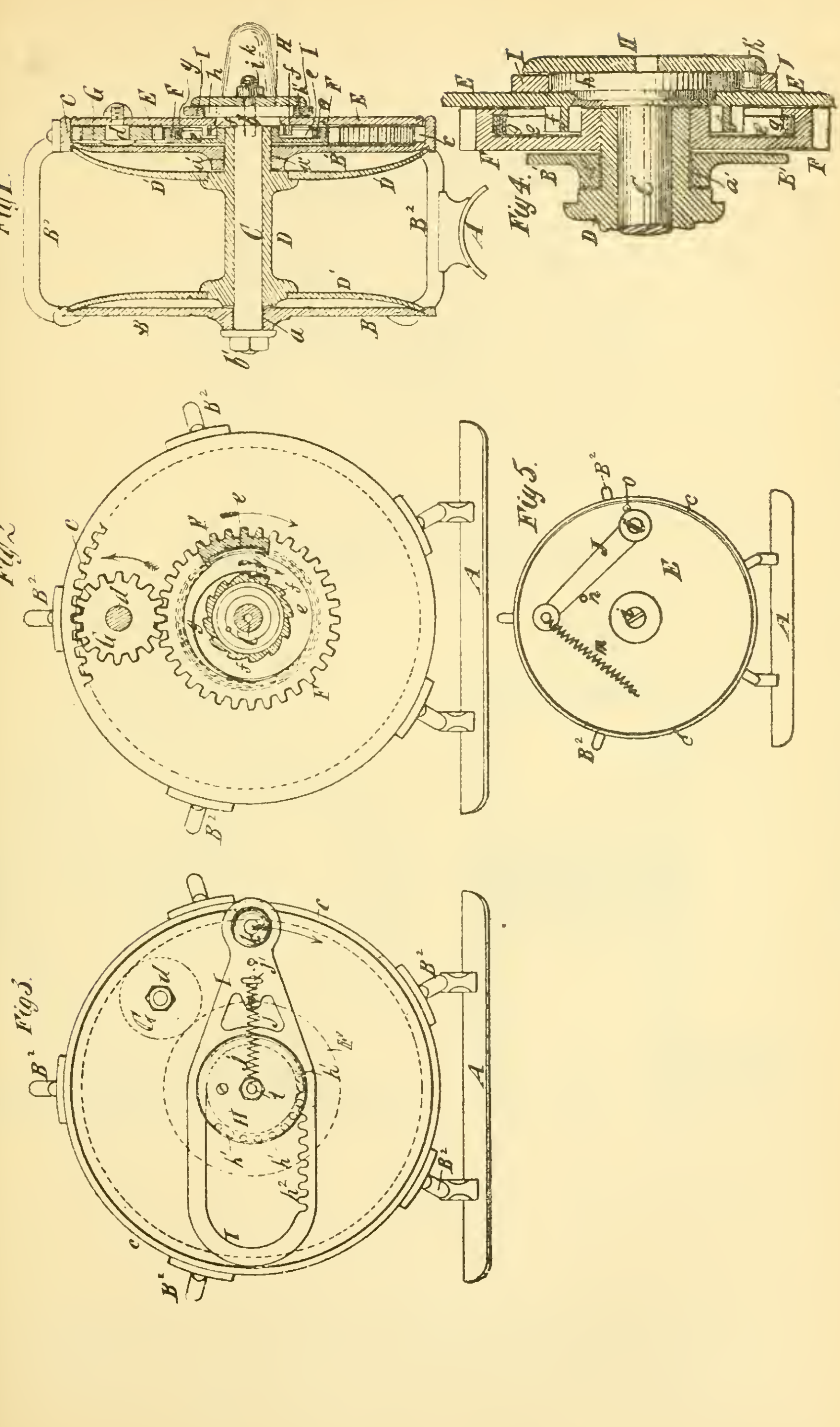
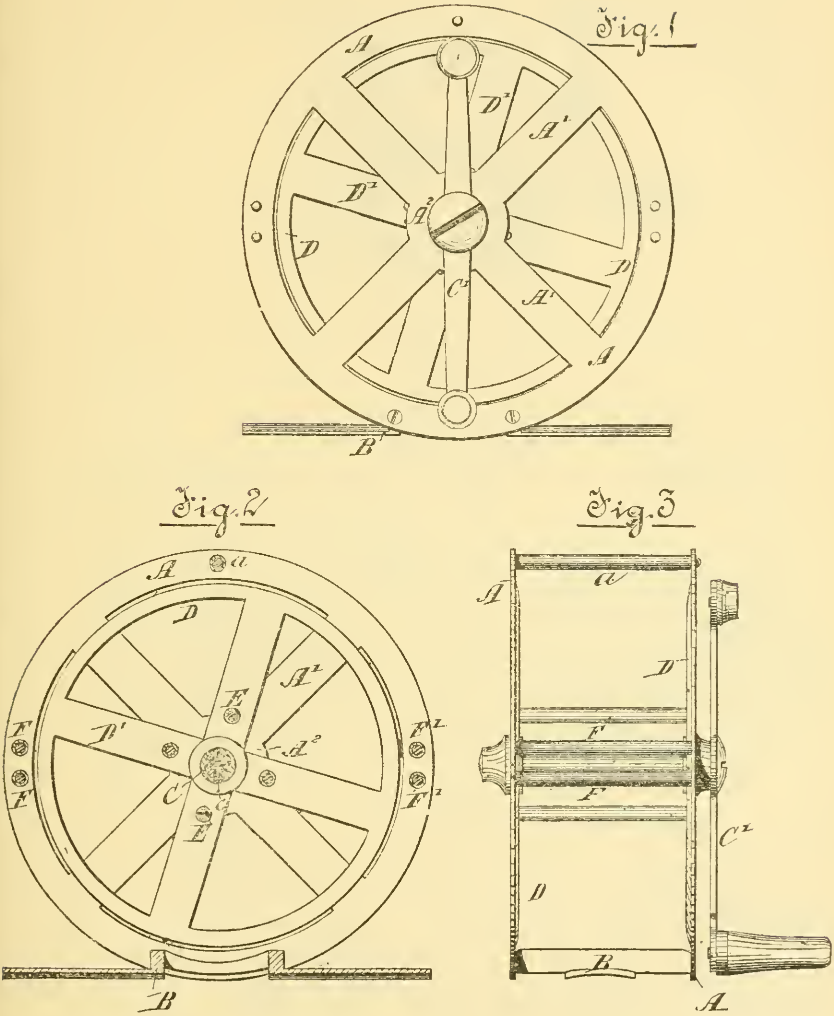


FIG-7-

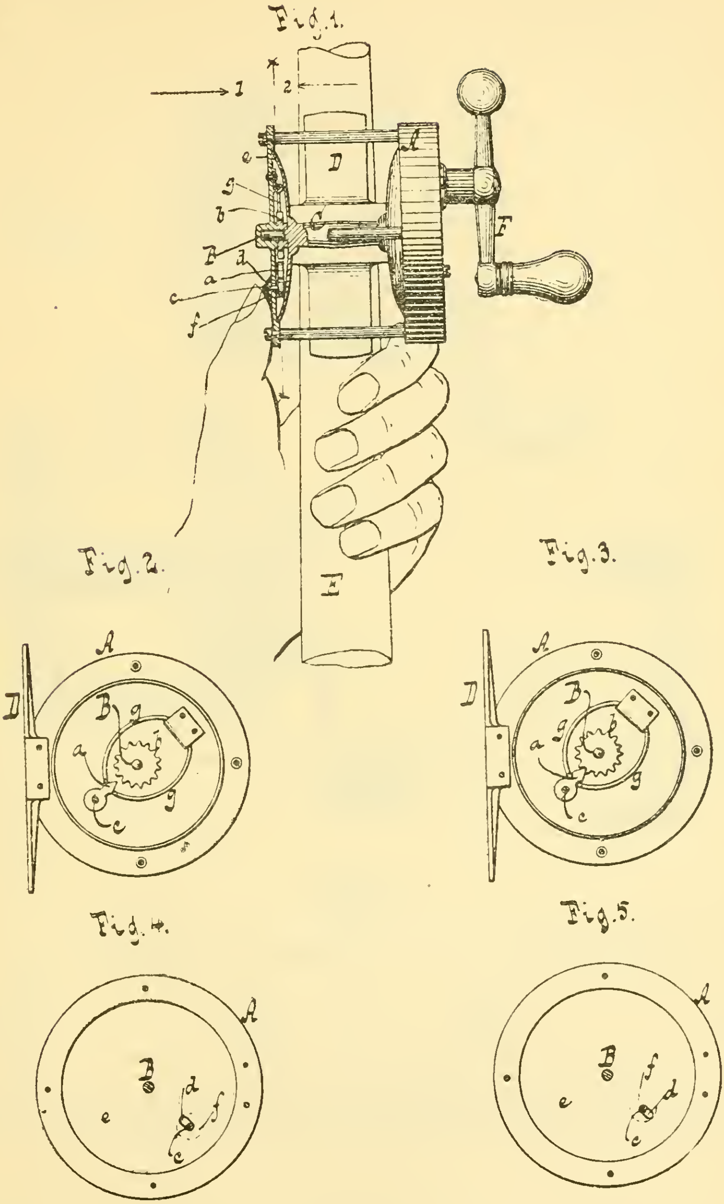
No. 259,935. Fisherman's Reel, by F. R. Smith. See p. [43].



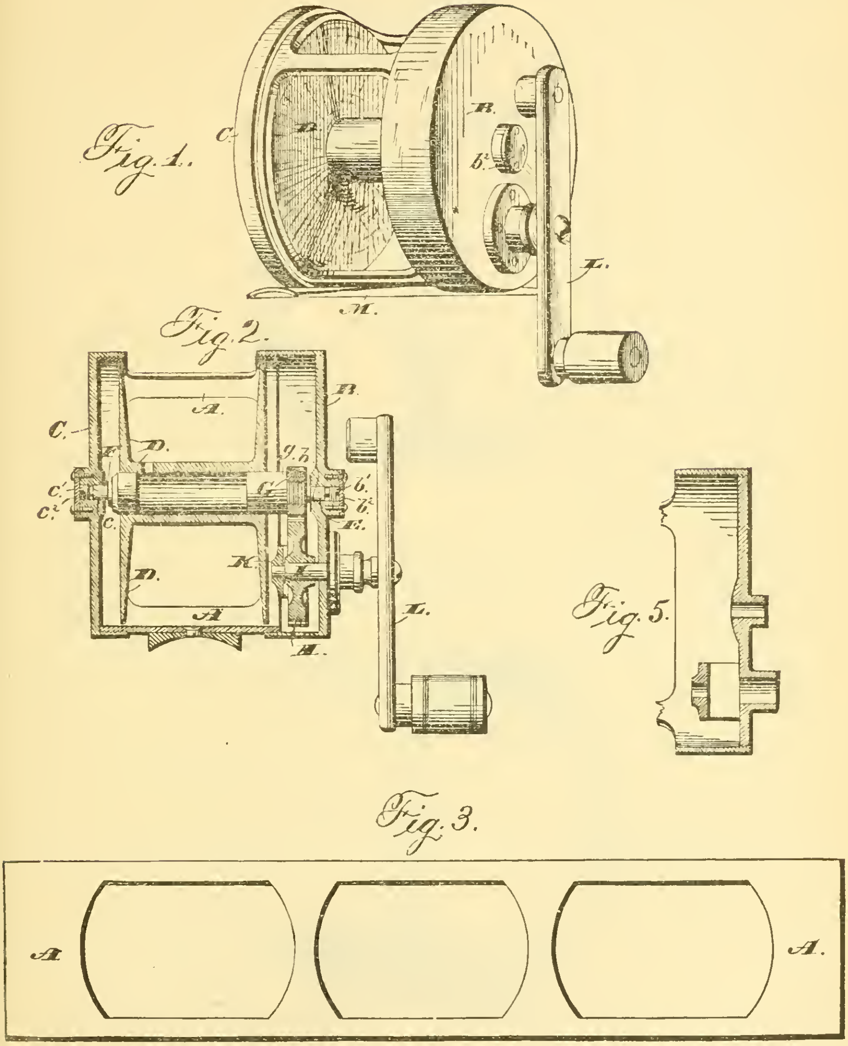
No. 260,932. Fishing-reel, by J. B. D'A. Boulton. See p. [44].



No. 264,092. Fishing-reel, by G. H. Matthews and G. T. Ostell. See p. [46].



No. 271,166. Fishing-reel, by E. C. Vom Hofe. See p. [47].



No. 281,918. Fishing-reel, by G. H. Palmer. See p. [48].

Fig 4.

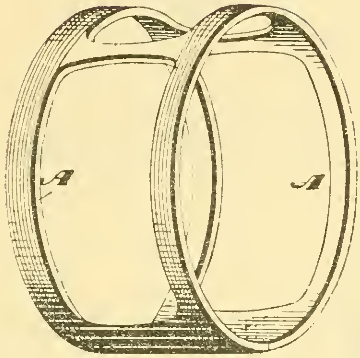
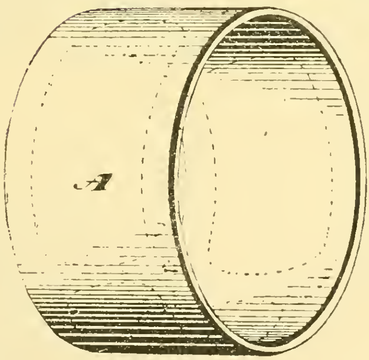
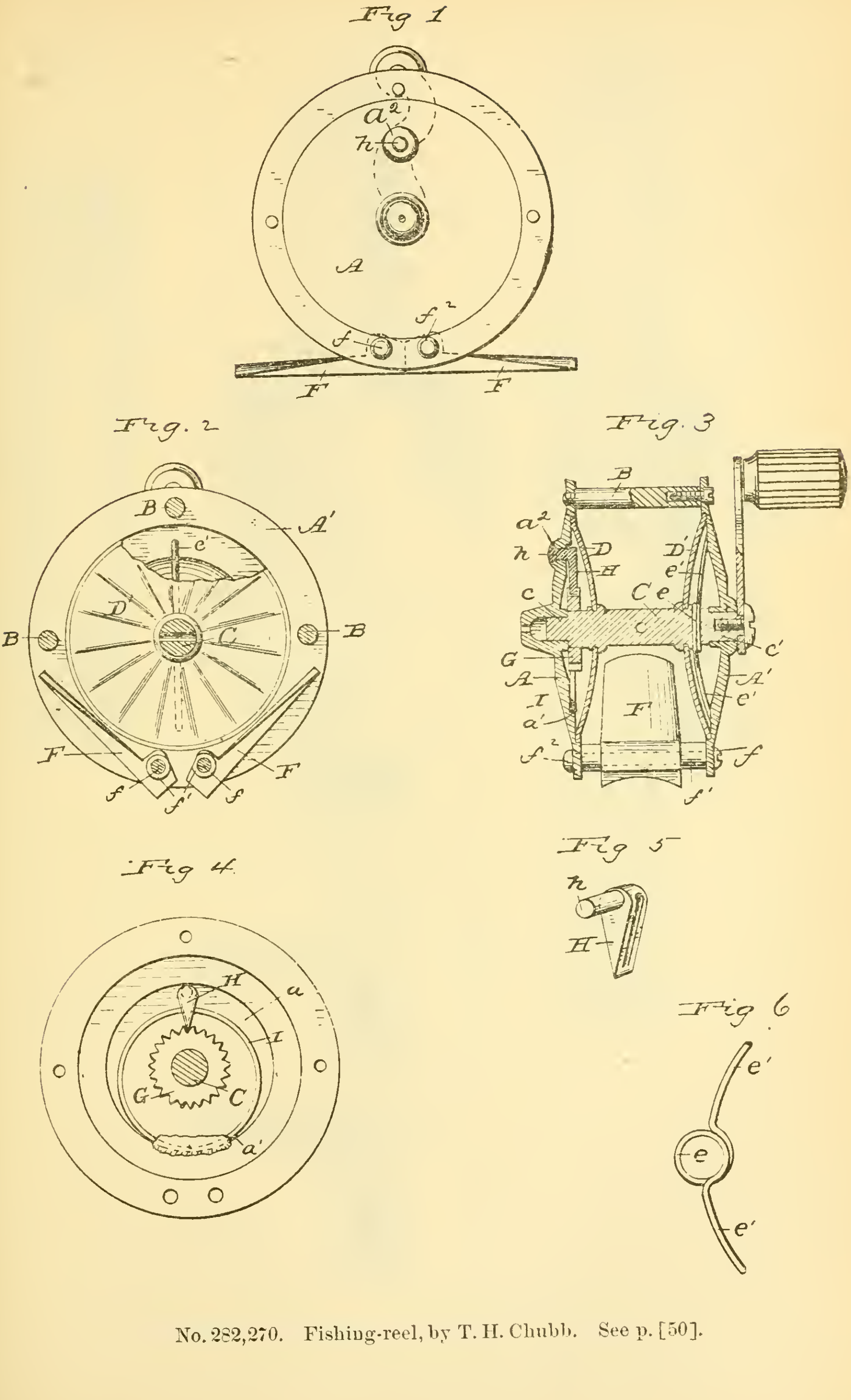


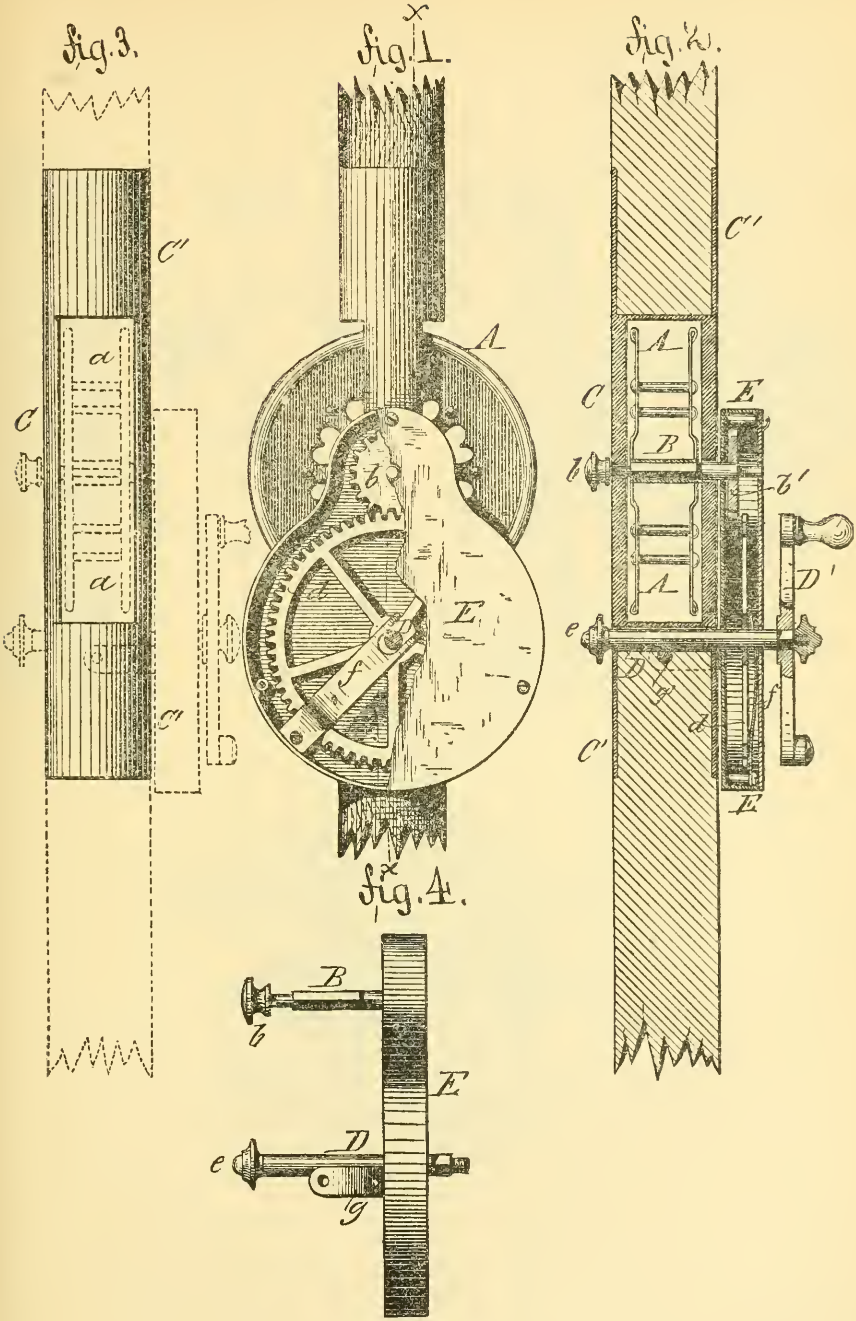
Fig 6



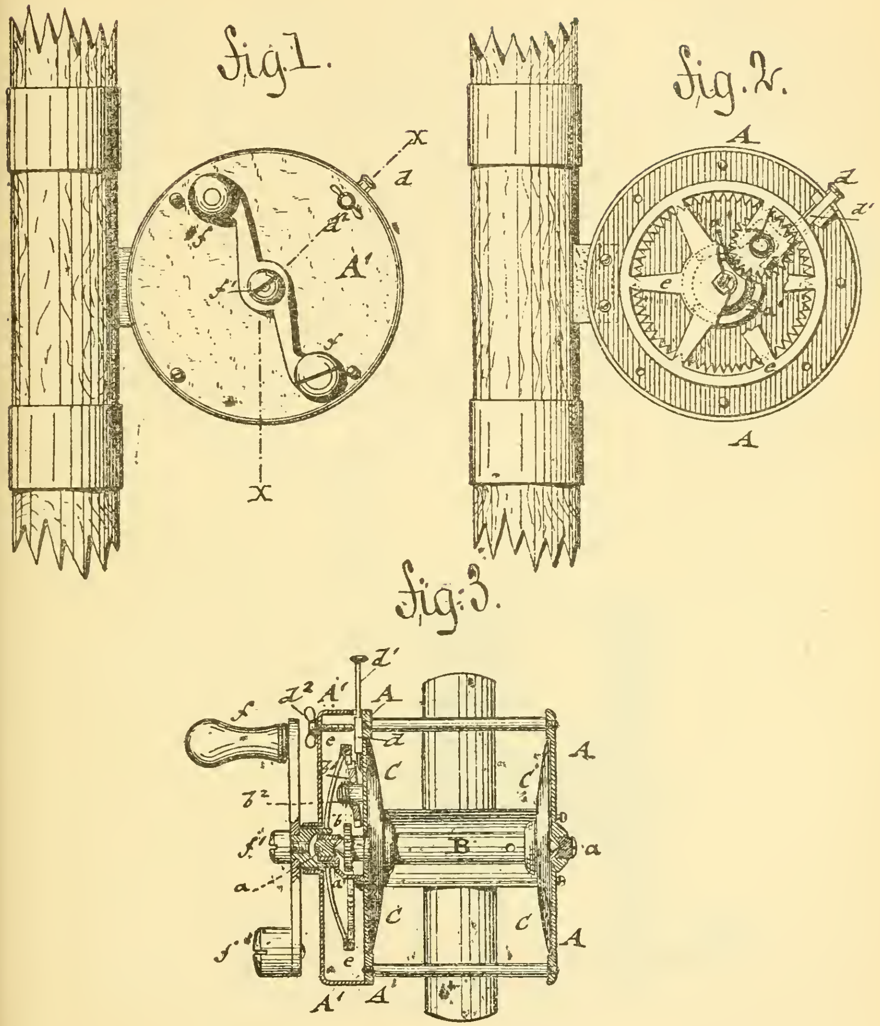
No. 281,918. Fishing-reel, by G. H. Palmer. See p. [48].



No. 282,270. Fishing-reel, by T. H. Chubb. See p. [50].



No. 283,084. Fishing-reel, by A. Dreiser. See p. [51].



No. 283,496. Fishing-reel, by A. Lang. See p. [52].

Fig. 1

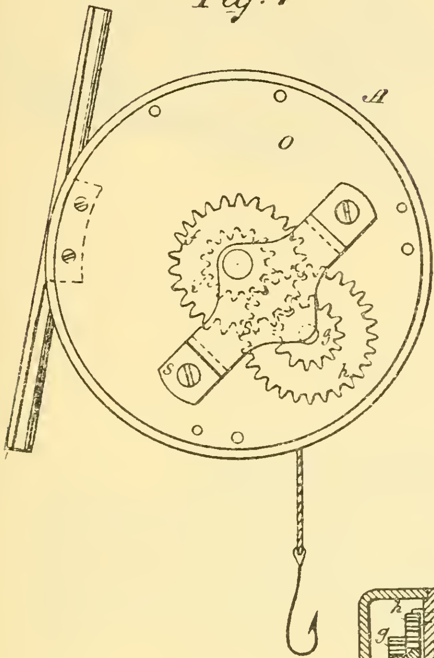


Fig. 2

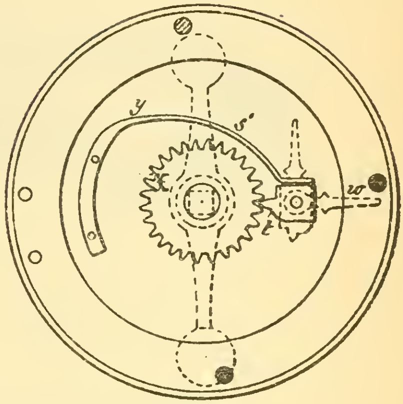
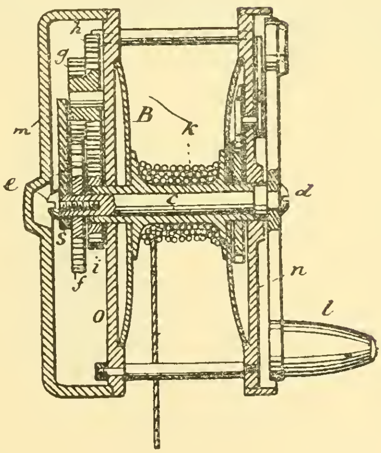
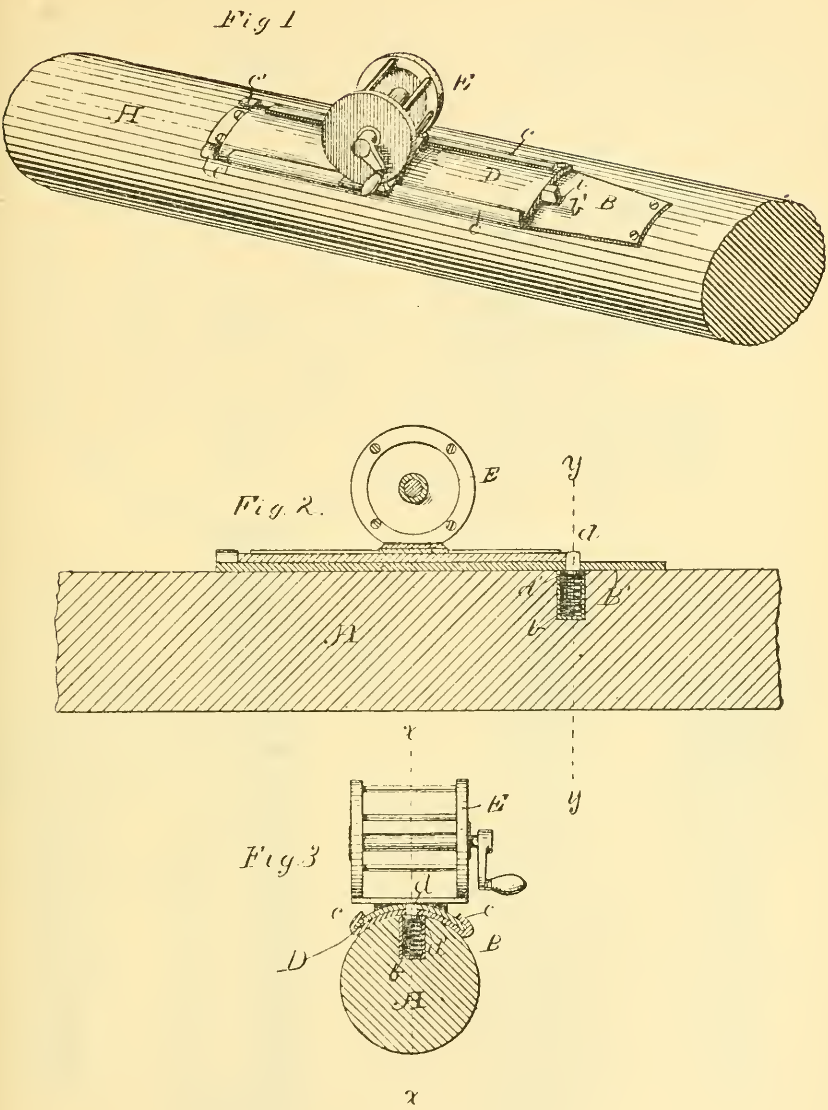


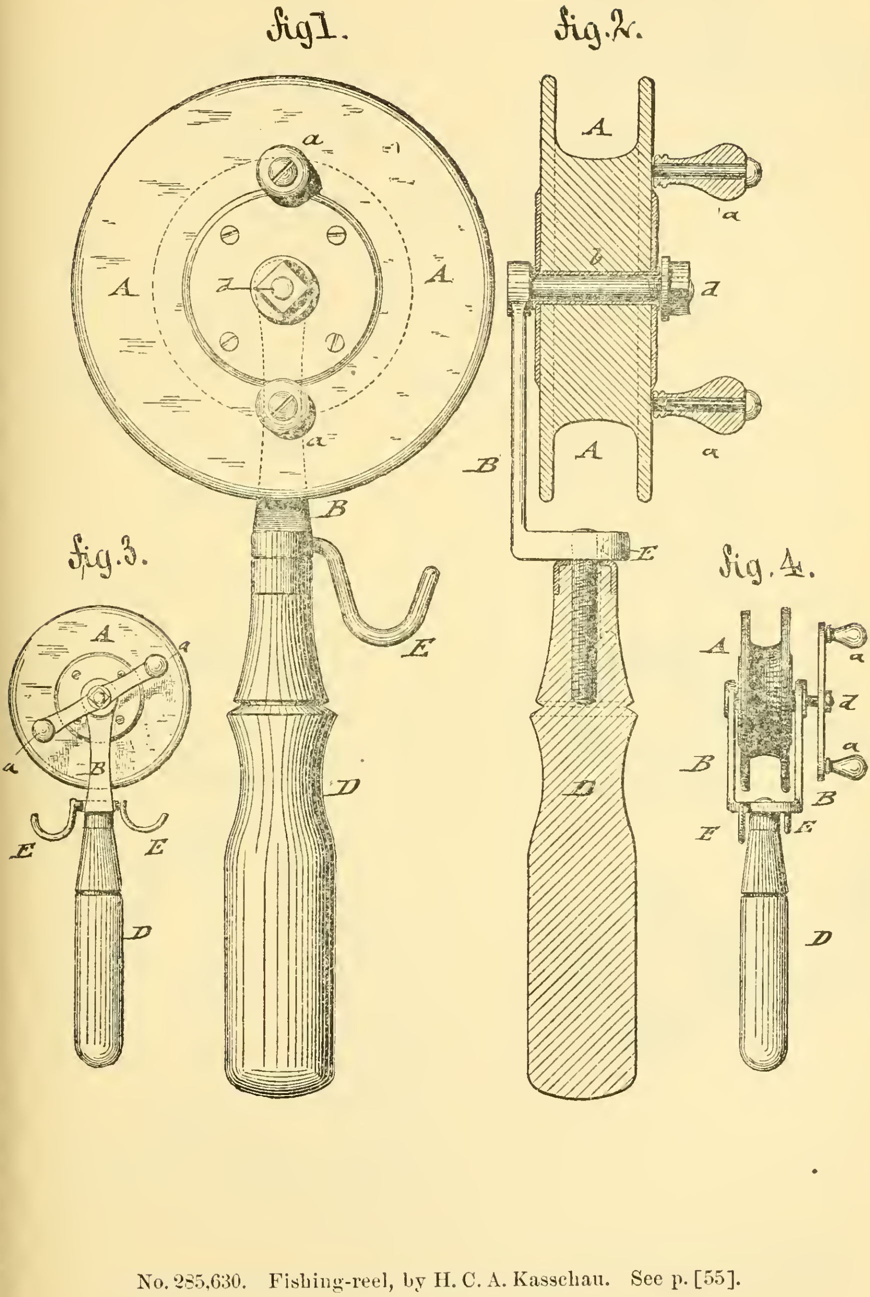
Fig. 3.



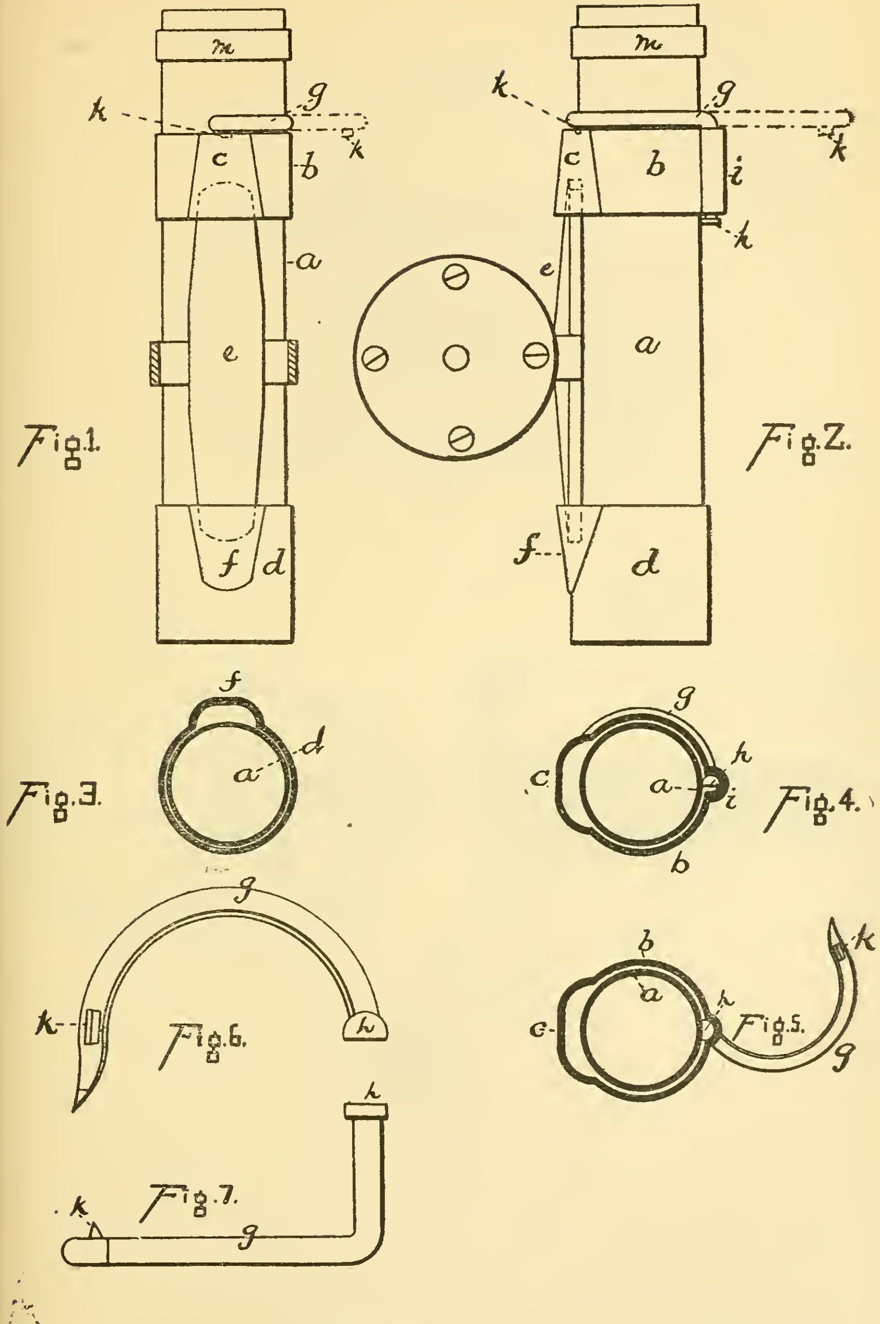
No. 284,217. Fishing-reel, by F. Malleson. See p. [53].



No. 285,346. Device for Attaching Reels to Fishing-rods, by W. B. Doubleday.
See p. [54].



No. 285,630. Fishing-reel, by H. C. A. Kasschau. See p. [55].



No. 294,429. Reel-fastening for Fishing-rods, by G. L. Bailey. See p. [55].

Fig 1

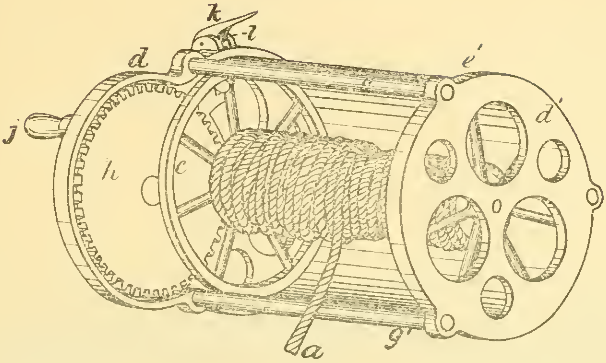


Fig. 2

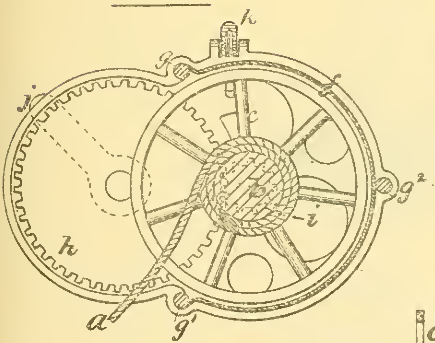


Fig. 3

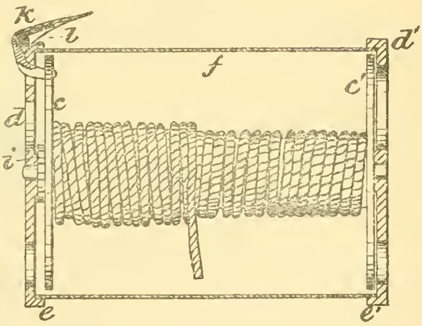
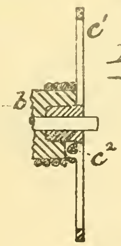


Fig 4



No. 296,196. Line-reel, by W. N. Lockwood. See p. [56].

Fig. 1.

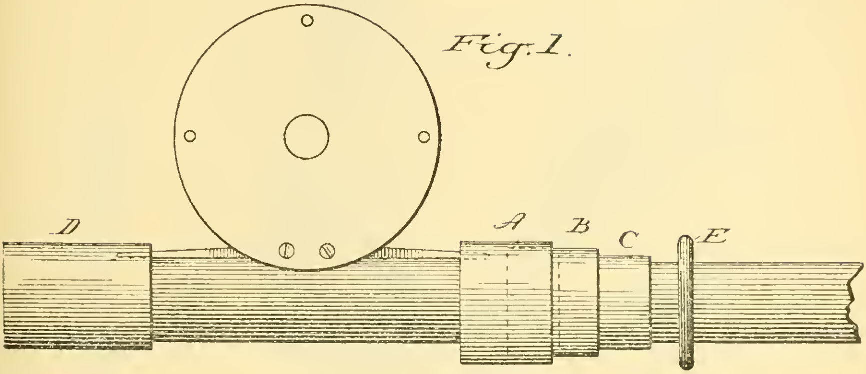


Fig. 3.

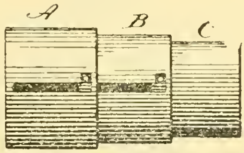
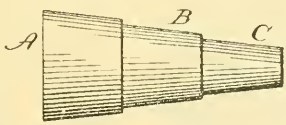
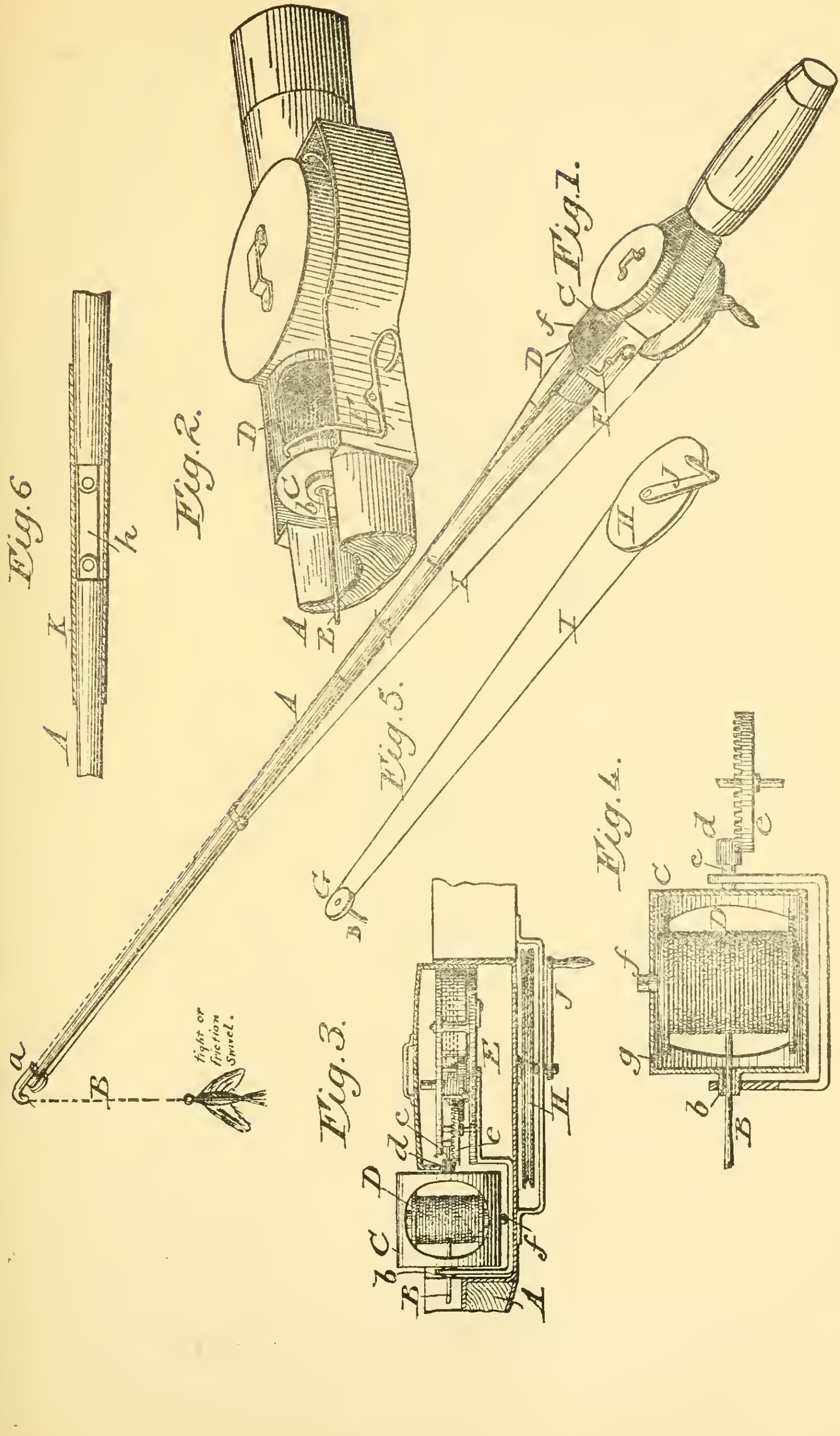


Fig. 2.



No. 303,186. Reel-fastening for Fishing-rods, by H. F. Price. See p. [57].



No. 303,347. Fishing-tackle, by A. Wakeman. See p. [57].

Fig. 1.

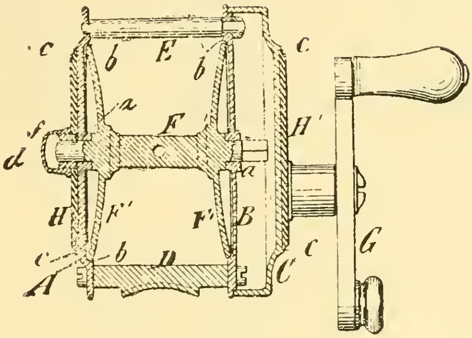
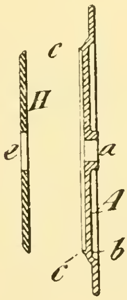


Fig. 2.



No. 306,162. Fishing-reel, by John Kopf. See p. [58].

Fig 1

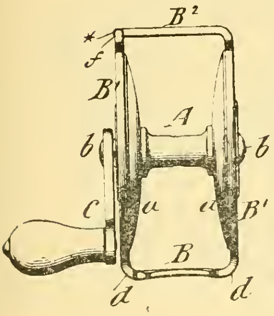


Fig 2

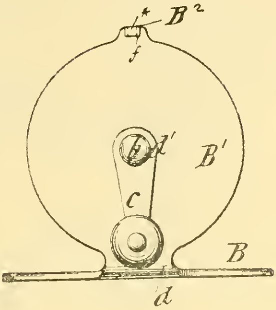


Fig 3

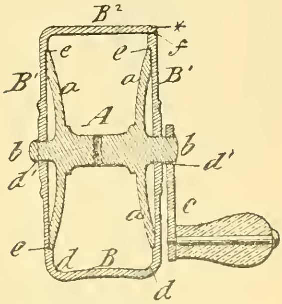


Fig 4

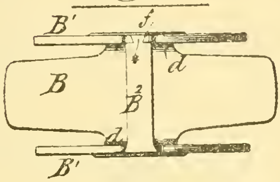
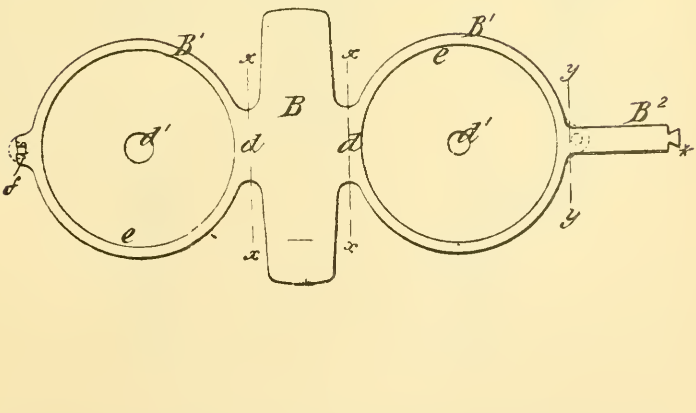


Fig 5



No. 309,305. Method of Making Fishing-reels, by John Kopf. See p. [59].

Fig. 1.

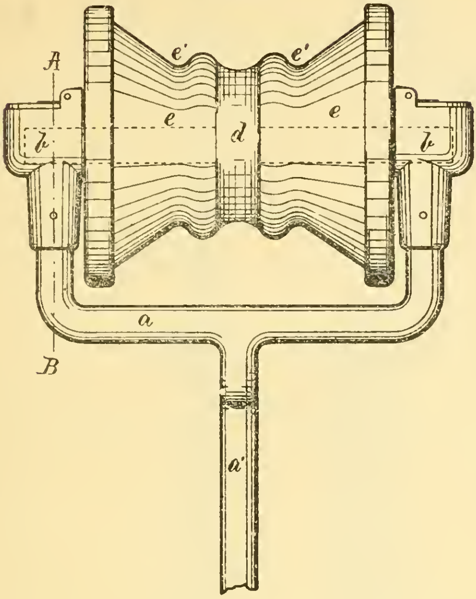


Fig. 3

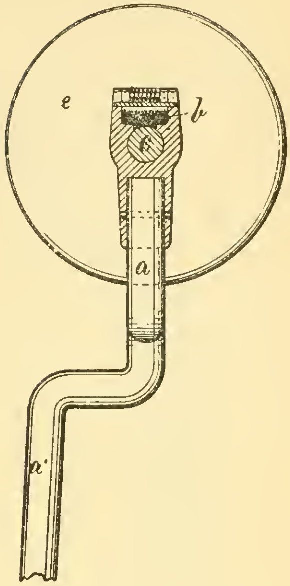


Fig. 2.

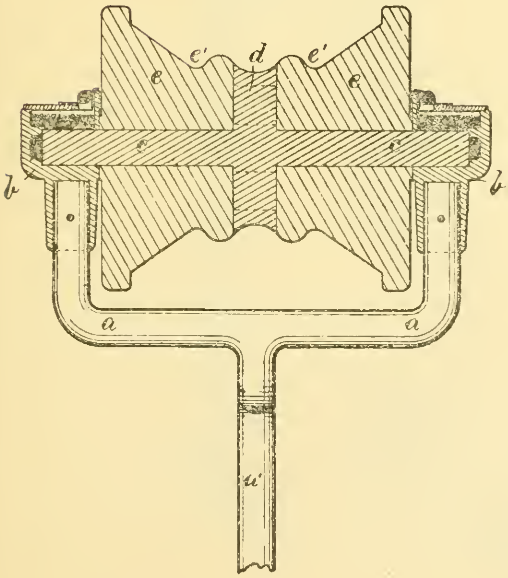
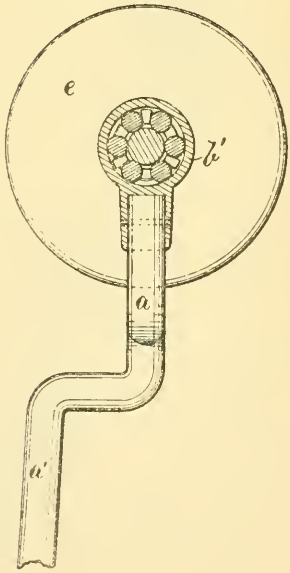
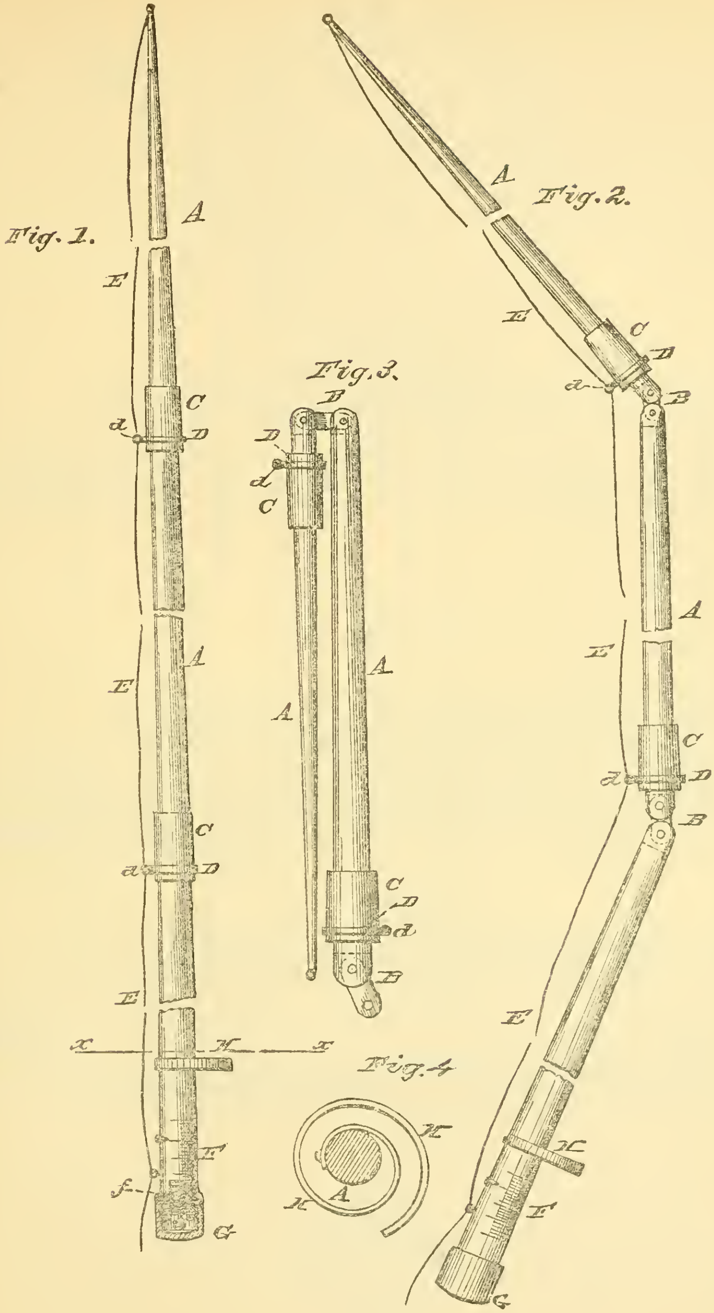


Fig. 4.



No. 272,870. Trawl-roller, by T. R. Ferrall. See p. [60].



No. 252,008. Fishing-rod, by G. P. Andrews. See p. [61].

Fig. 1.

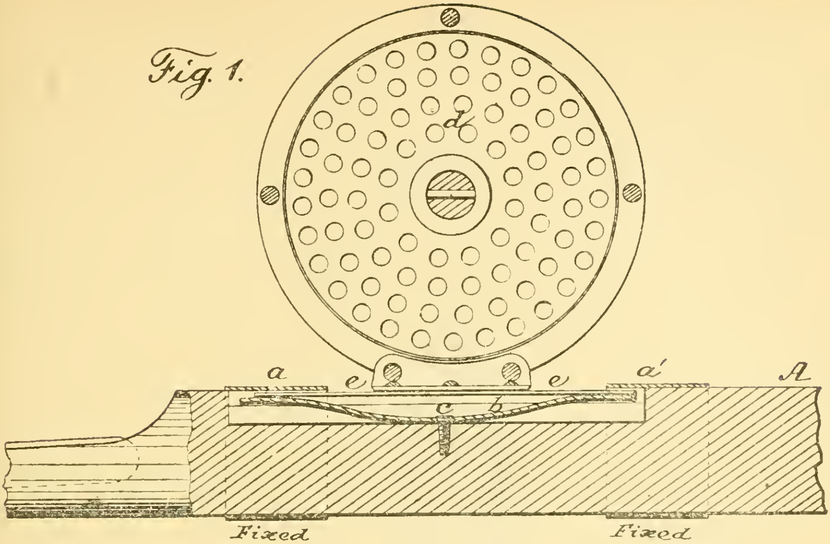


Fig. 2.

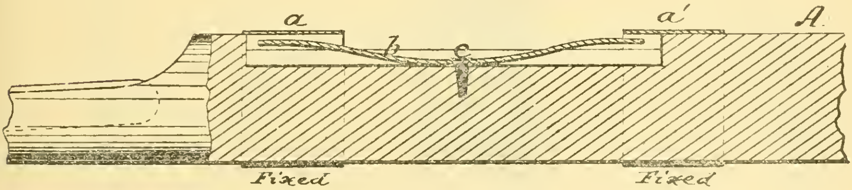


Fig. 4.

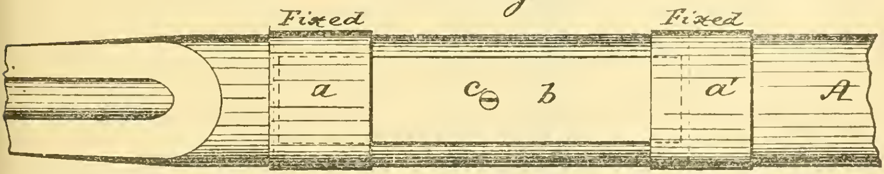
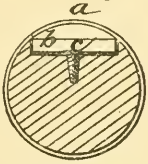
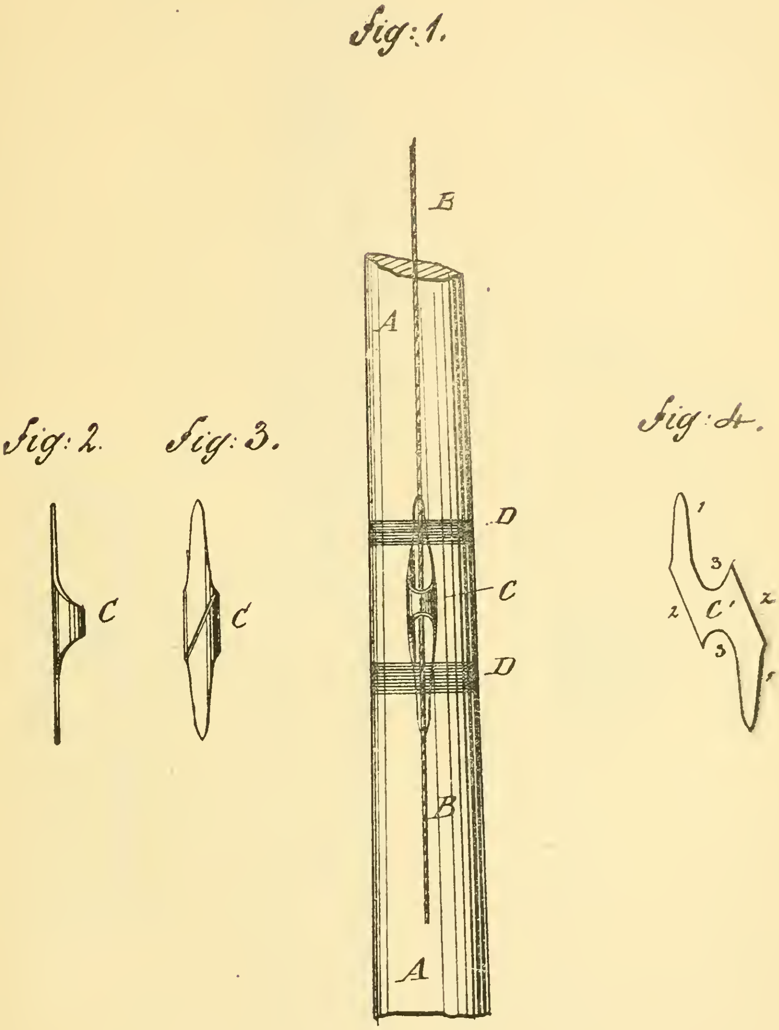


Fig. 3.

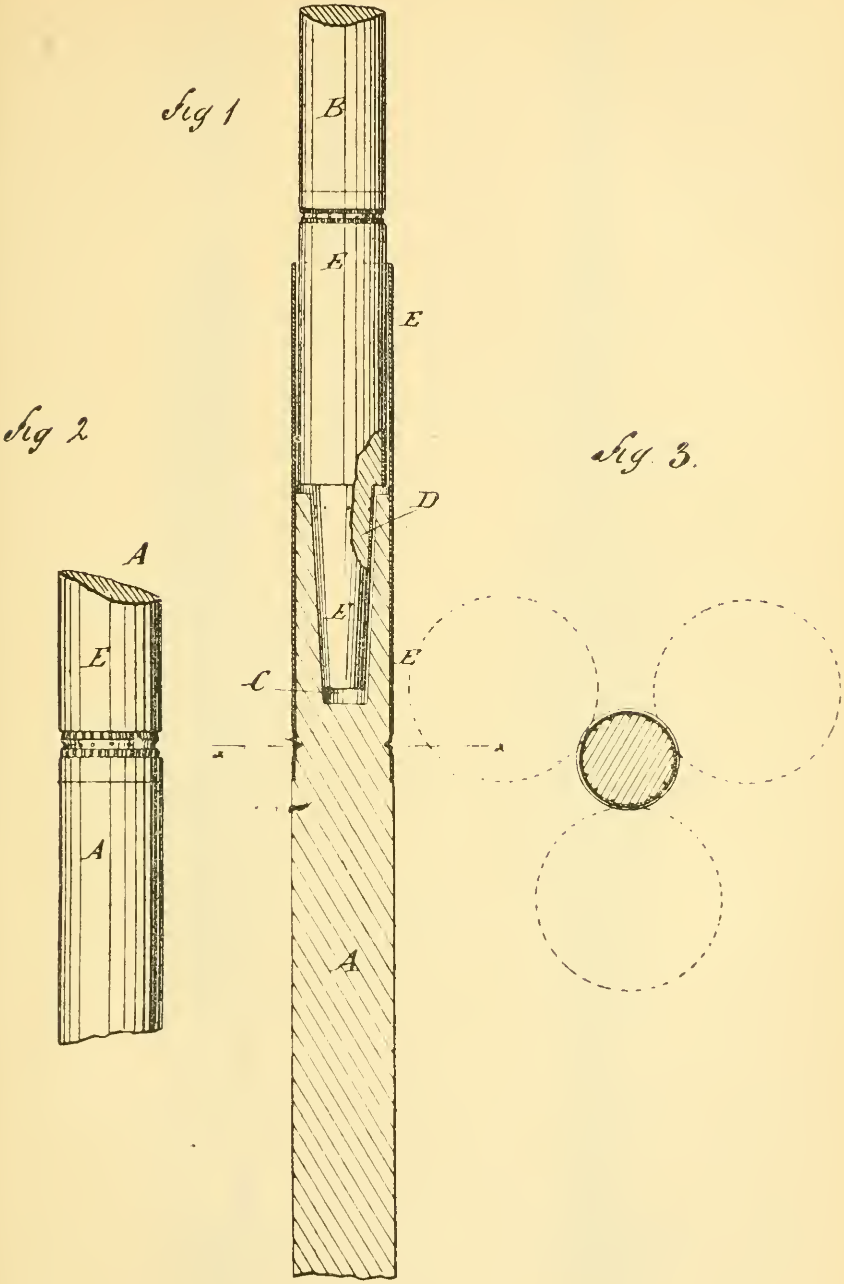
a



No. 258,902. Reel-seat for Fishing-rods, by H. Eggleston. See p. [61].



No. 263,484. Tie-guide for Fishing-rods, by T. H. Chubb. See p. [61].



No. 264,243. Ferrule for Fishing-rods, by T. H. Chubb. See p. [62].

Fig. 1.

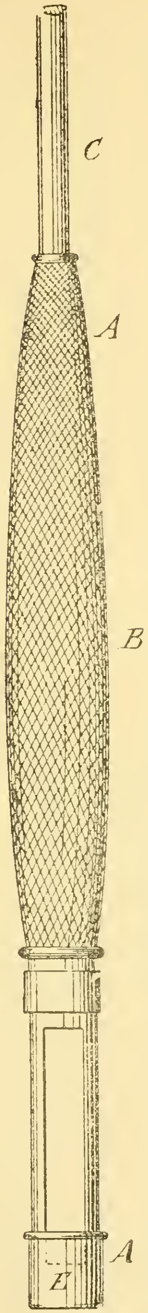
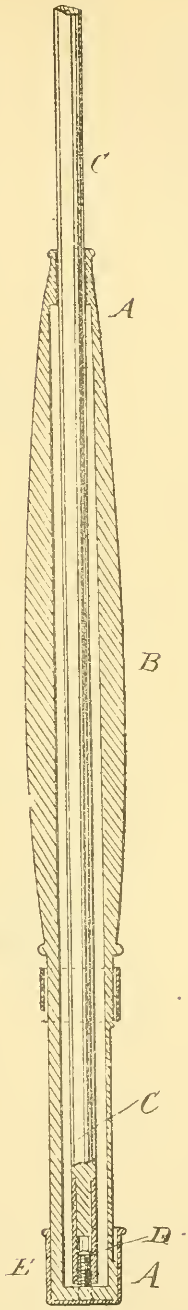


Fig. 2.



No. 270,460. Fishing-rod, by W. Mitchell. See p. [62].

Fig. 1.

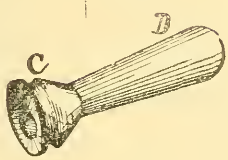
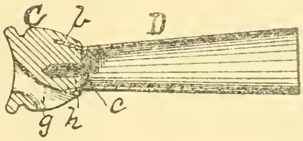
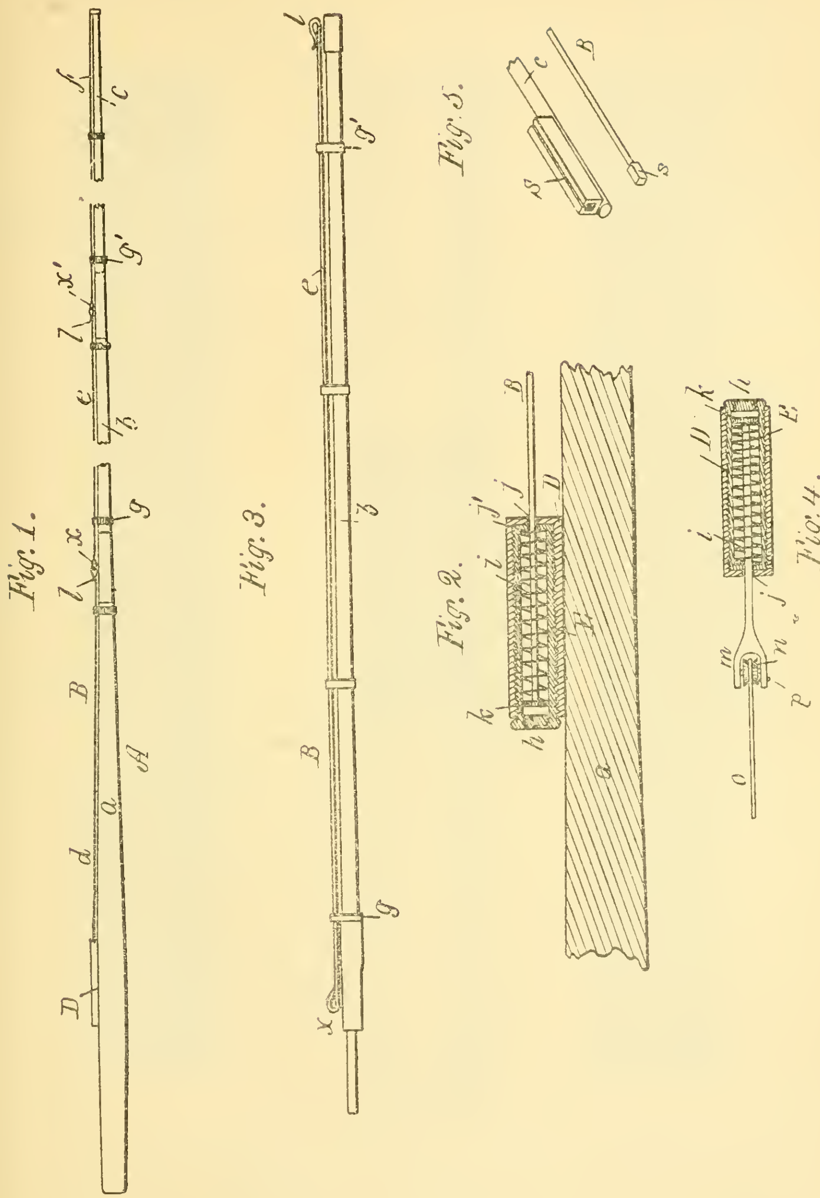


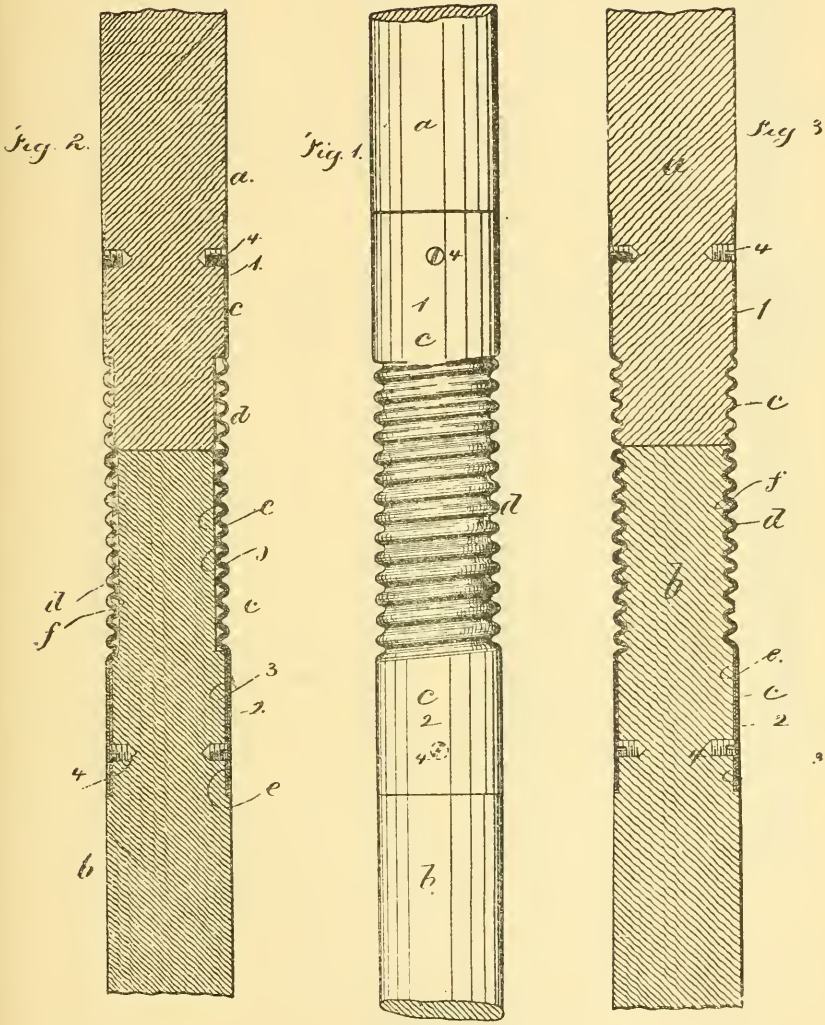
Fig. 2.



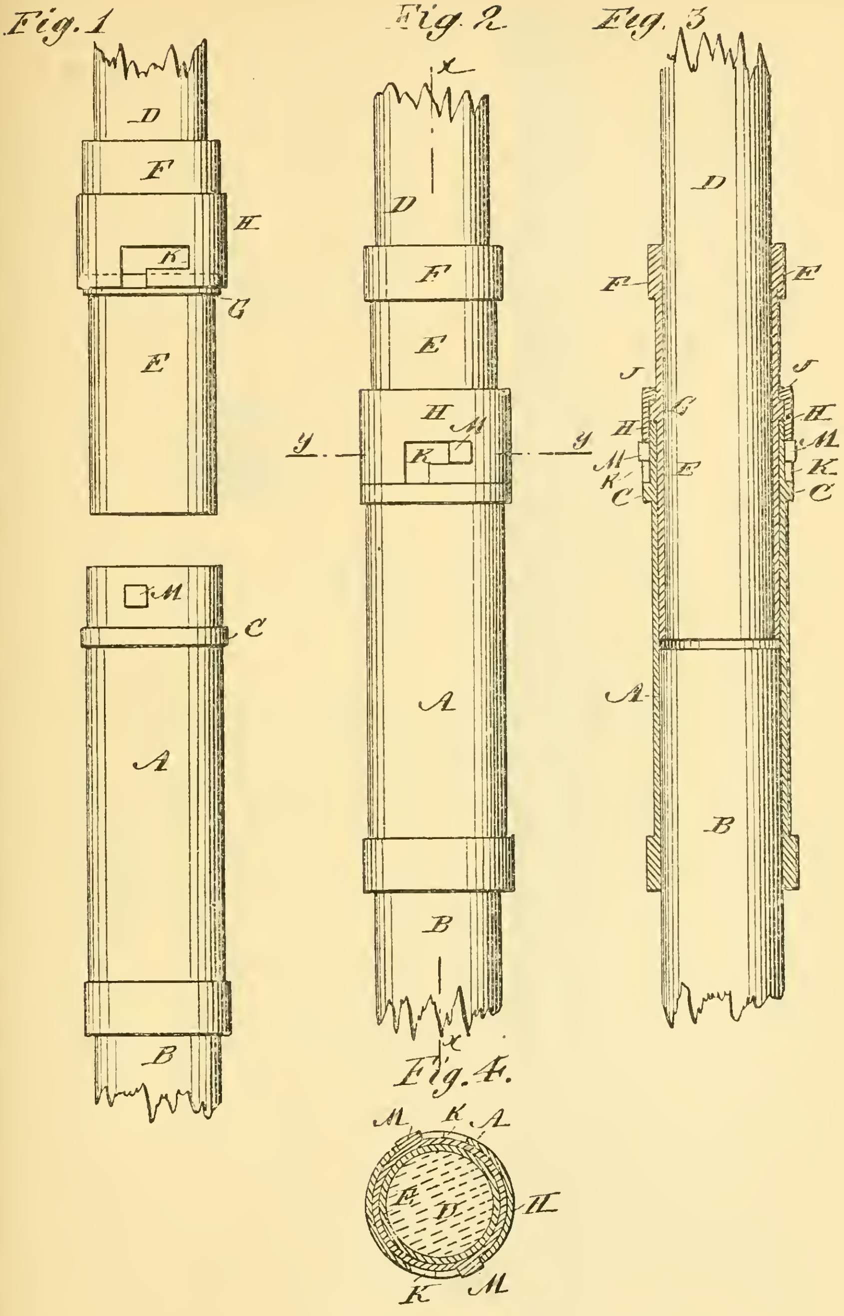
No. 277,230. Fishing-rod Tip, by T. H. Chubb. See p. [63].



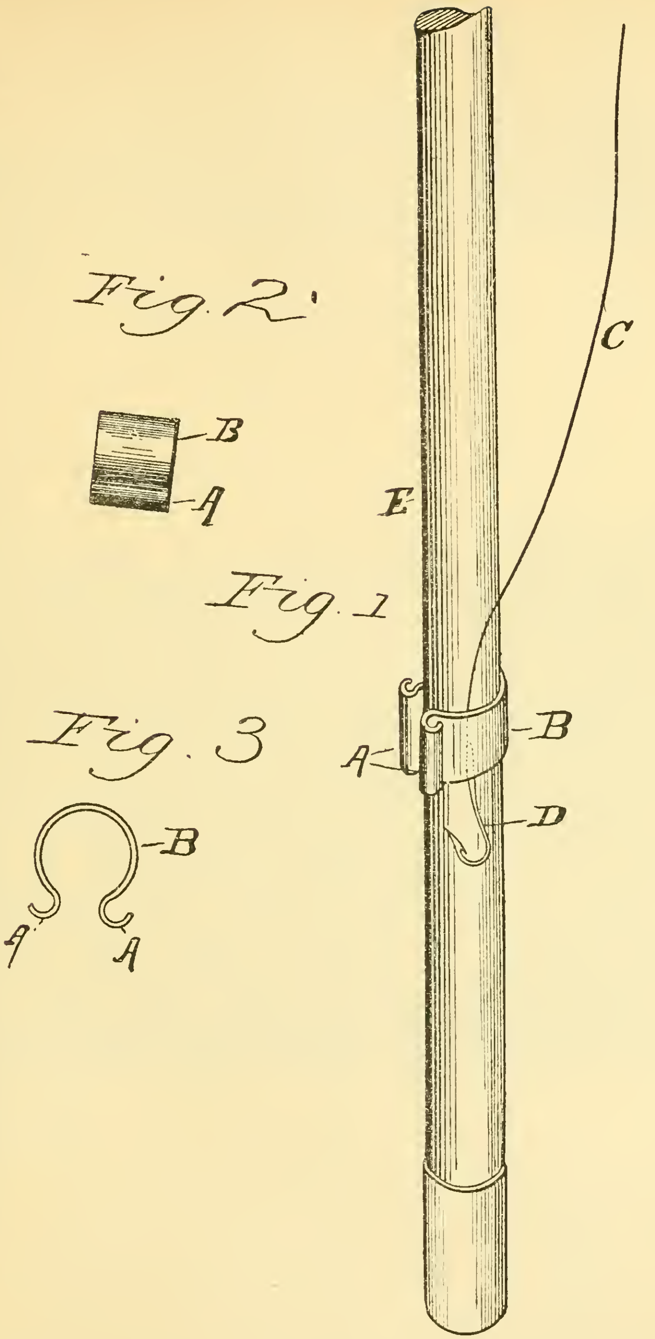
No. 279,988. Tension Equalizer for Fishing-rods, by R. Smith. See p. [63].



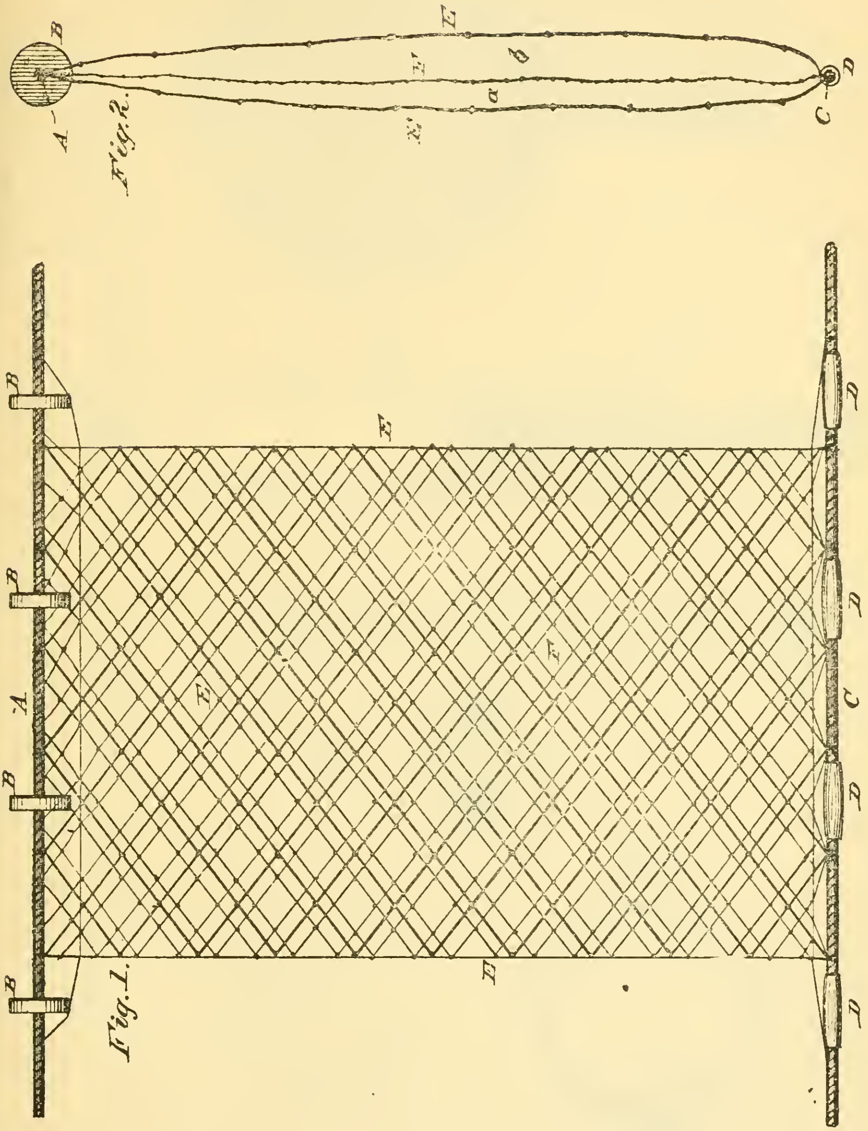
No. 285,493. Joint or Coupling for Rods, by J. E. Langdon. See p. [65].



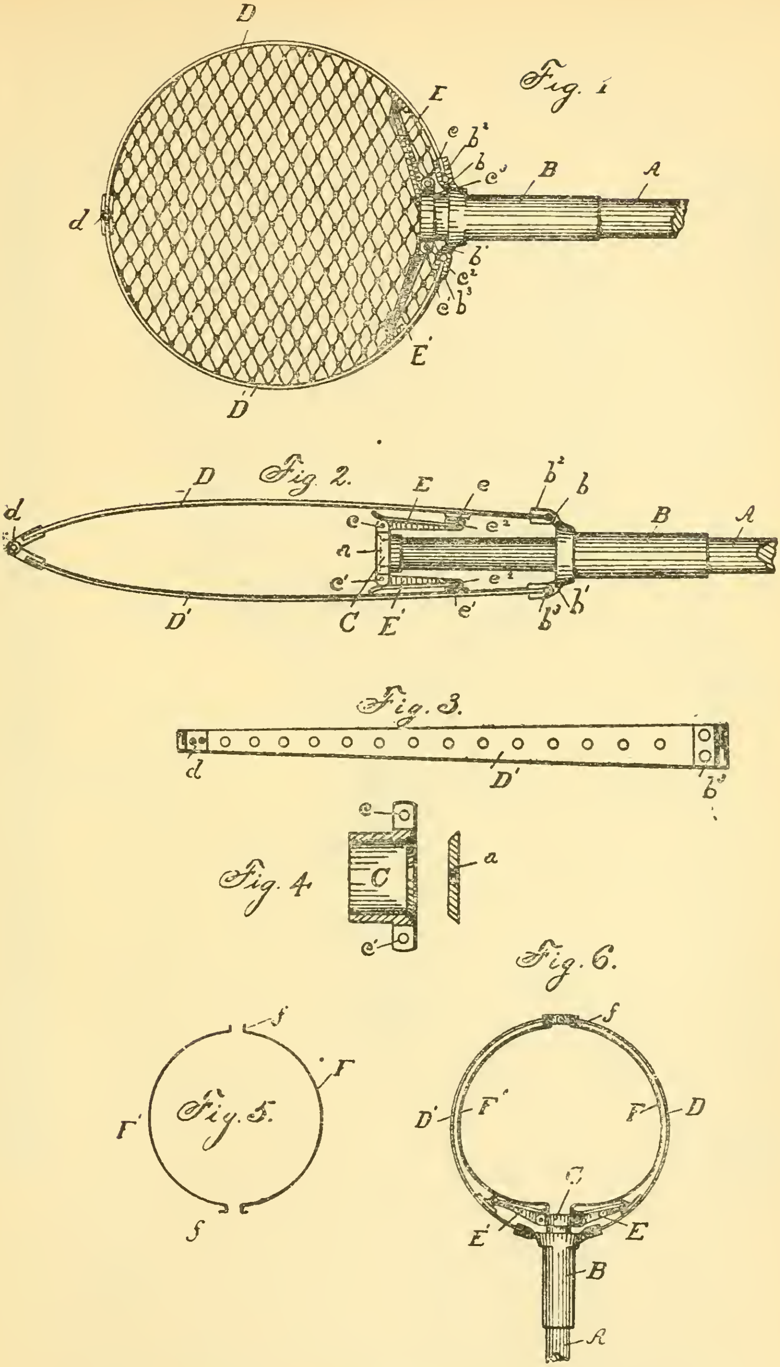
No. 303,474. Lock-joints for Fishing-rods, by J. Webb. See p. [65].



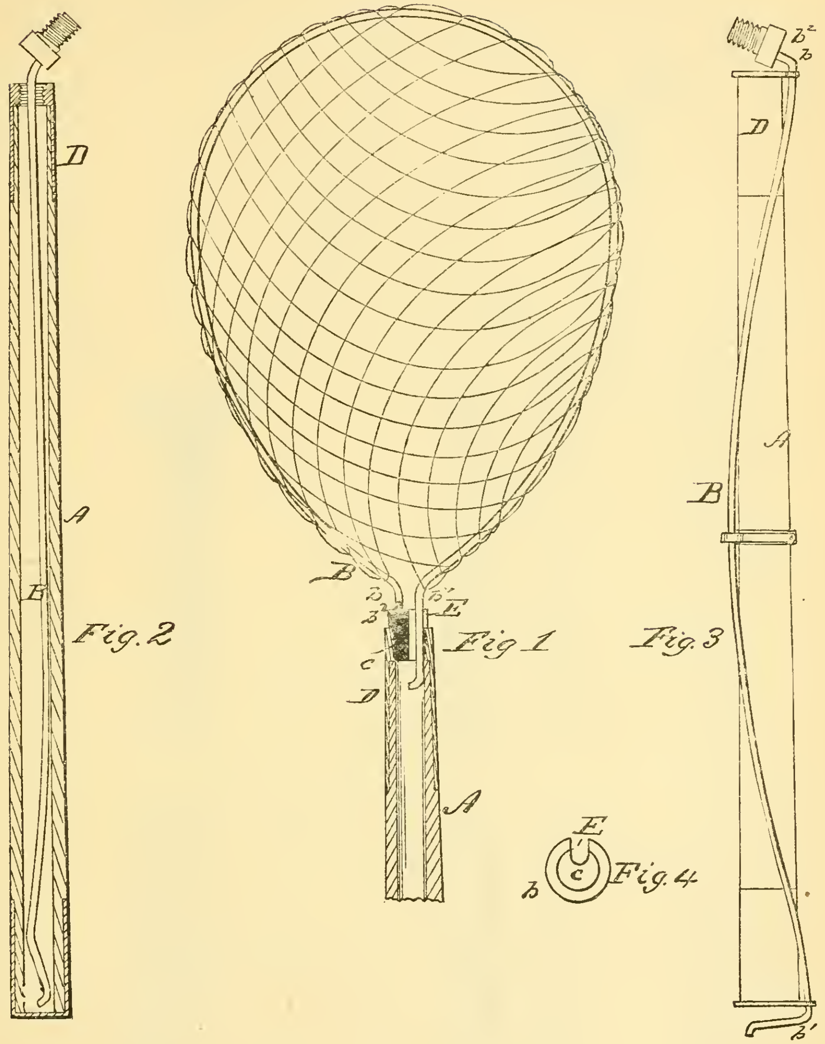
No. 309,028. Fish-line and Hook Guard, by W. W. Byington. See p. [66].



No. 255,671. Gill-net, by M. & T. Reynolds. See p. [66].

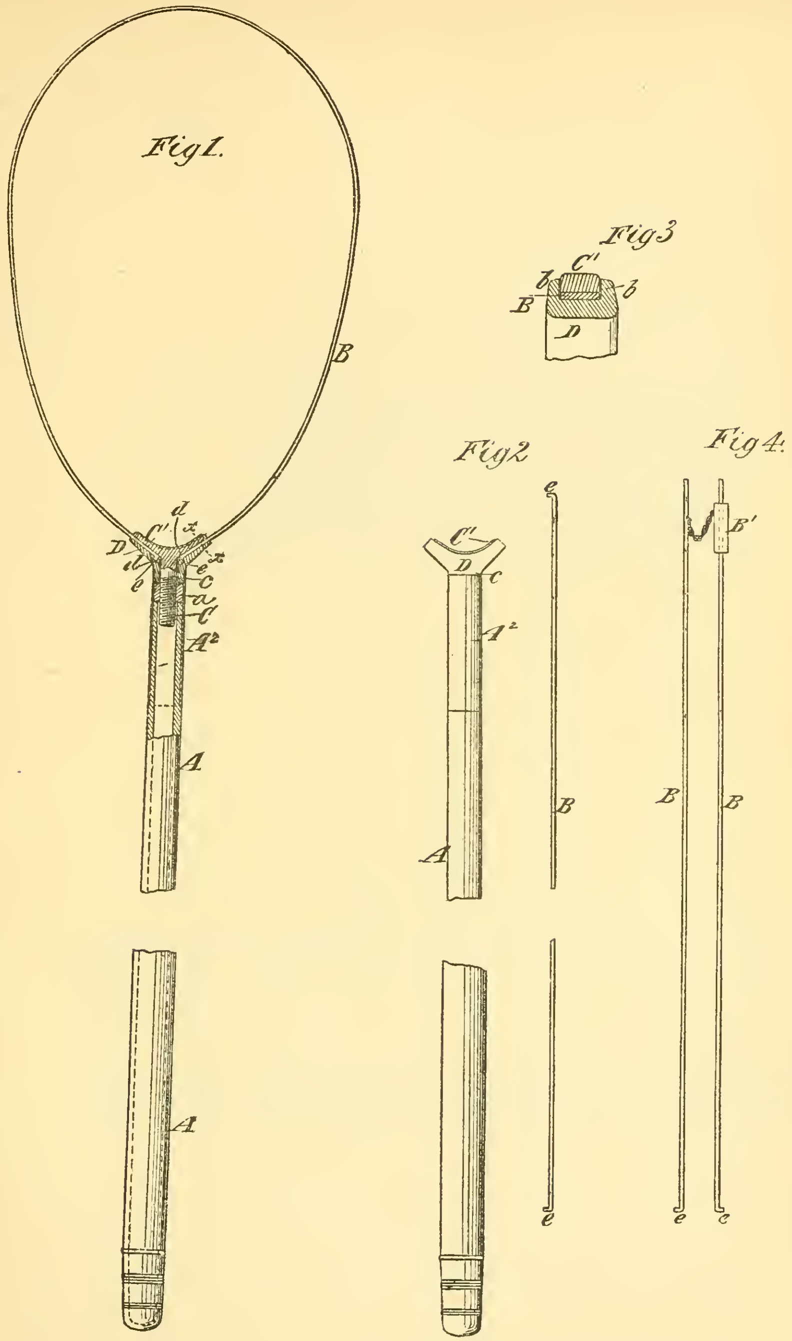


No. 270,641. Fish-net, by J. N. Dodge. See p. [67].



No. 272,305. Landing-net, by O. M. Muncaster. See p. [68].

PLATE LXXXVII.



No. 273,651. Landing-net, by R. J. Welles. See p. [68].

Fig. 1.

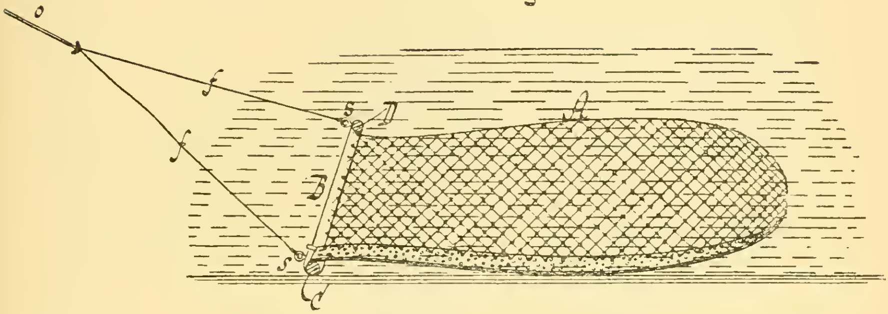
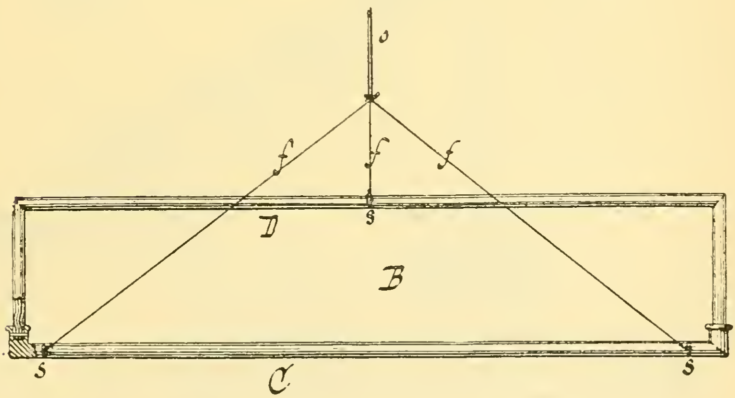


Fig. 2.



No. 255,561. Sponge-fishing Net, by E. Arapian. See p. [69].

Fig: 1.

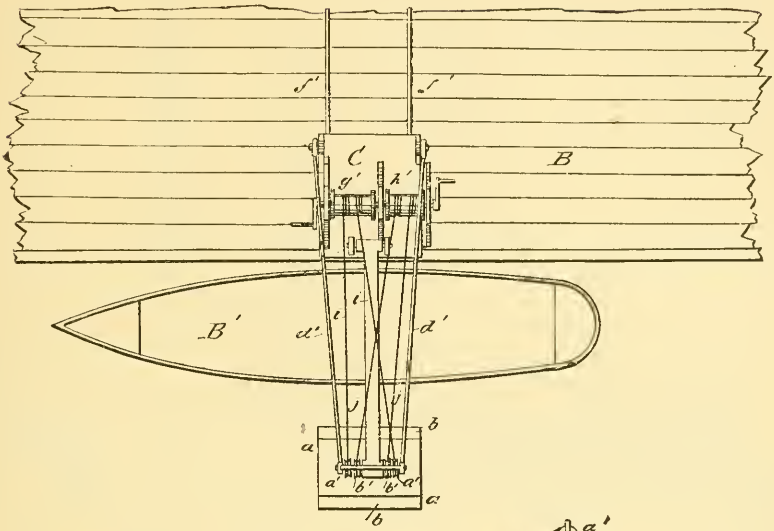
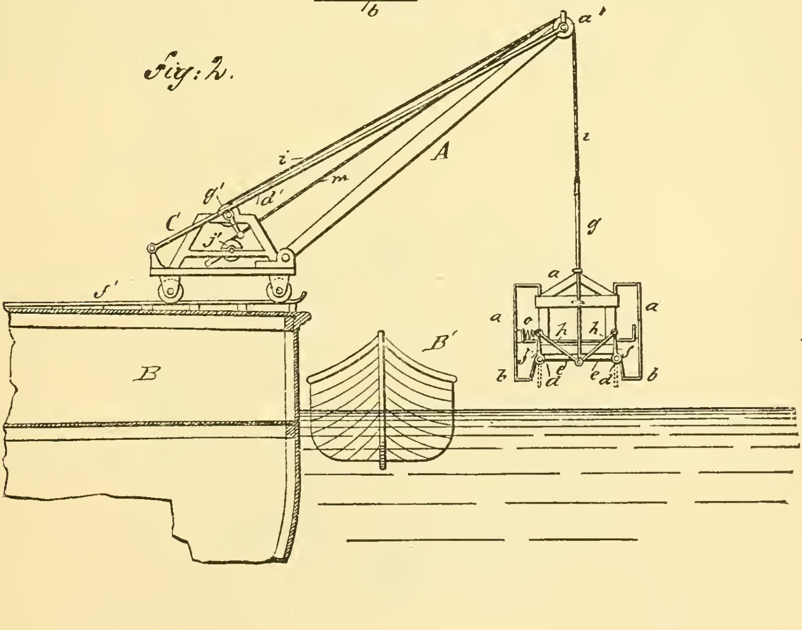
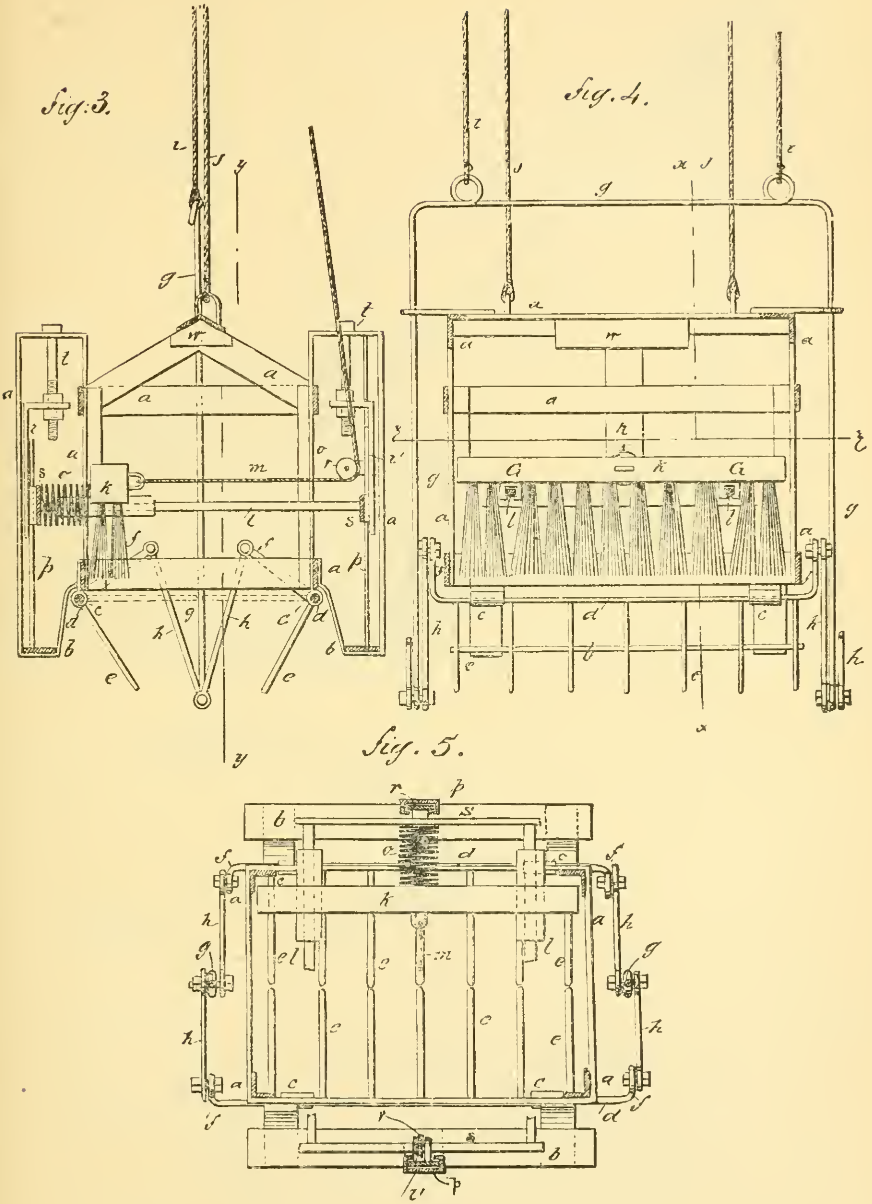


Fig: 2.



No. 279,792. Oyster-dredge, by E. Paterson. See p. [70].



No. 279,792. Oyster-dredge, by E. Paterson. See p. [70].

Fig. 1.

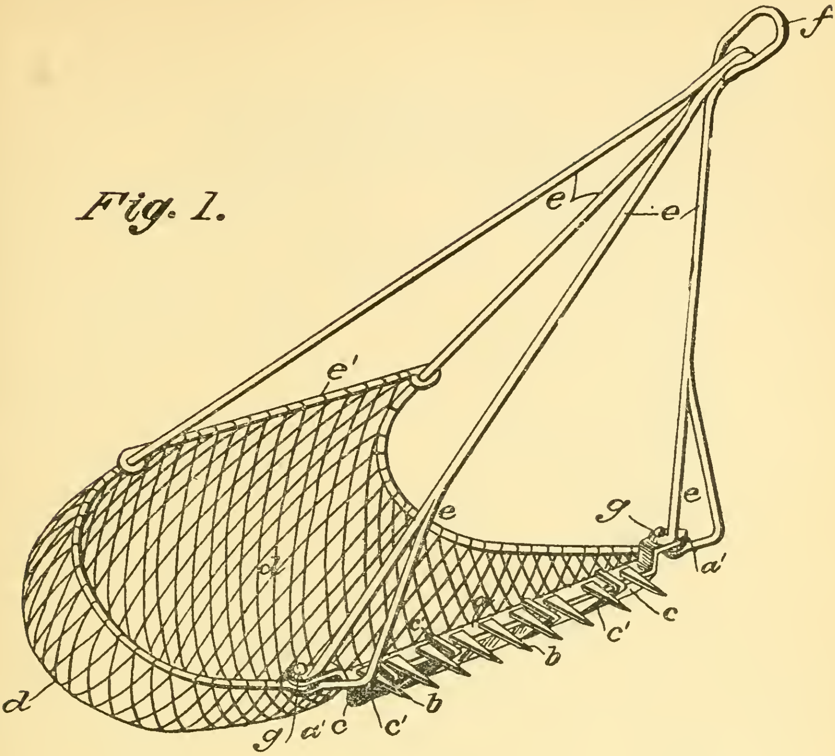


Fig. 2.

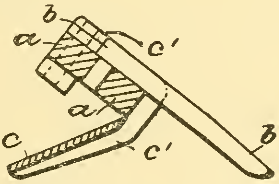
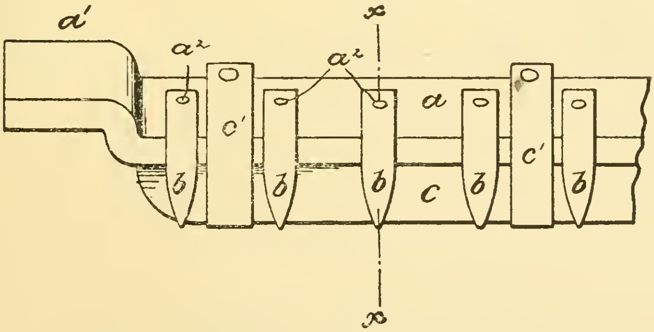


Fig. 3.



No. 284,156. Oyster-dredge, by J. N. Woodruff. See p. [72].

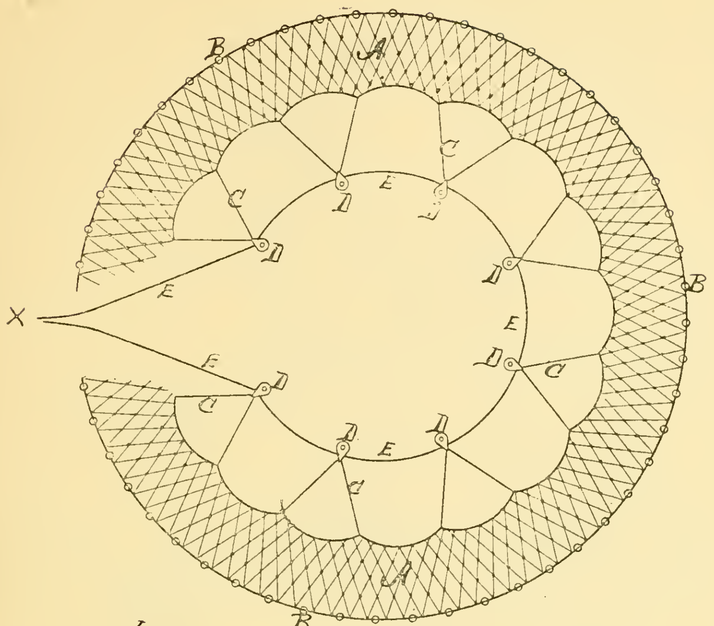


Fig. 1.

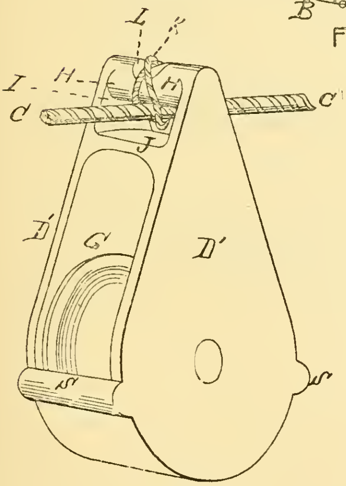


Fig. 2.

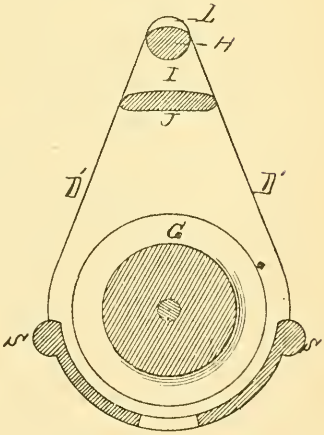
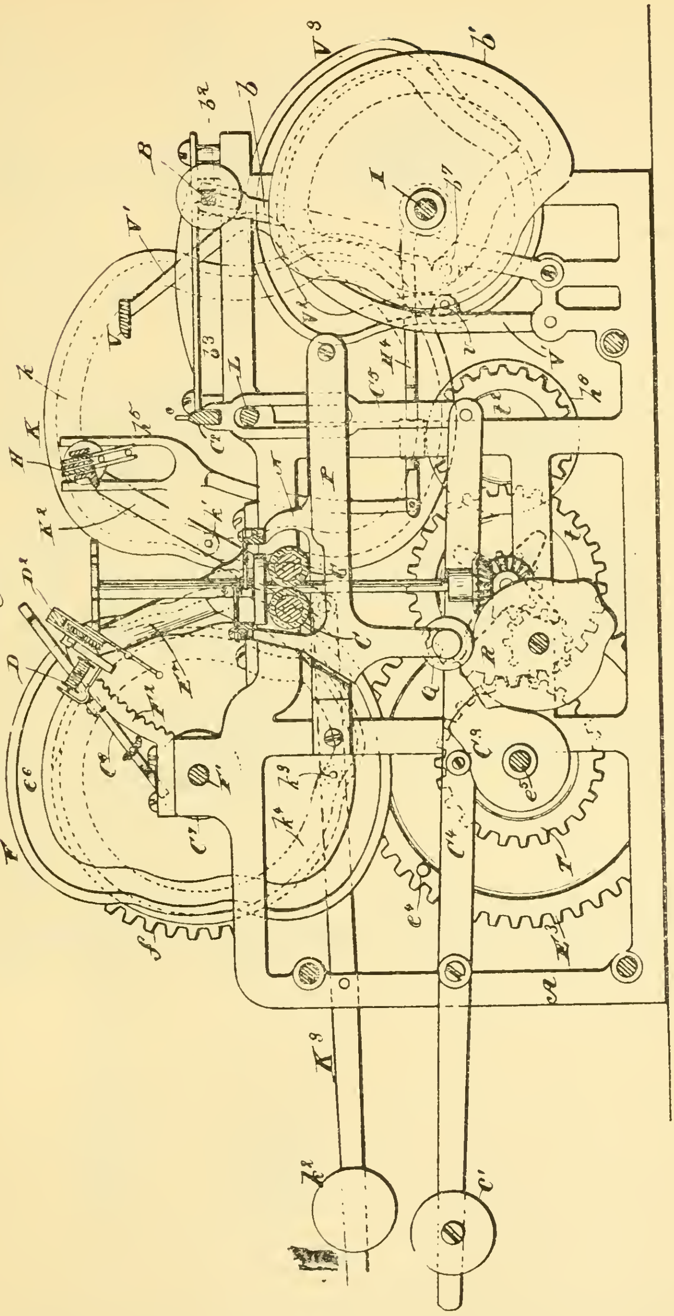


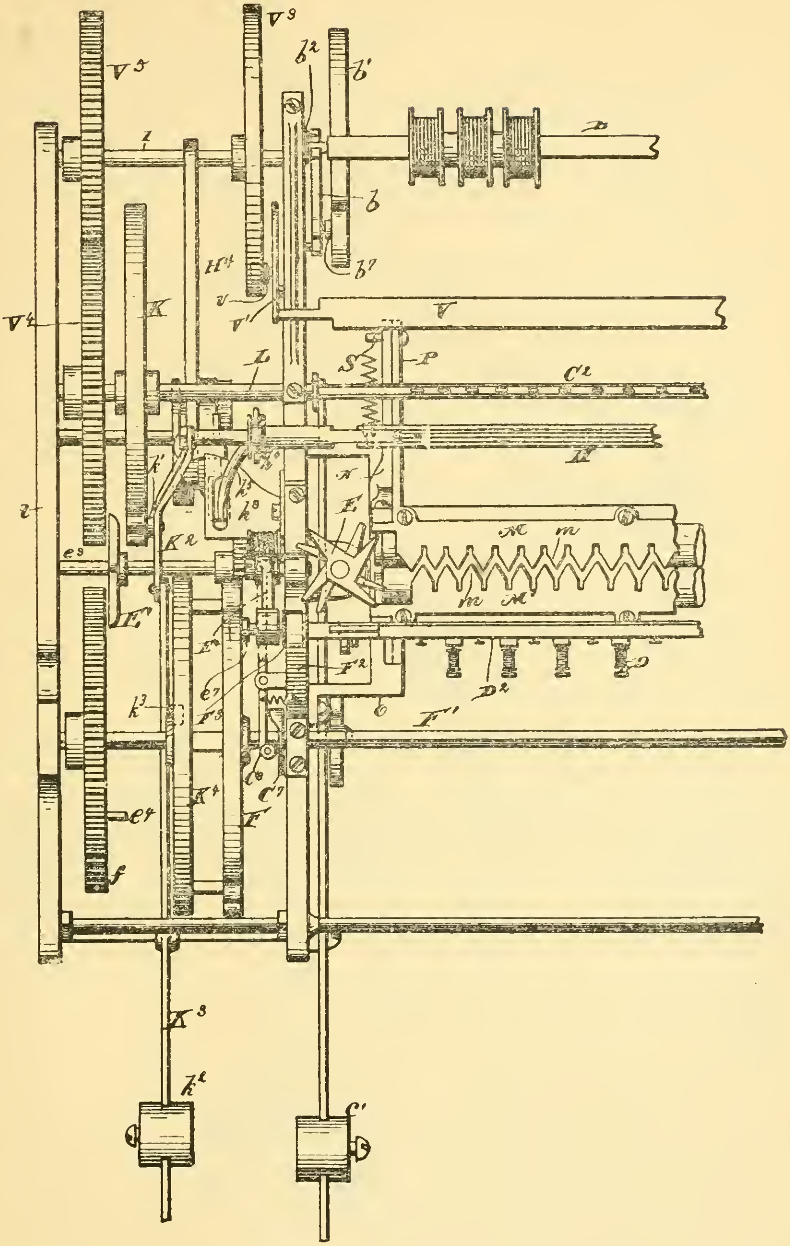
Fig. 3.

No. 288,650. Purse-block for Seines, by G. Merchant, jr. See p. [72].

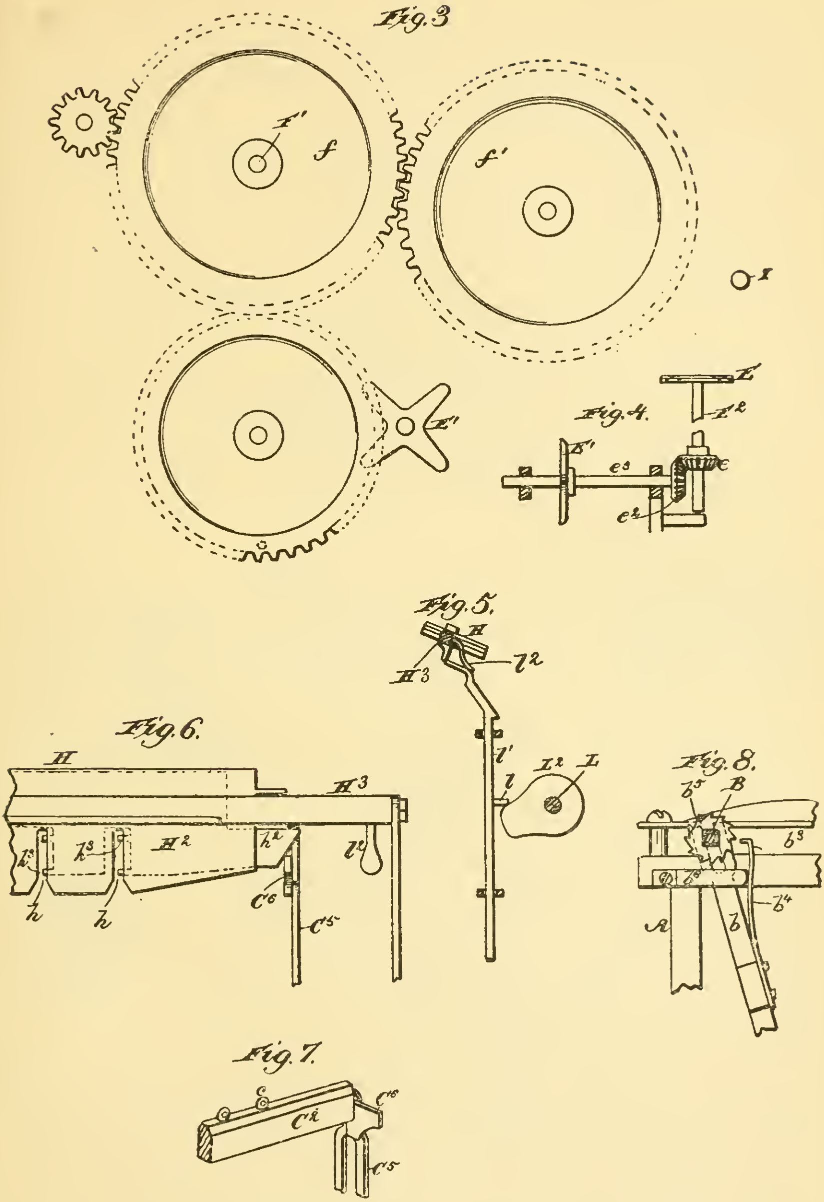
Fig. 1.



No. 256,287. Machine for Making Fish-nets, by J. Chaunier. See p. [73].



No. 256,287. Machine for Making Fish-nets, by J. Chaunier. See p. [73].



No. 256,287. Machine for Making Fish-nets, by J. Chaunier. See p. [73].

Fig. 9.

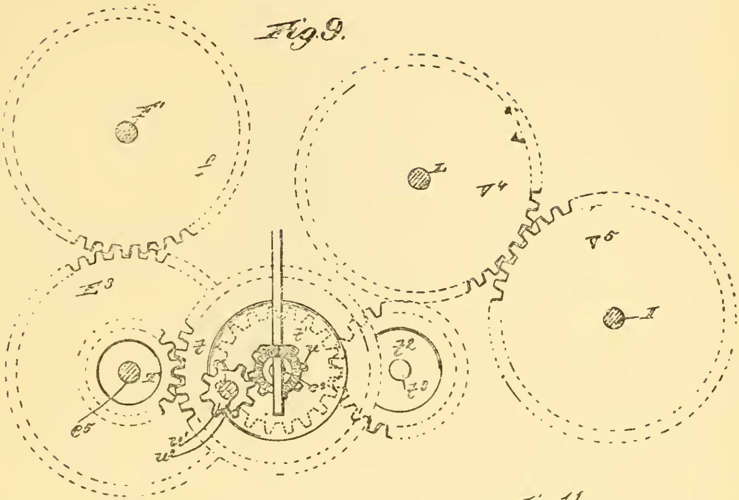


Fig. 10

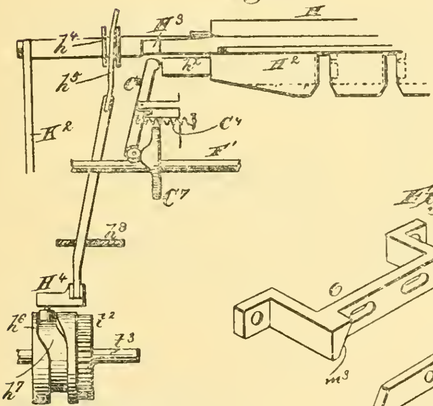


Fig. 11.

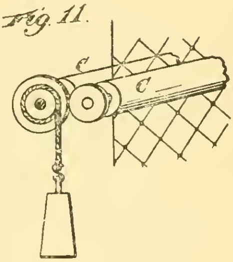
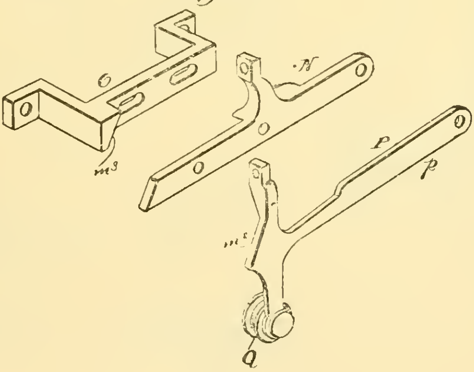
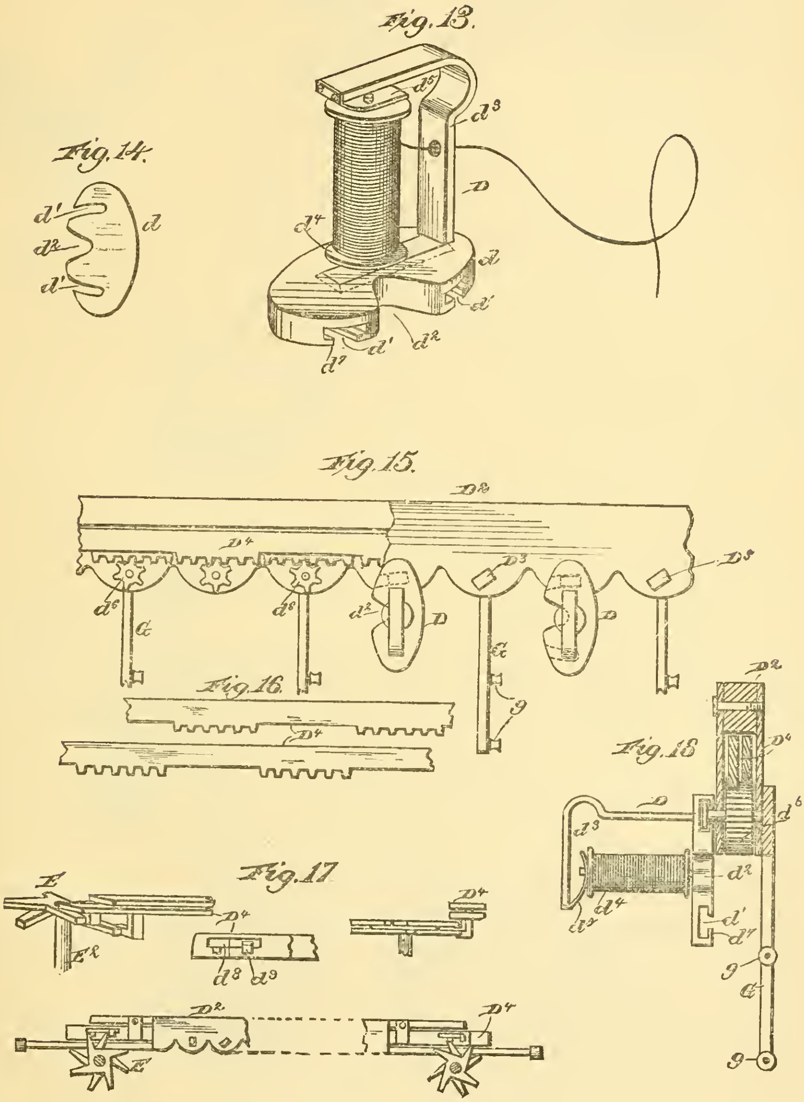


Fig. 12.



No. 256,287 Machine for Making Fish-nets, by J. Channier. See p. [73].



No. 256,287. Machine for Making Fish-nets, by J. Chaunier. See p. [73].

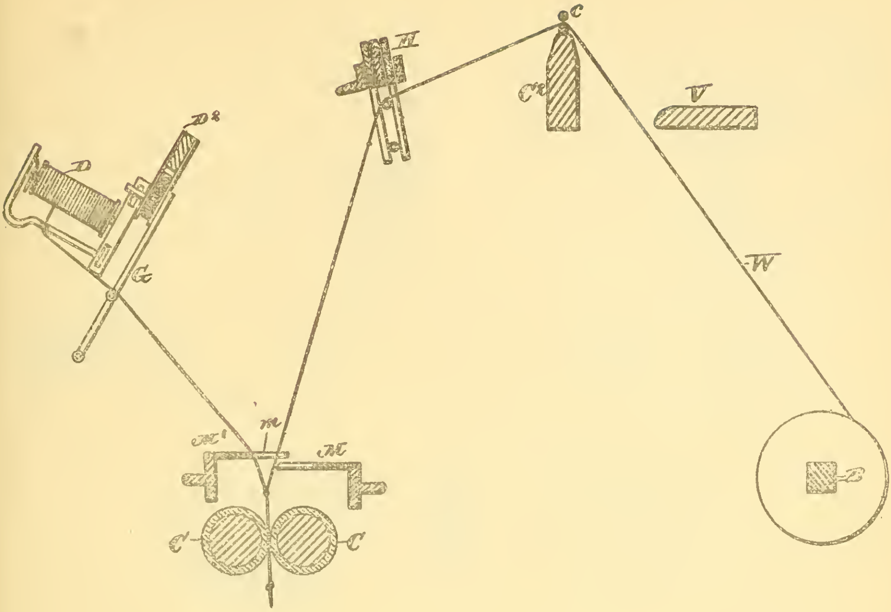
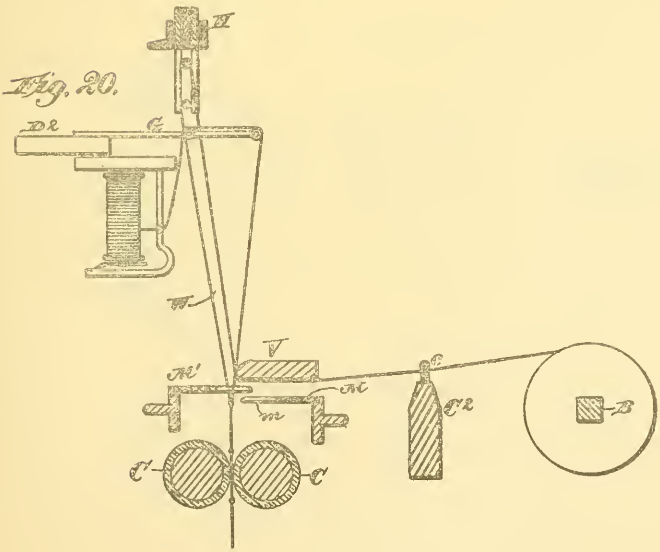
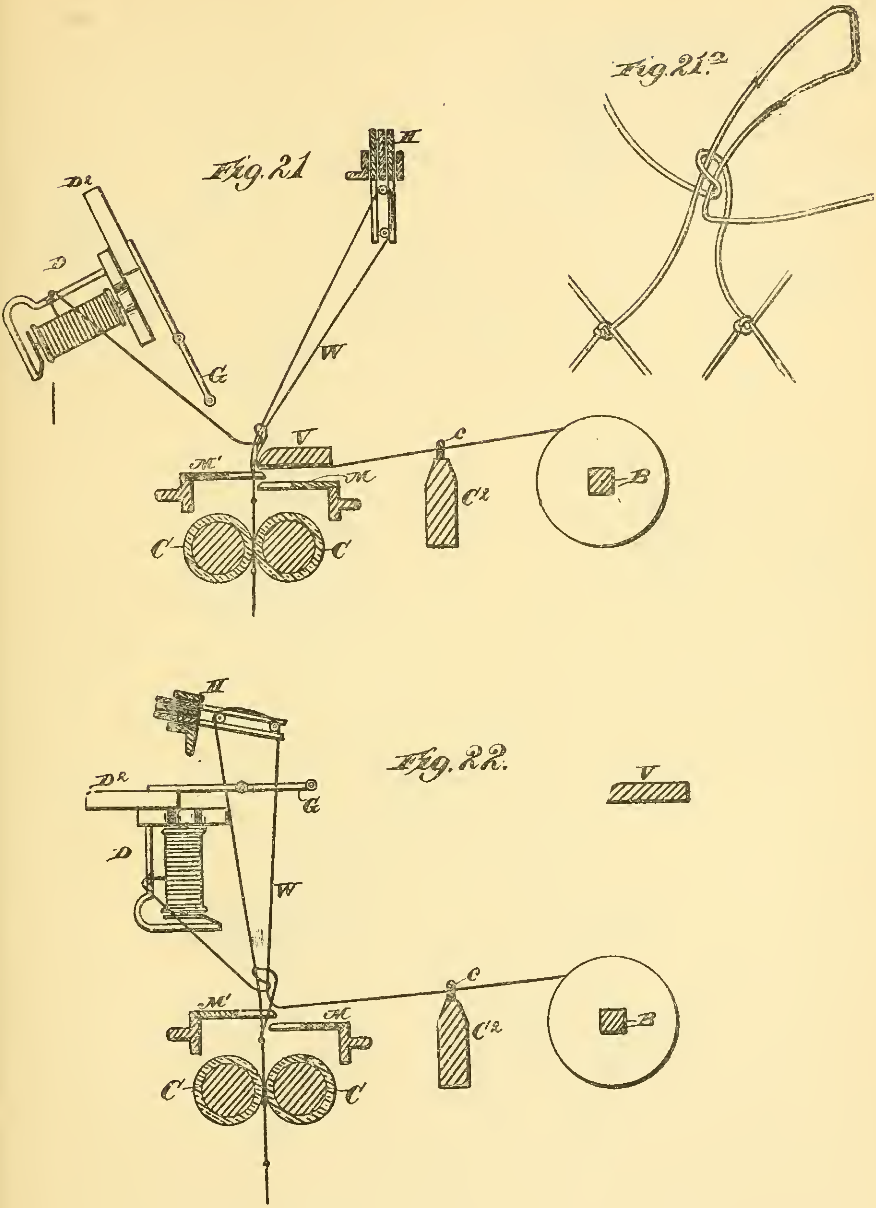


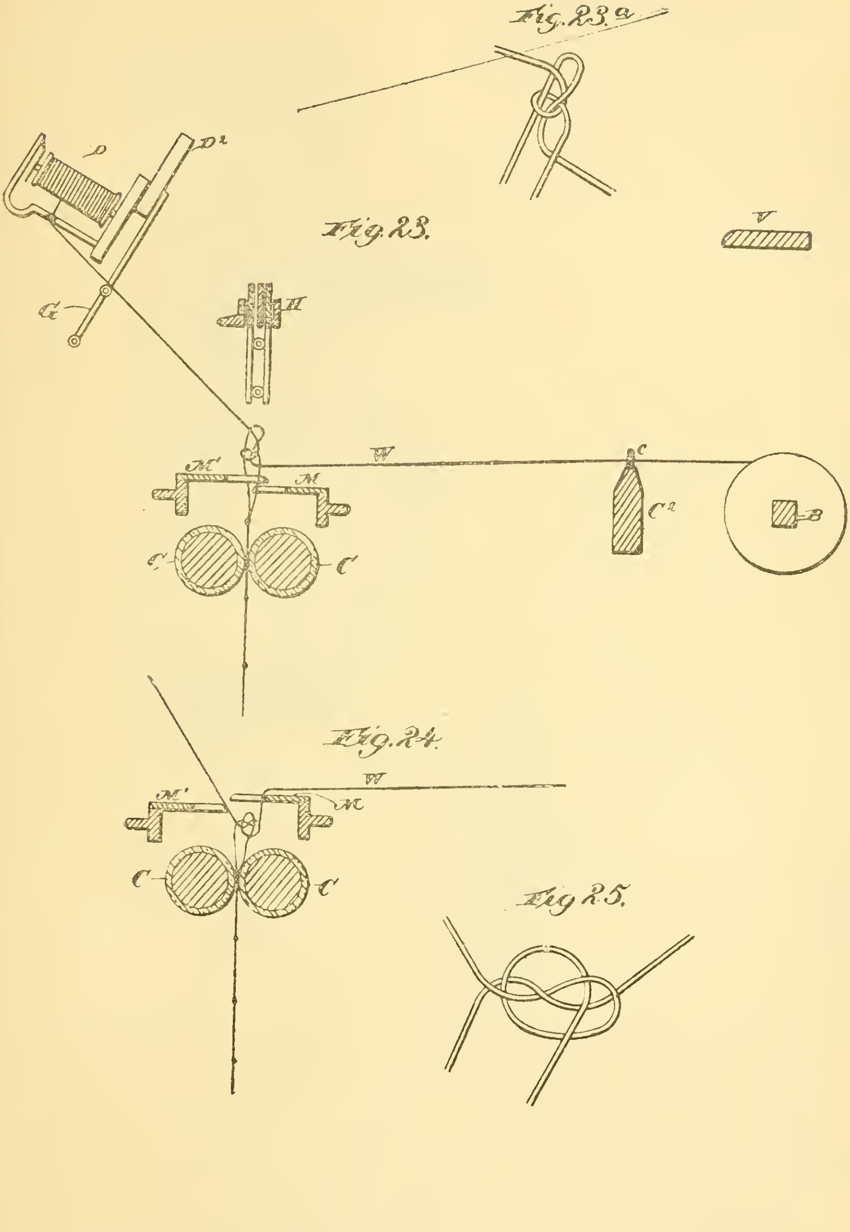
Fig. 20.



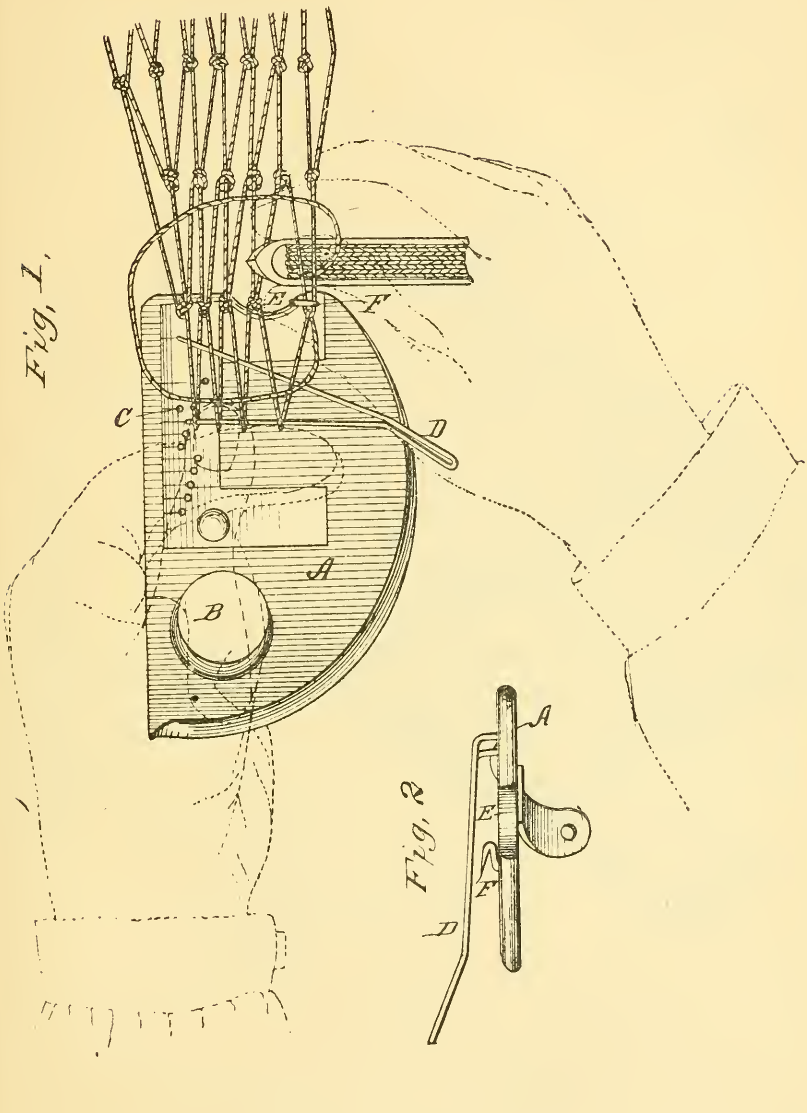
No. 256,287. Machine for Making Fish-nets, by J. Chaunier. See p. [73].



No. 256,287. Machine for Making Fish-nets, by J. Chaunier. See p. [73].

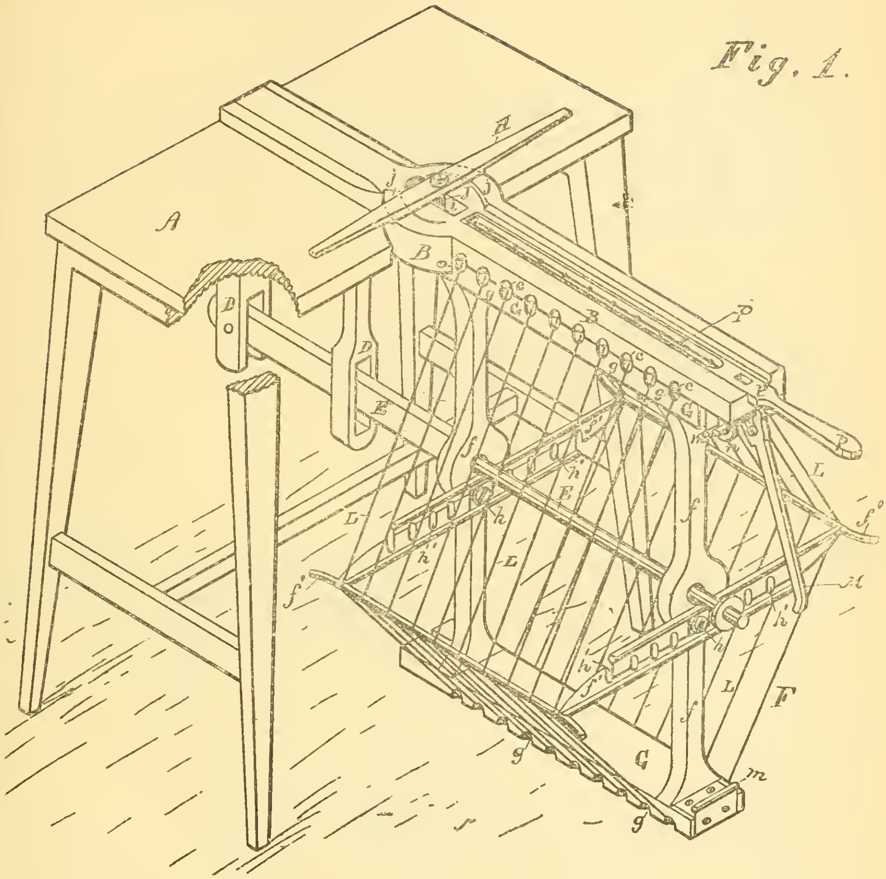


No. 256,287. Machine for Making Fish-nets, by J. Chaunier. See p. [73].



No. 262,140. Knitting-board for Manufacturing Nets, by N. D. Sollers. See p. [77].

Fig. 1.



No. 295,262. Machine for Casting Leads on Fish-net Lines, by E. Manula. See p. [79].

Fig. 2.

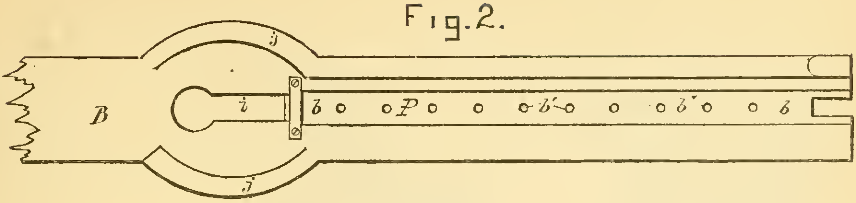


Fig. 3.

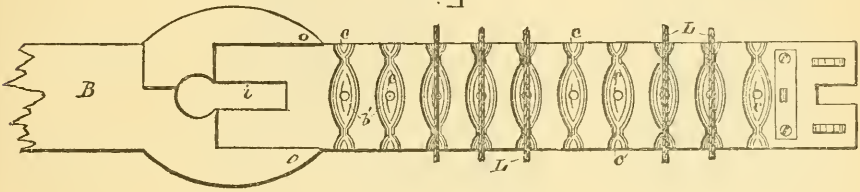


Fig. 4.

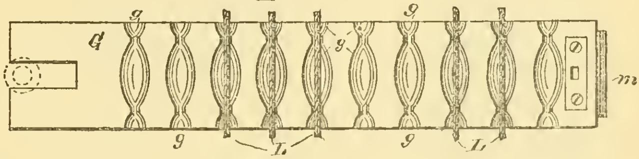
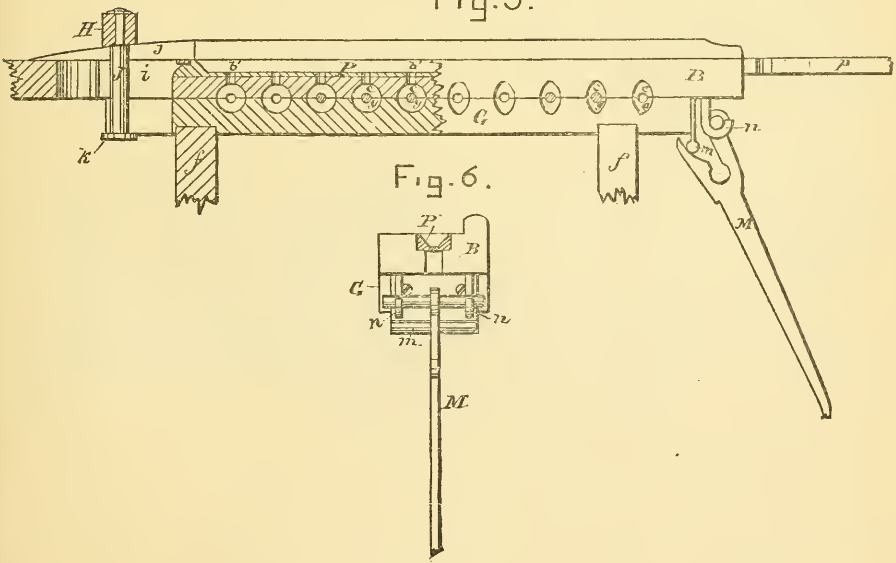
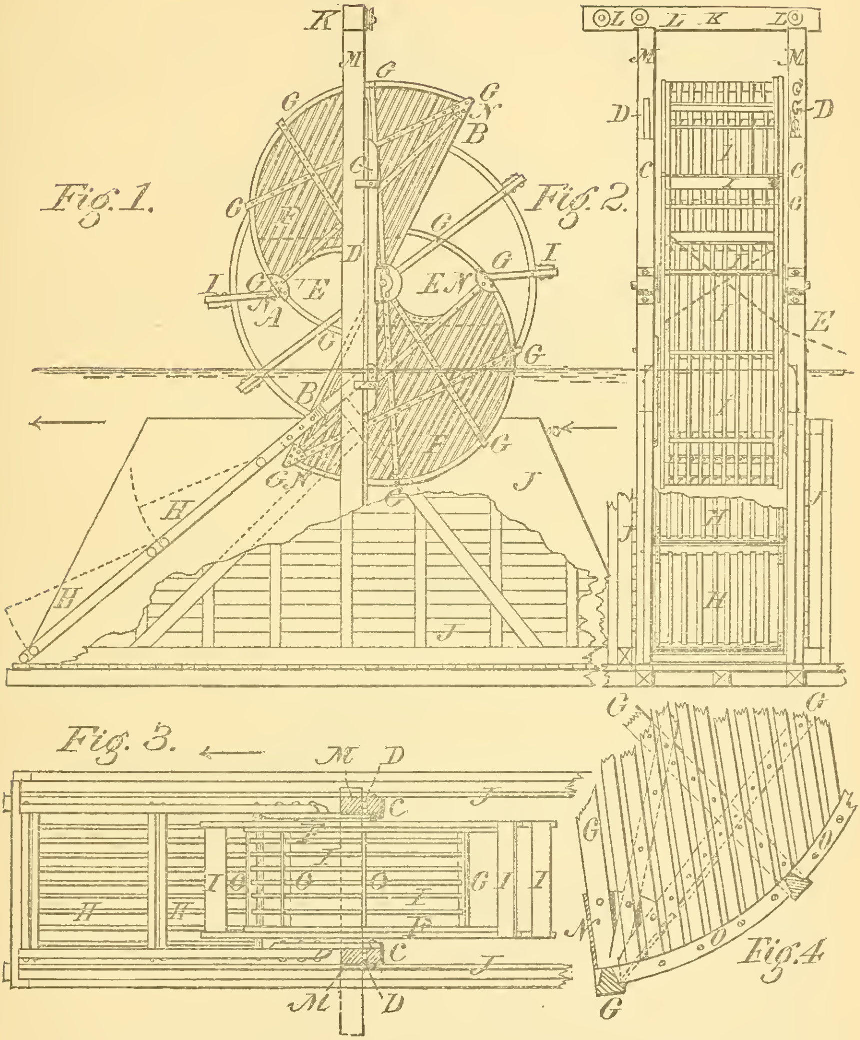


Fig. 5.



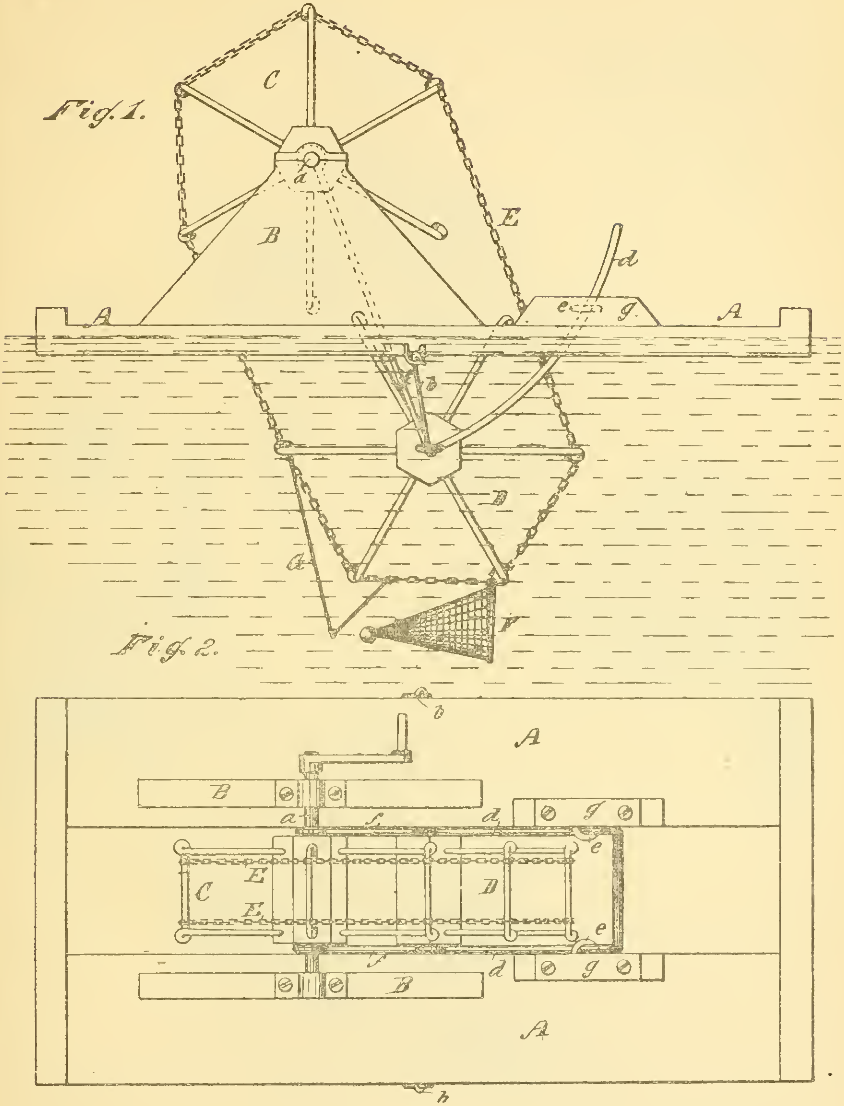
No. 295,262. Machine for Casting Leads on Fish-net Lines, by E. Manula. See p. [79].



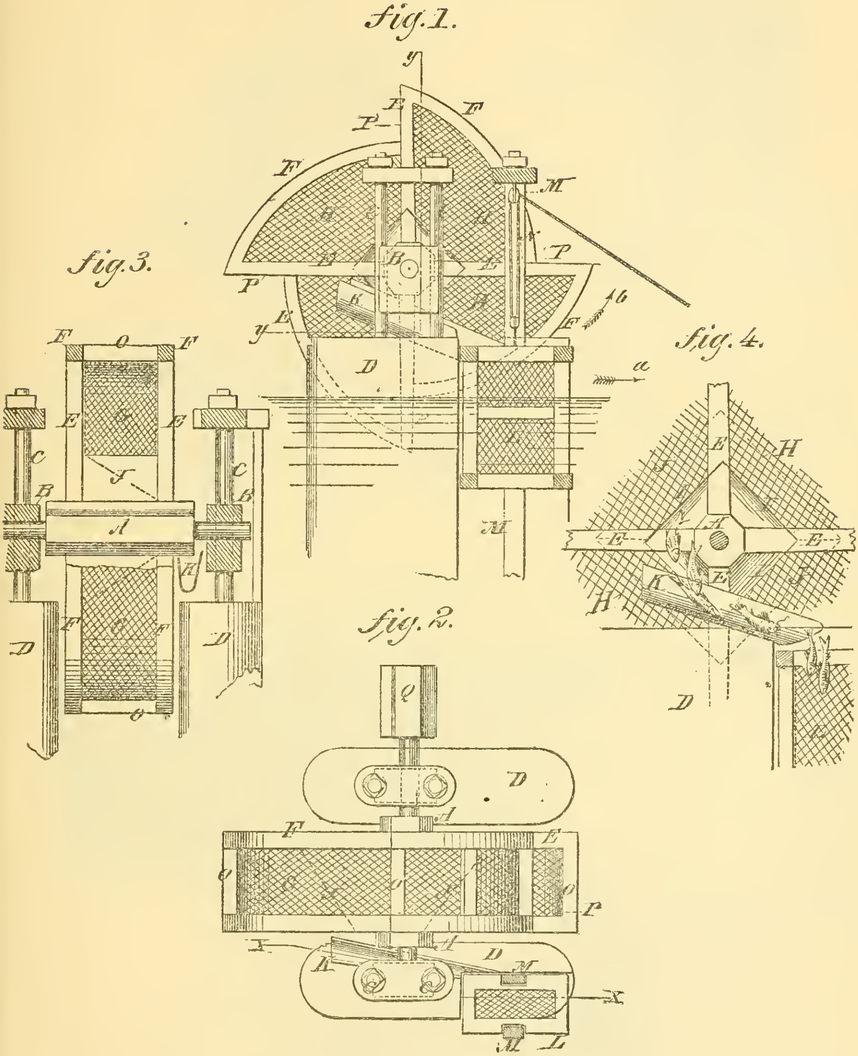
No. 257,960. Fish-wheel, by W. R. McCord. See p. [80].

Fig. 1.

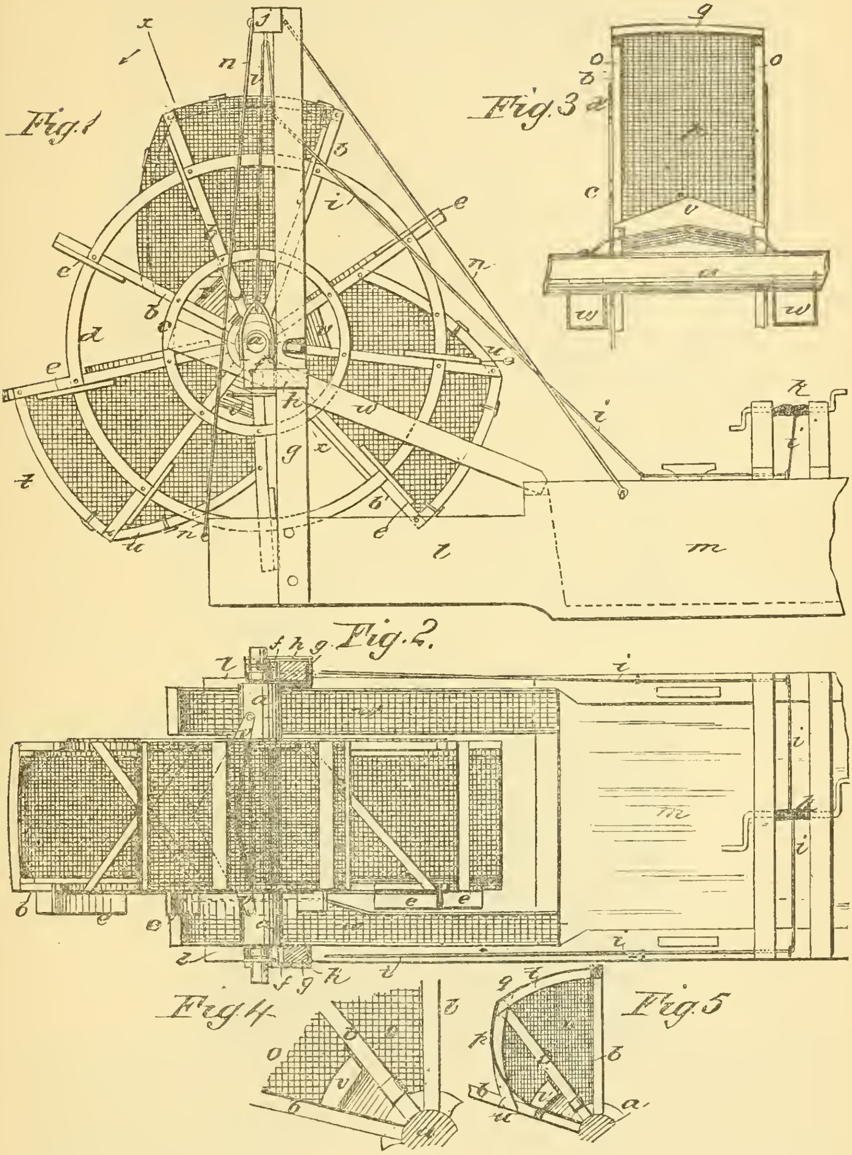
Fig. 2.



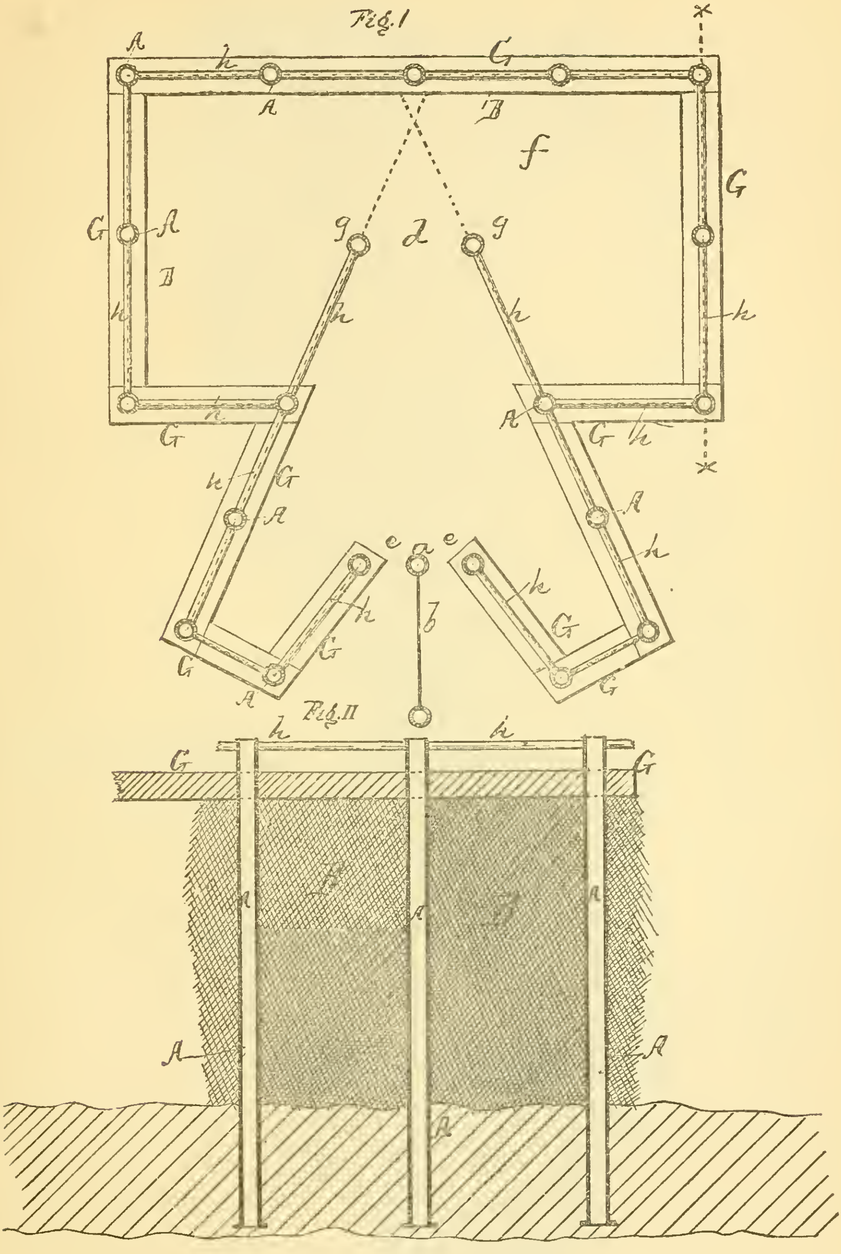
No. 259,143. Mechanical Device for Catching Fish, by T. Heaton. See p. [82].



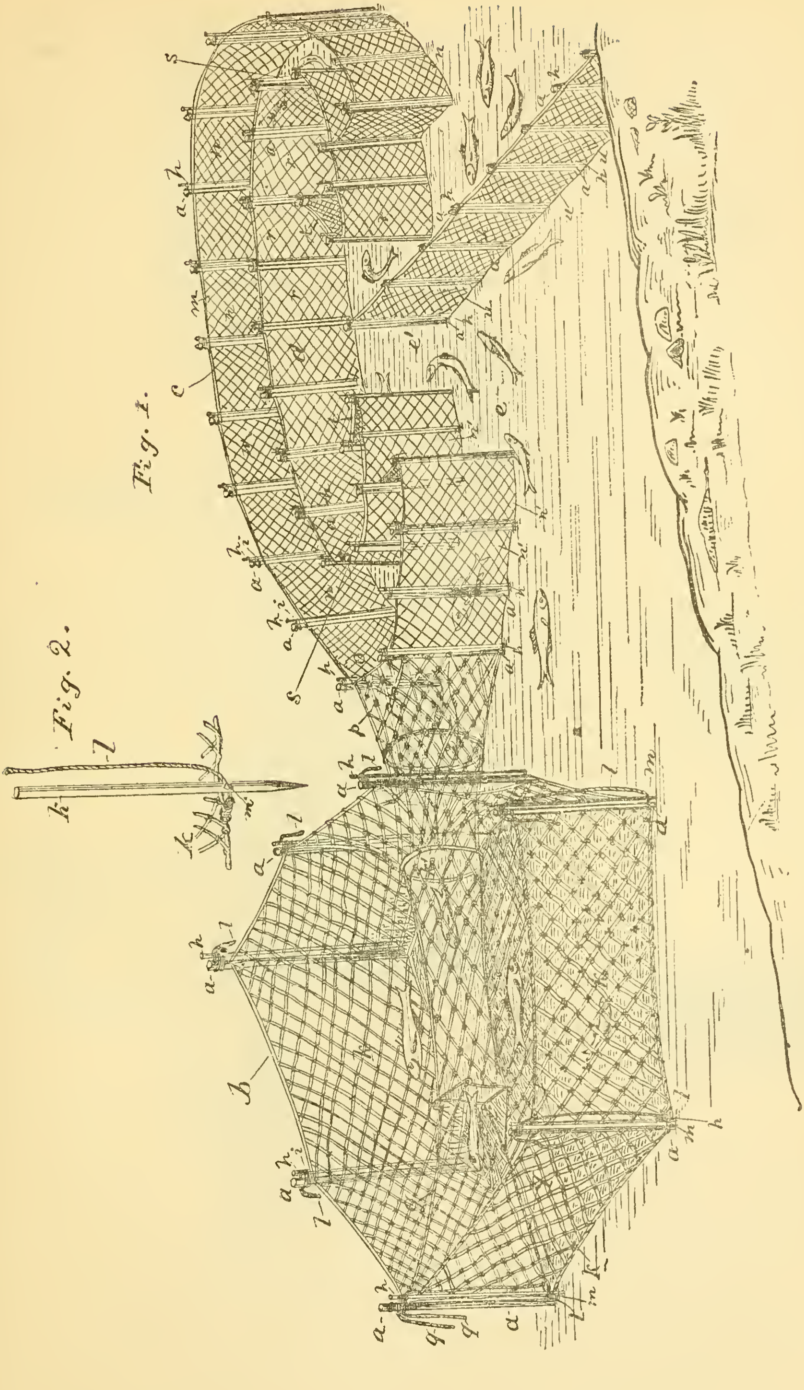
No. 264,395. Fishing-wheel, by S. Wilson. See p. [82].



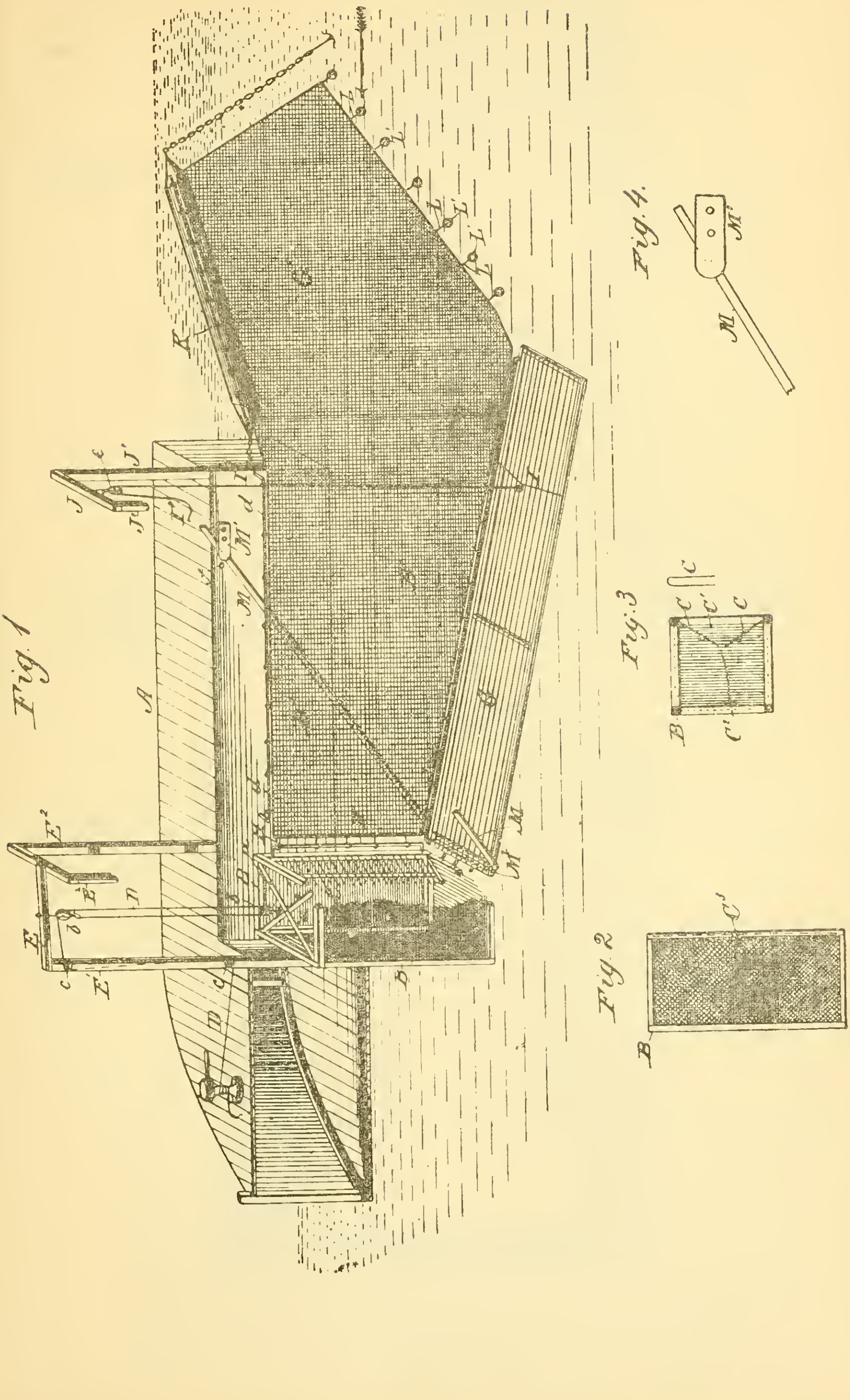
No. 301,653. Fishing-machine, by T. F. Williams. See p. [83].



No. 252,466. Fish-trap, by A. N. Hoxie and E. Collins. See p. [84].



No. 254,989. Fish-trap, by M. B. Marshall. See p. [84].



No. 270,411. Fish-trap, by J. M. Frazer. See p. [85].

Fig. 1.

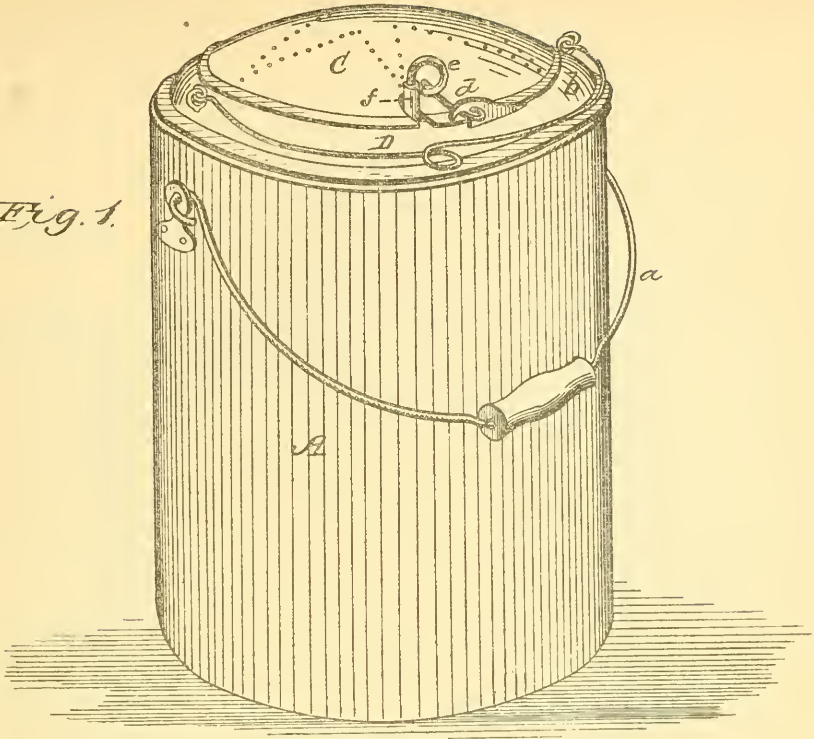
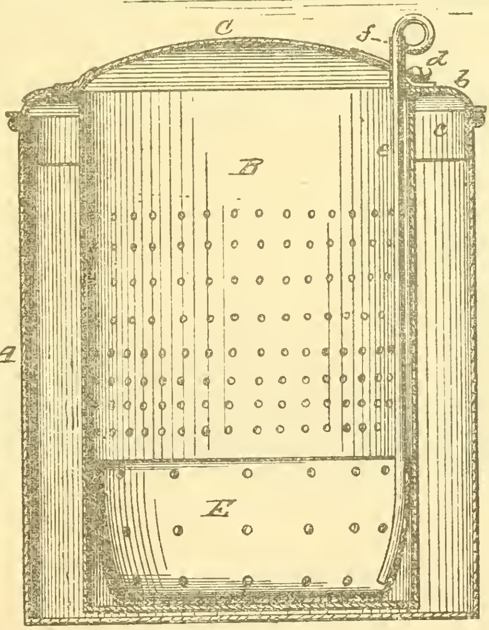
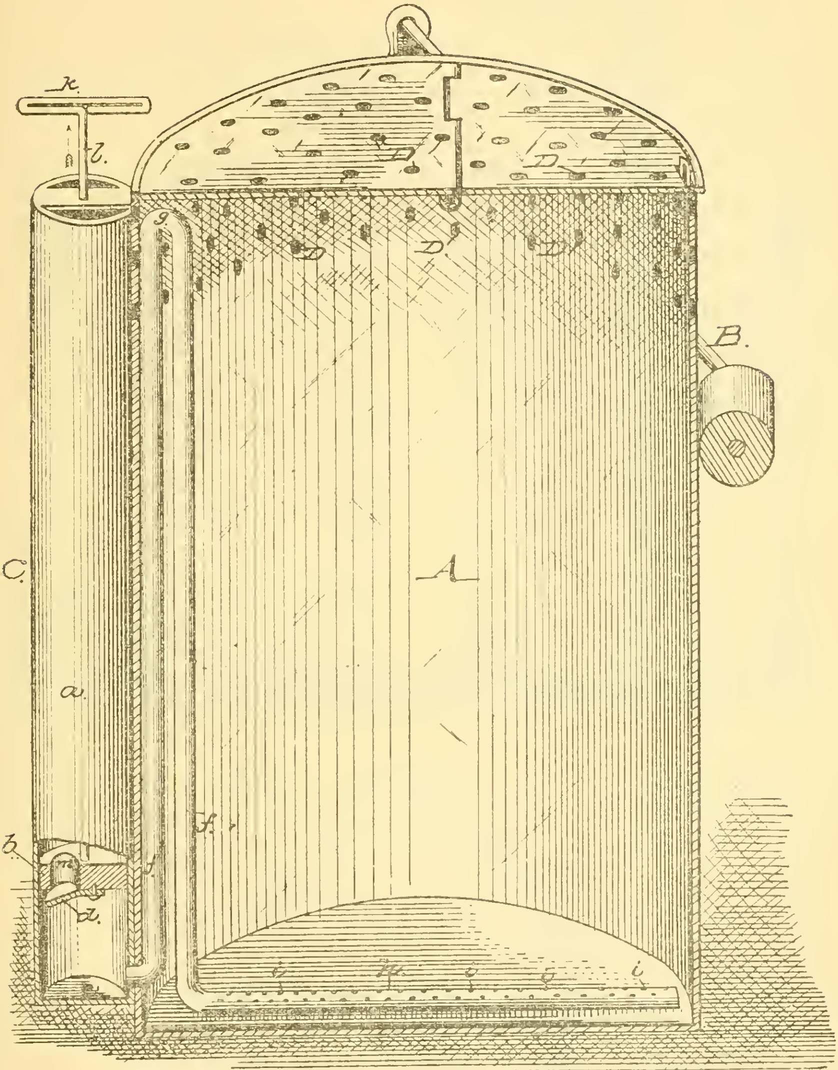


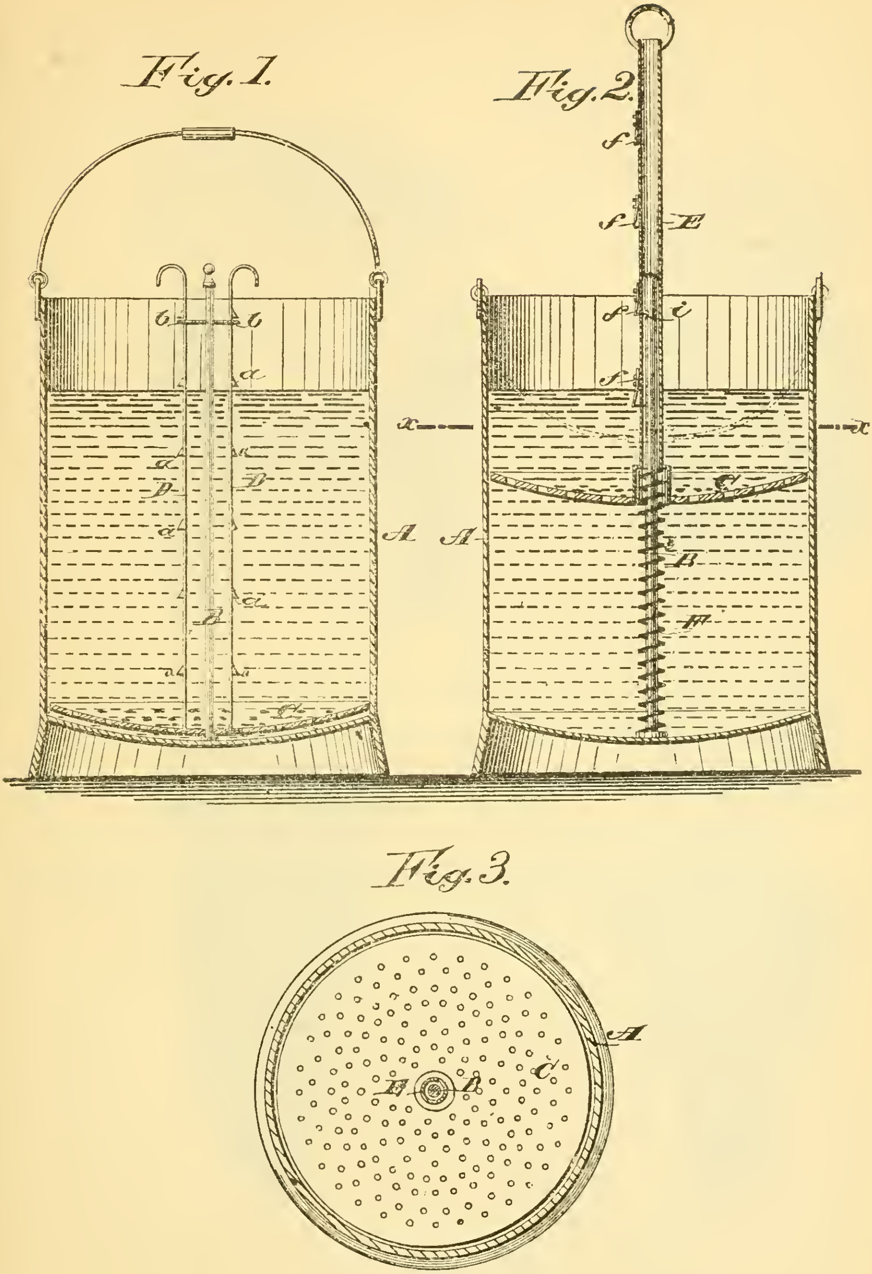
Fig. 2



No. 299,690. Fishing-bait Kettle, by W. H. Sherwood. See p. [88].



No. 299,765. Bait-fish Can, by R. K. Evans. See p. [88].



No. 302,086. Fisherman's Minnow-bucket, by G. W. Barton. See p. [89].

FIG. 1.

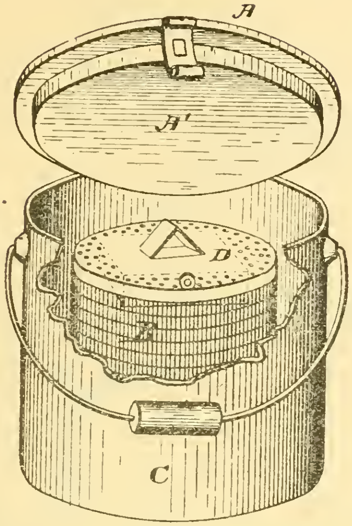


FIG. 2.

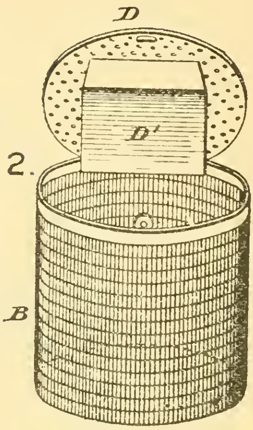


FIG. 4.

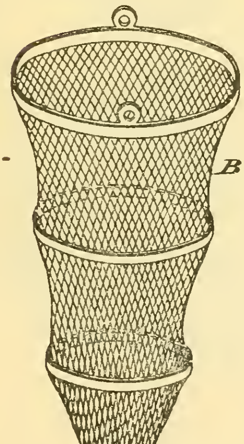
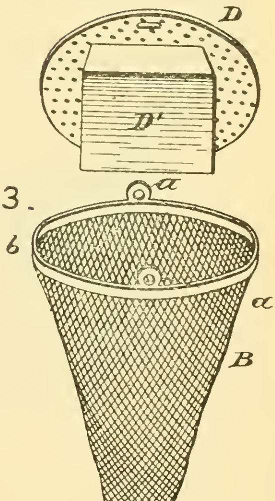
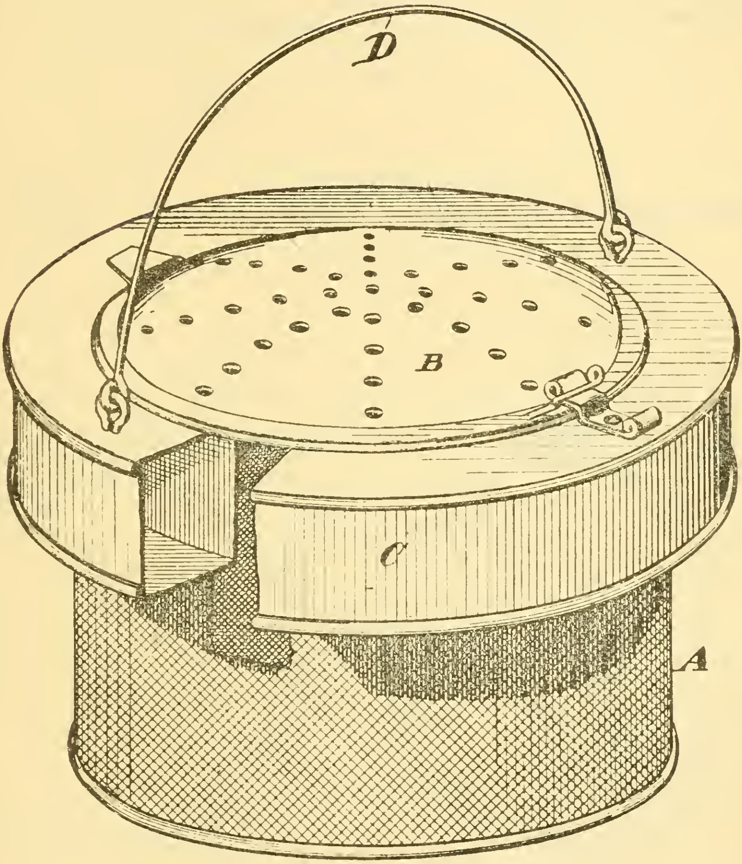


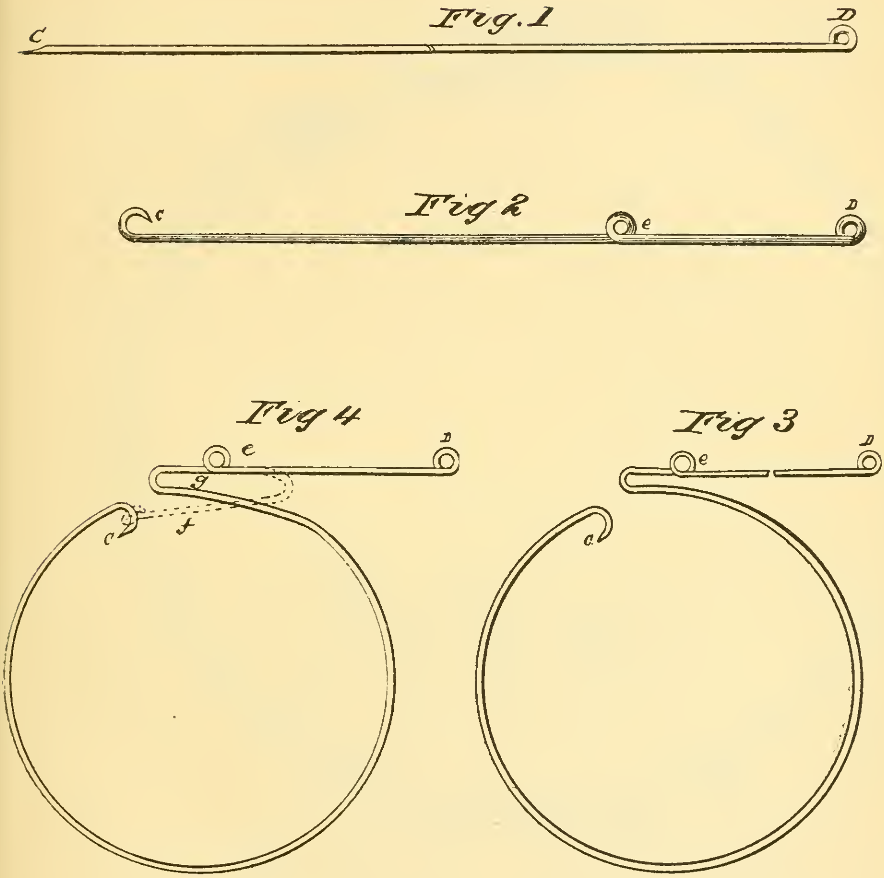
FIG. 3.



No. 302,161. Minnow-bucket, by T. W. Rudolph. See p. [89].

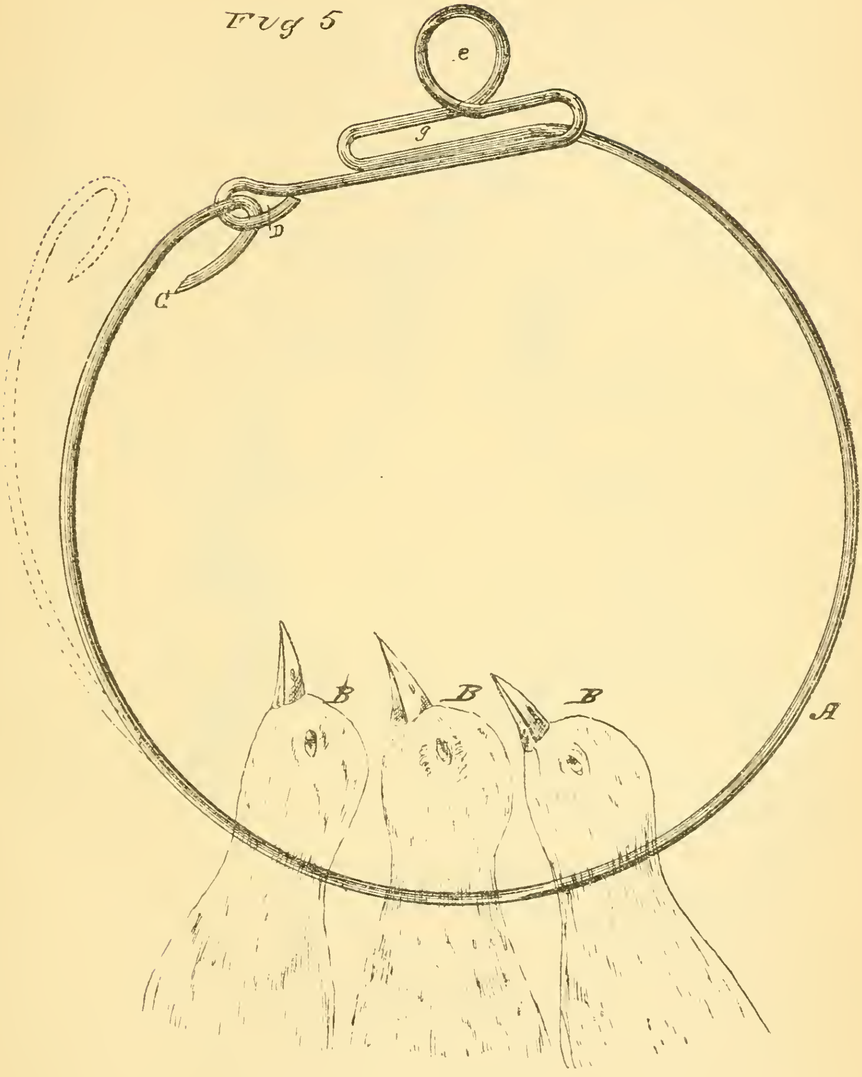


No. 307,375. Minnow-bucket, by C. F. Busche. See p. [90].

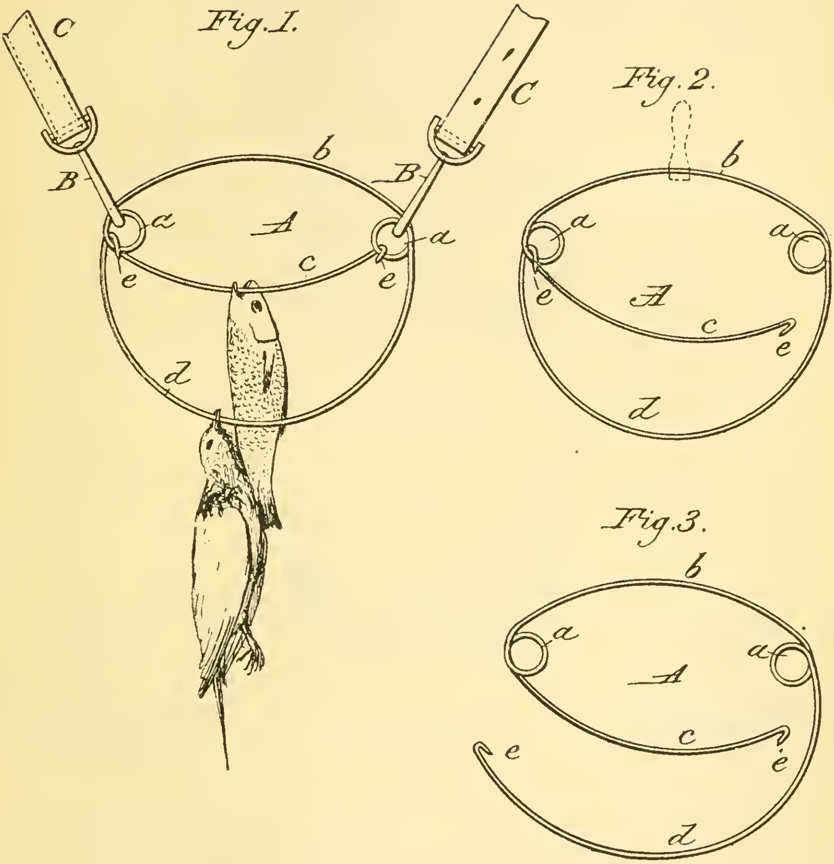


No. 253,501. Sportsman's Game-ring, by E. Bourne. See p. [90].

Fig 5



No. 253,501. Sportsman's Game-ring, by E. Bourne. See p. [90].



No. 276,945. Game-carrier, by A. White. See p. [91].

Fig 1.

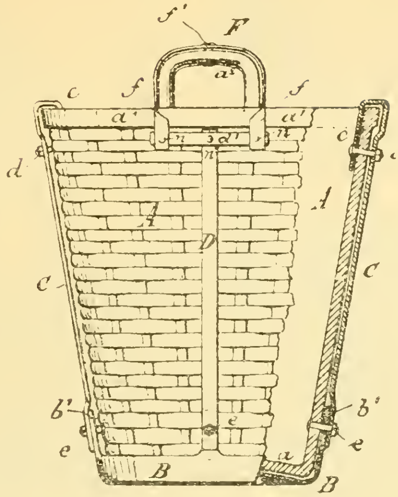


Fig 2.

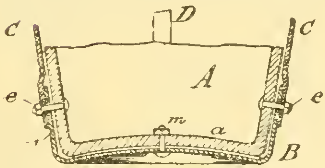


Fig 4

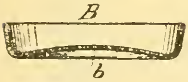


Fig 5.

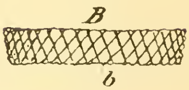
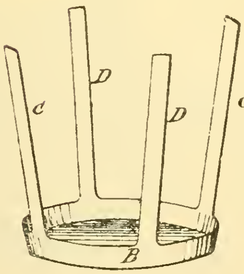


Fig 3.



No. 278,856. Basket, by W. F. Benedict. See p. [91].

Fig. 1.

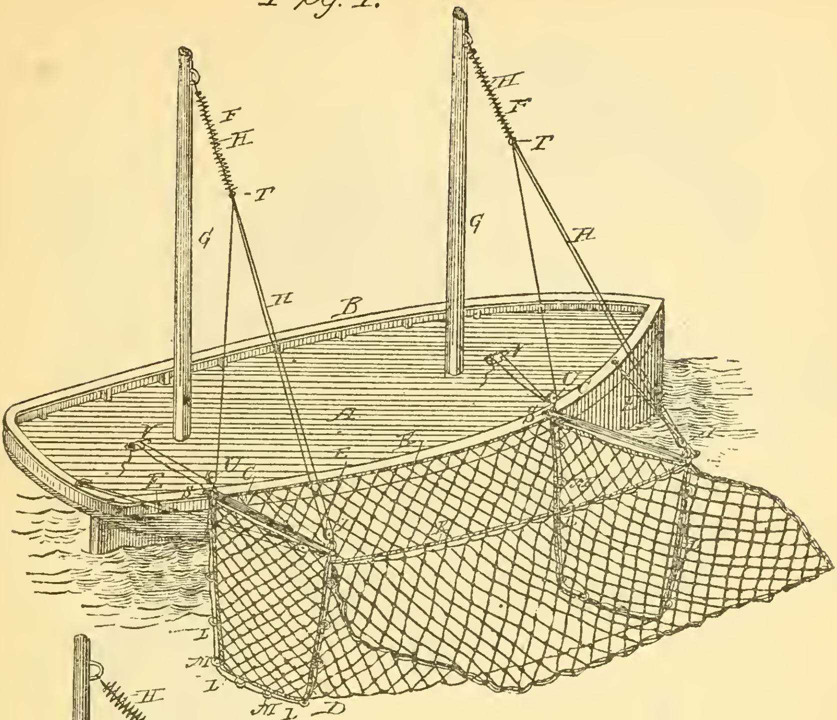
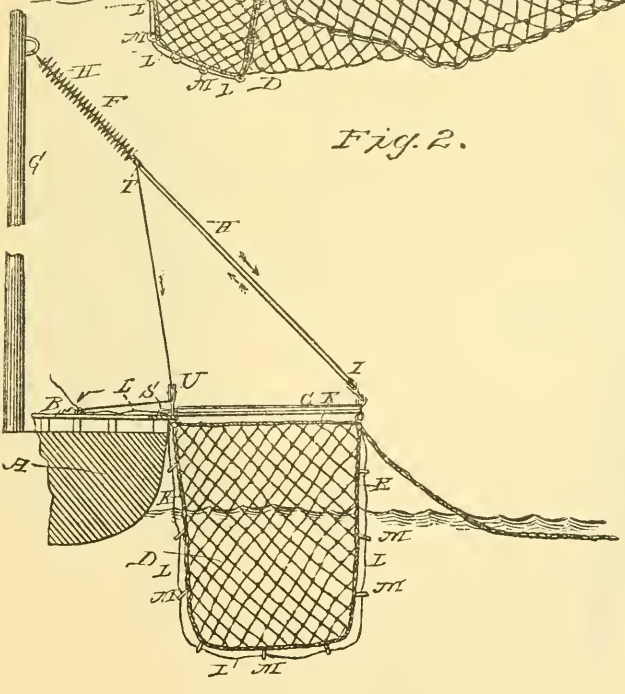
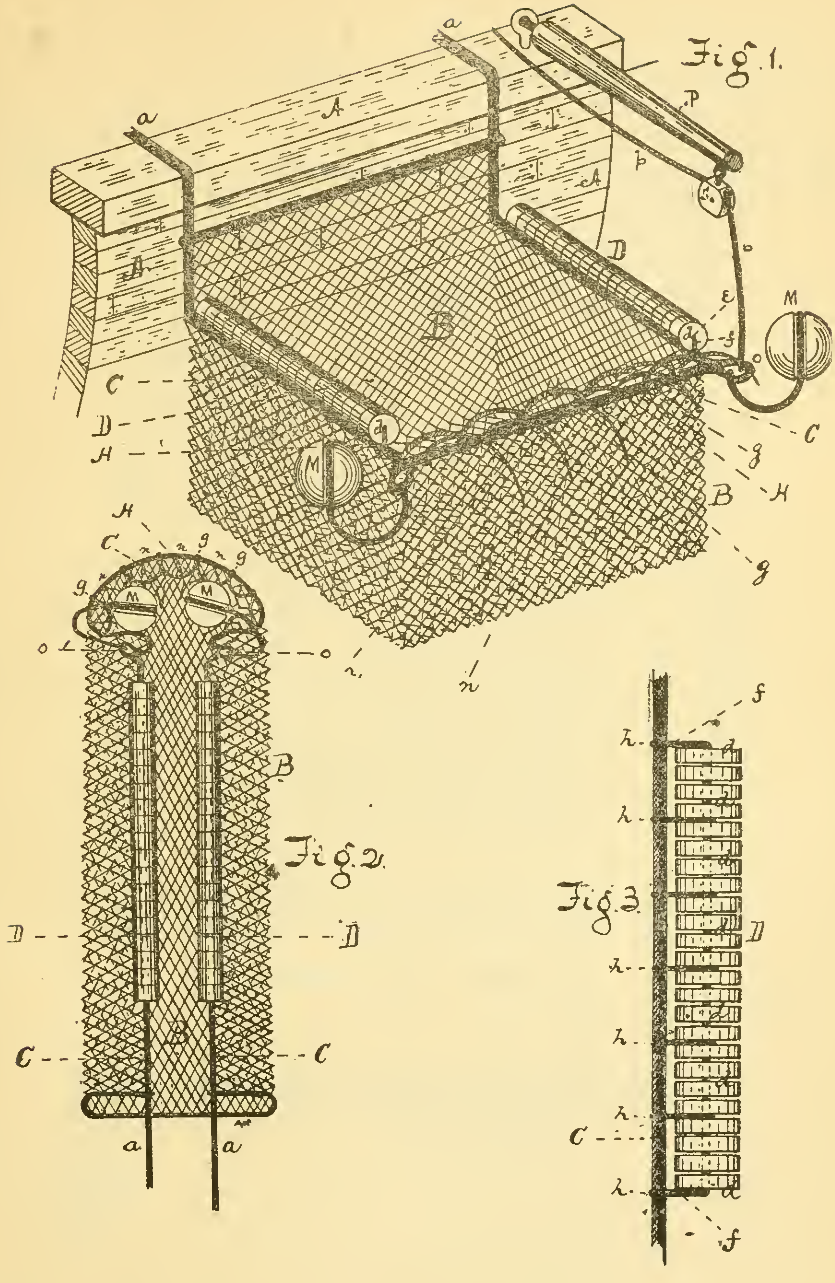


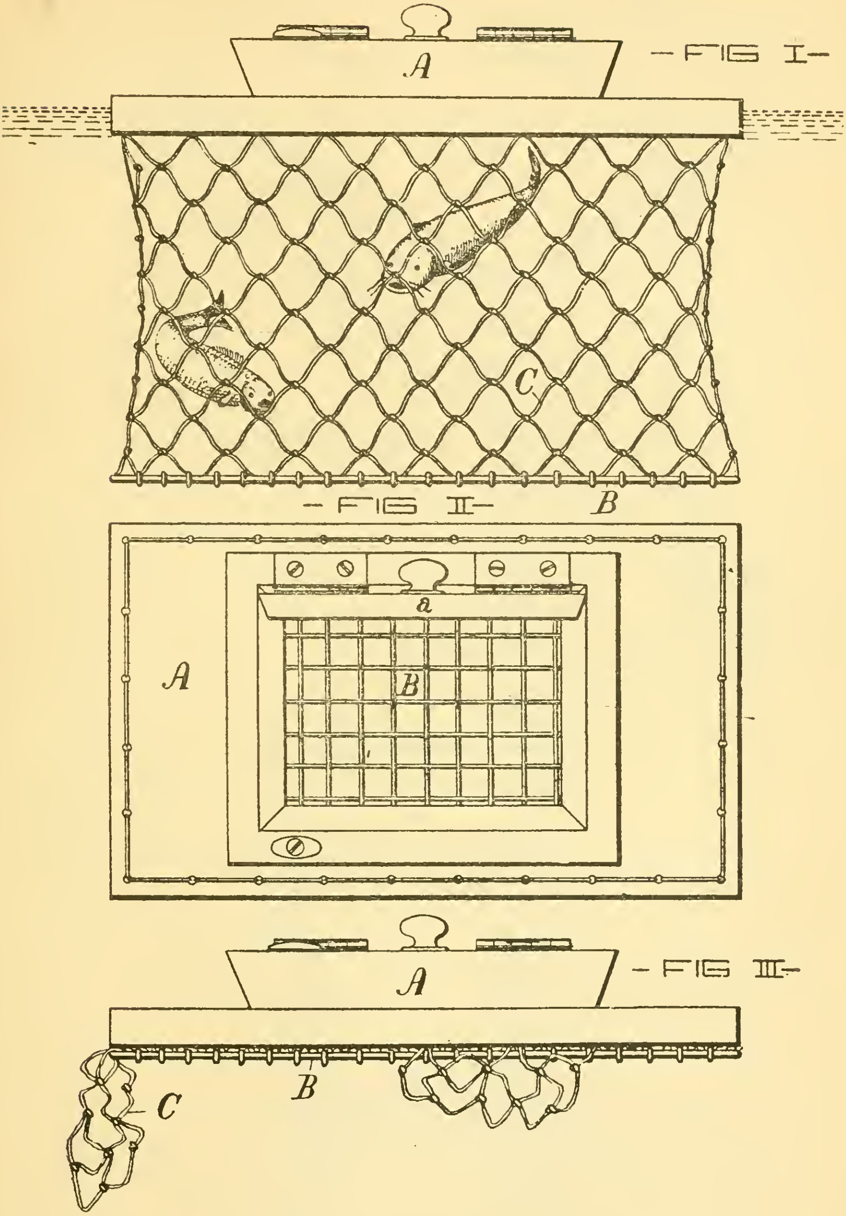
Fig. 2.



No. 257,597. Fishing Apparatus, by S. N. Long. See p. [92].



No. 268,558. Fish-sack, by M. S. Small. See p. [93].



No. 292,123. Live-box for Fish, by R. A. Lindsay. See p. [94].

Fig. 1.

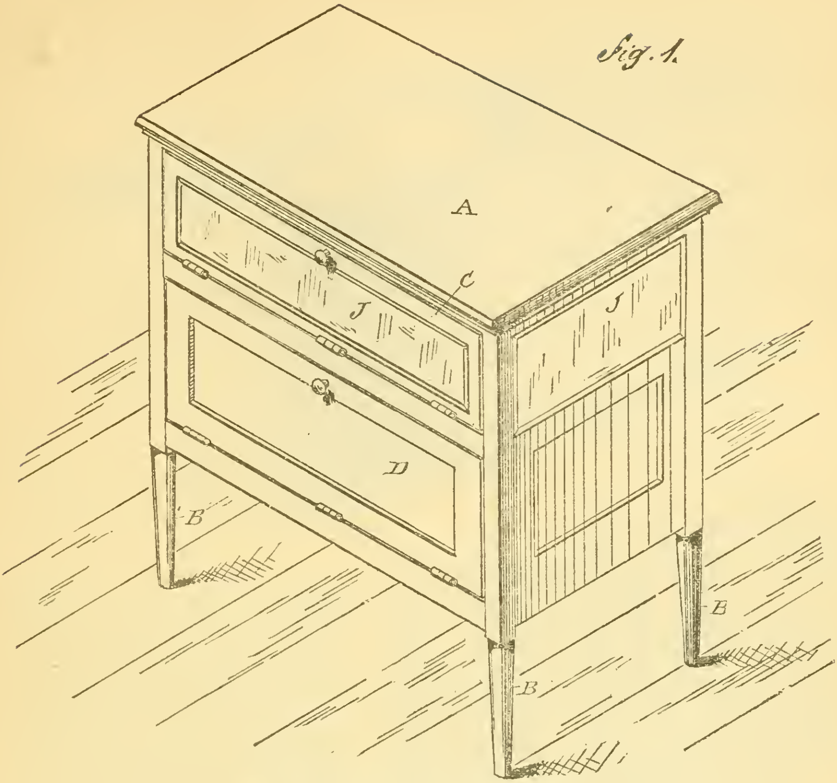
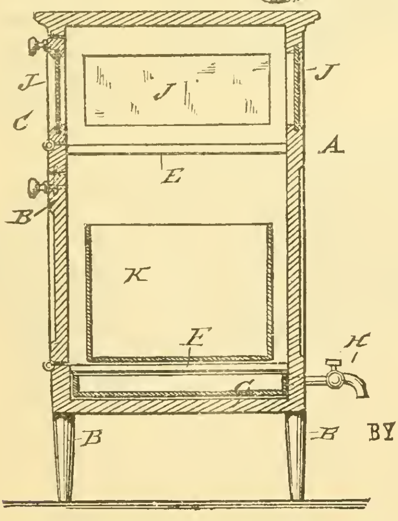
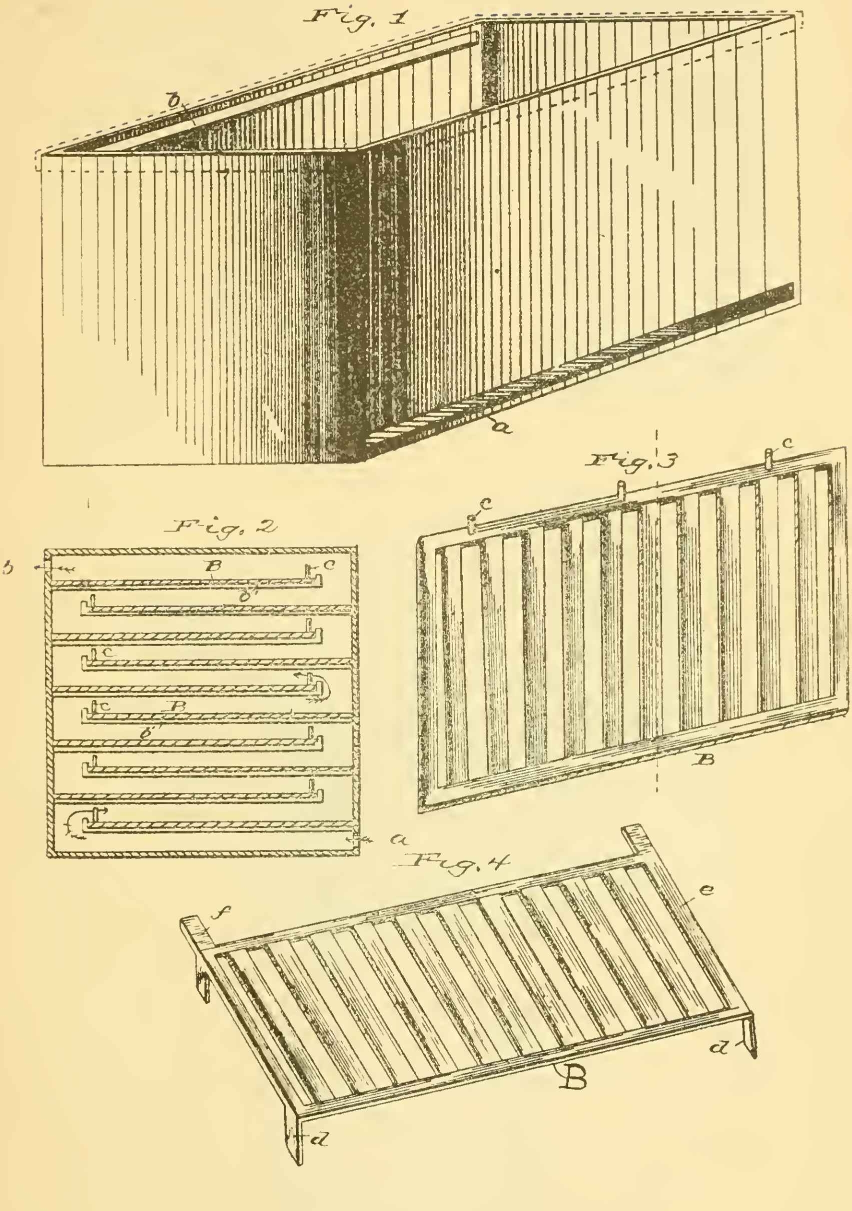


Fig. 2.



No. 265,544. Fish-safe, by D. Schmidt. See p. [94].



No. 291,195. Fish-package, by R. S. Jennings. See p. [95].

Fig. 5.

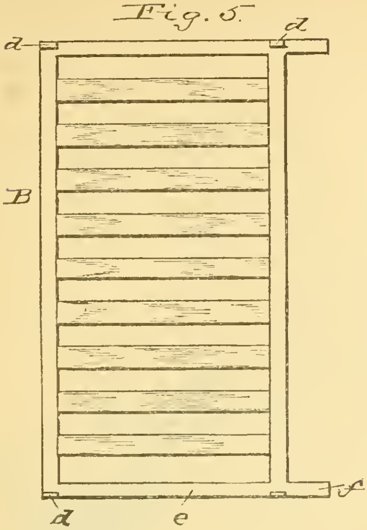


Fig. 6.

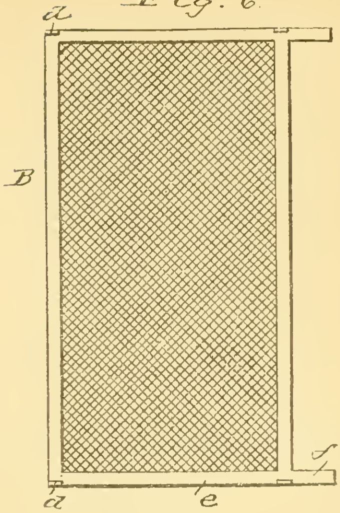


Fig. 7

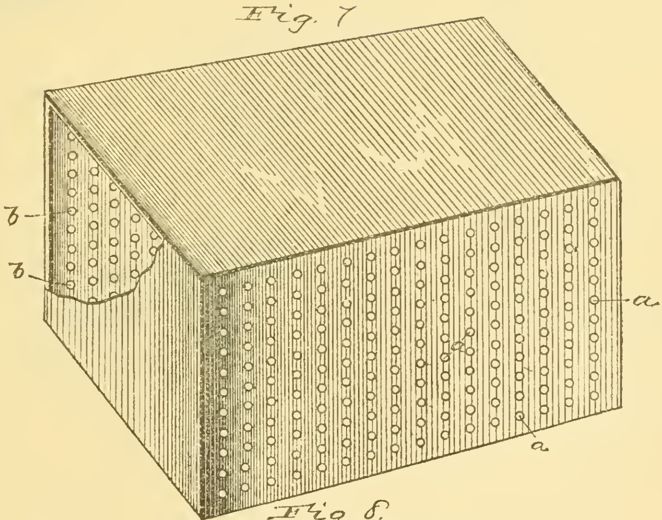
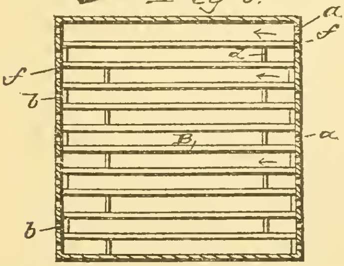


Fig 8.



No. 291,195. Fish-package, by R. S. Jennings. See p. [95].

Fig. 1.

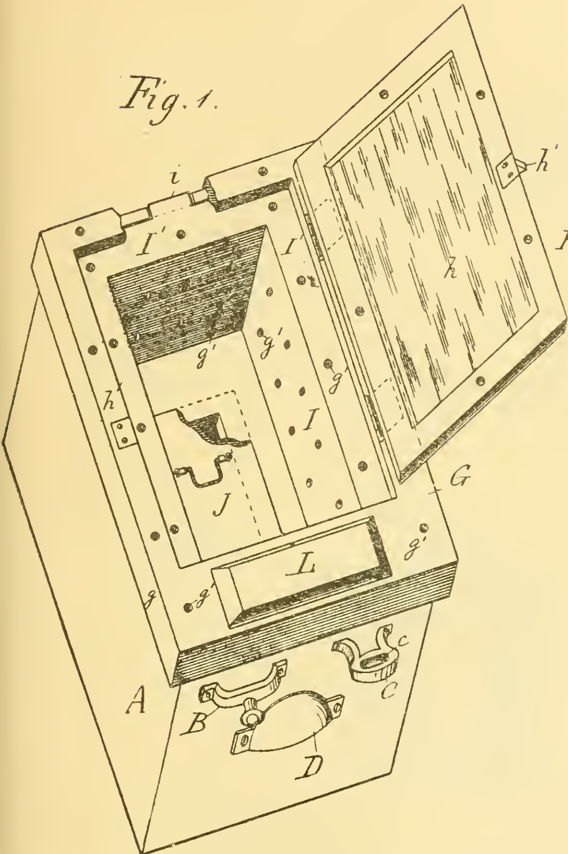
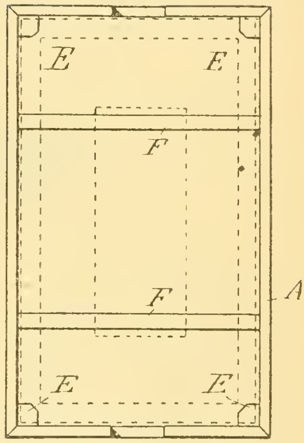


Fig. 2.



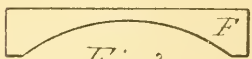
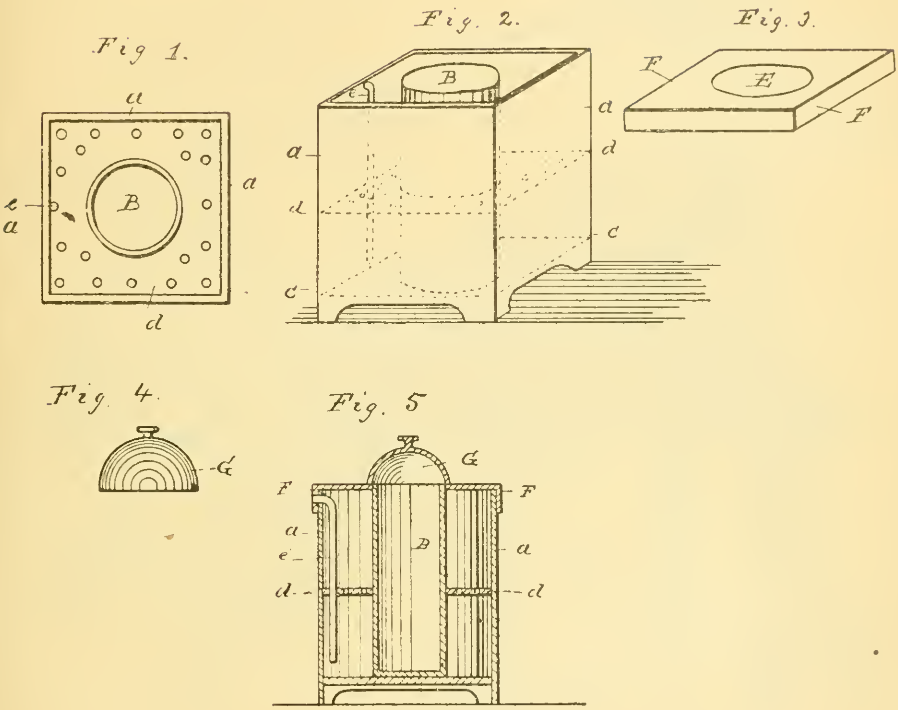


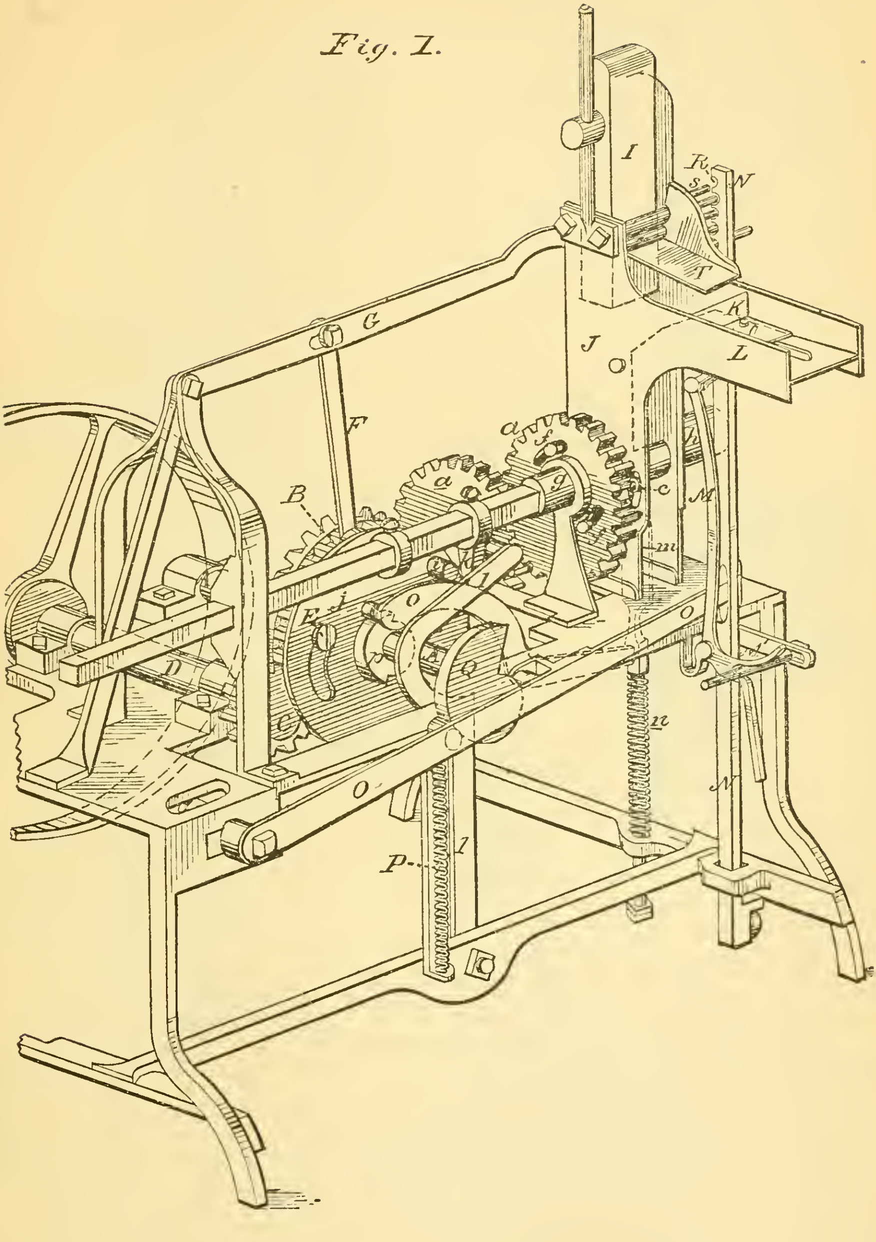
Fig. 3.

No. 295,517. Fish-box, by C. A. Bergtold. See p. [96].



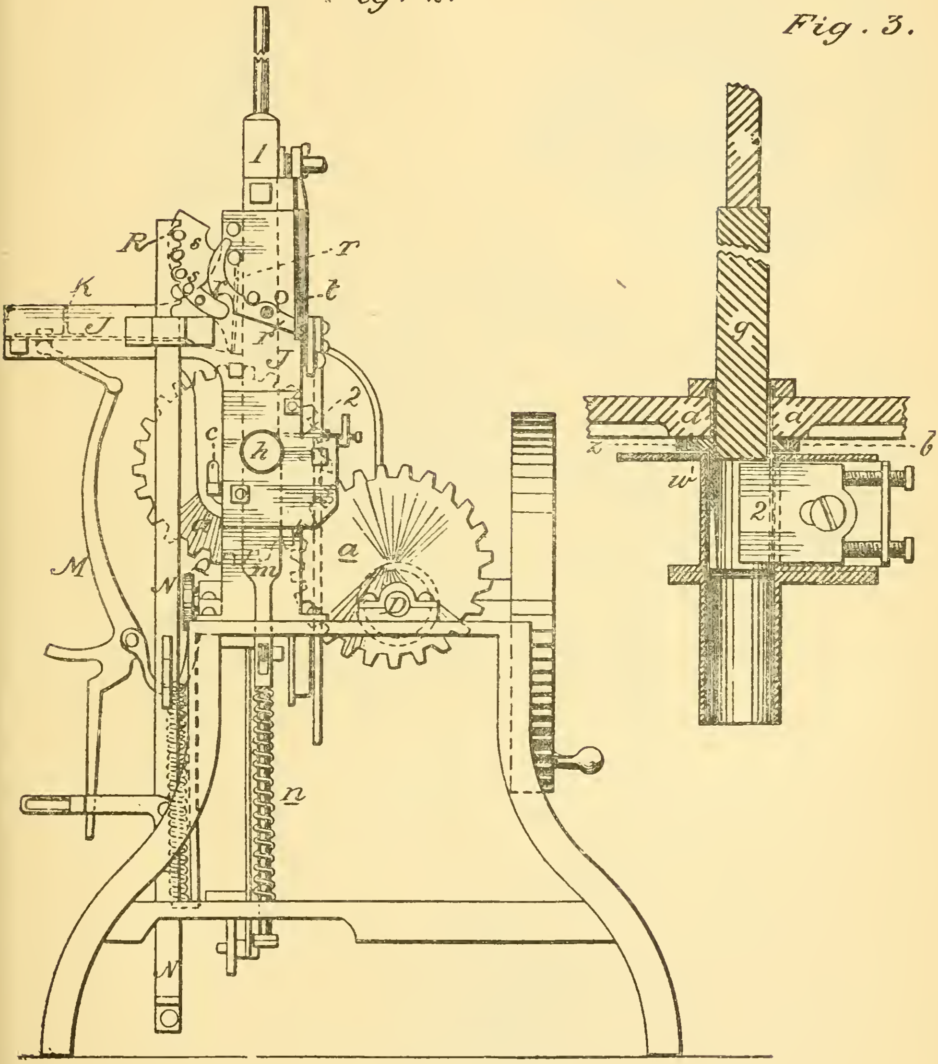
No. 300.061. Oyster Refrigerator, by S. L. Frazer and W. A. Brigham. See p. [96]

Fig. 1.



No. 259,442. Can-filling Apparatus, by W. West. See p. [97].

Fig. 2. Fig. 3.



No. 259,442. Can-filling Apparatus, by W. West. See p. [97].

Fig. 4.

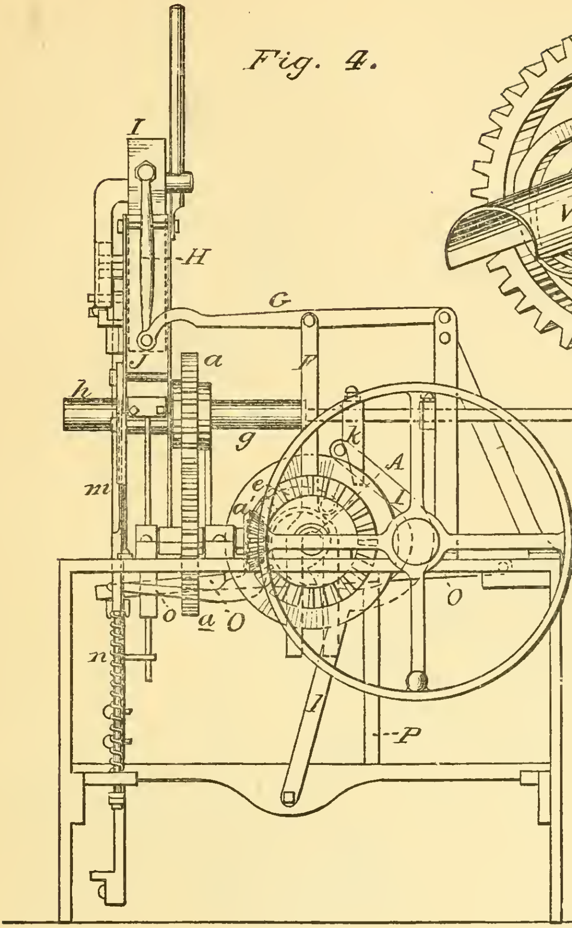


Fig. 5.

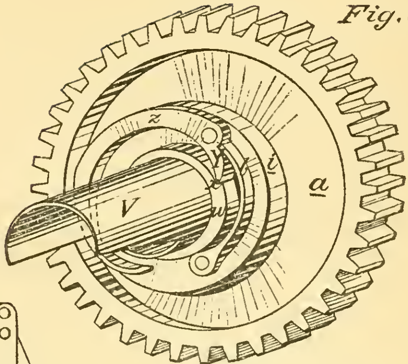


Fig. 6.

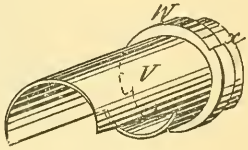
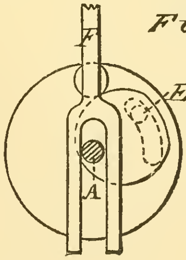
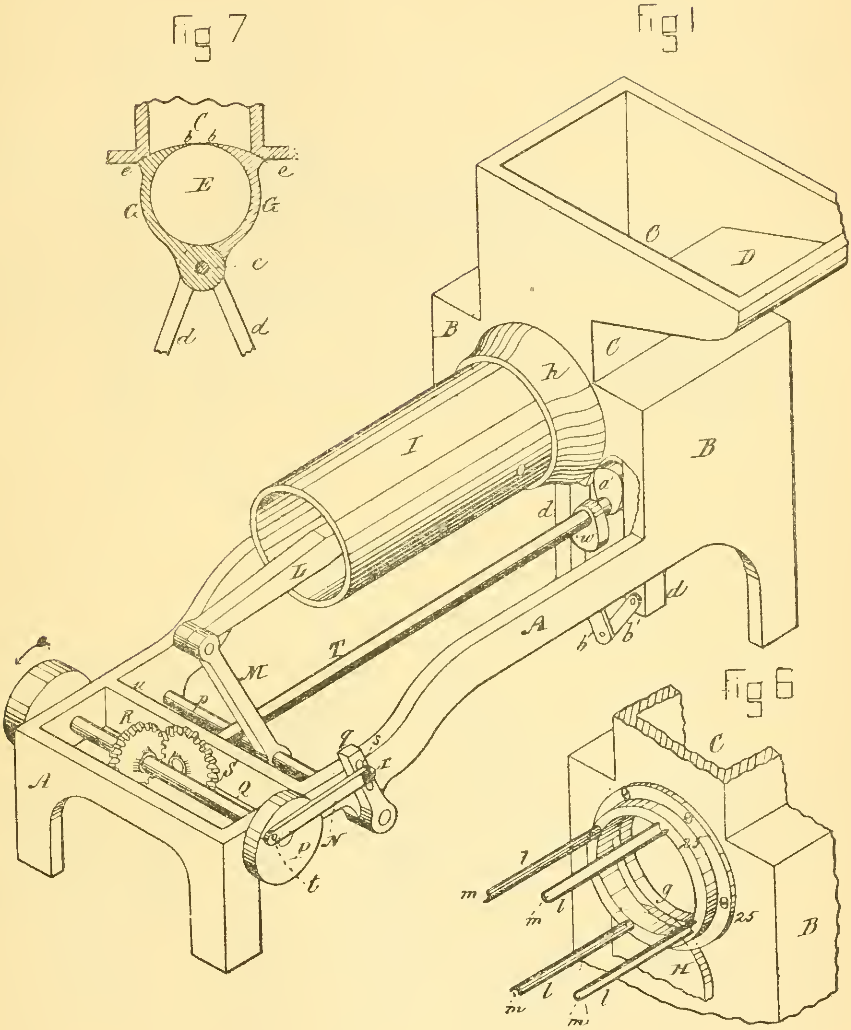


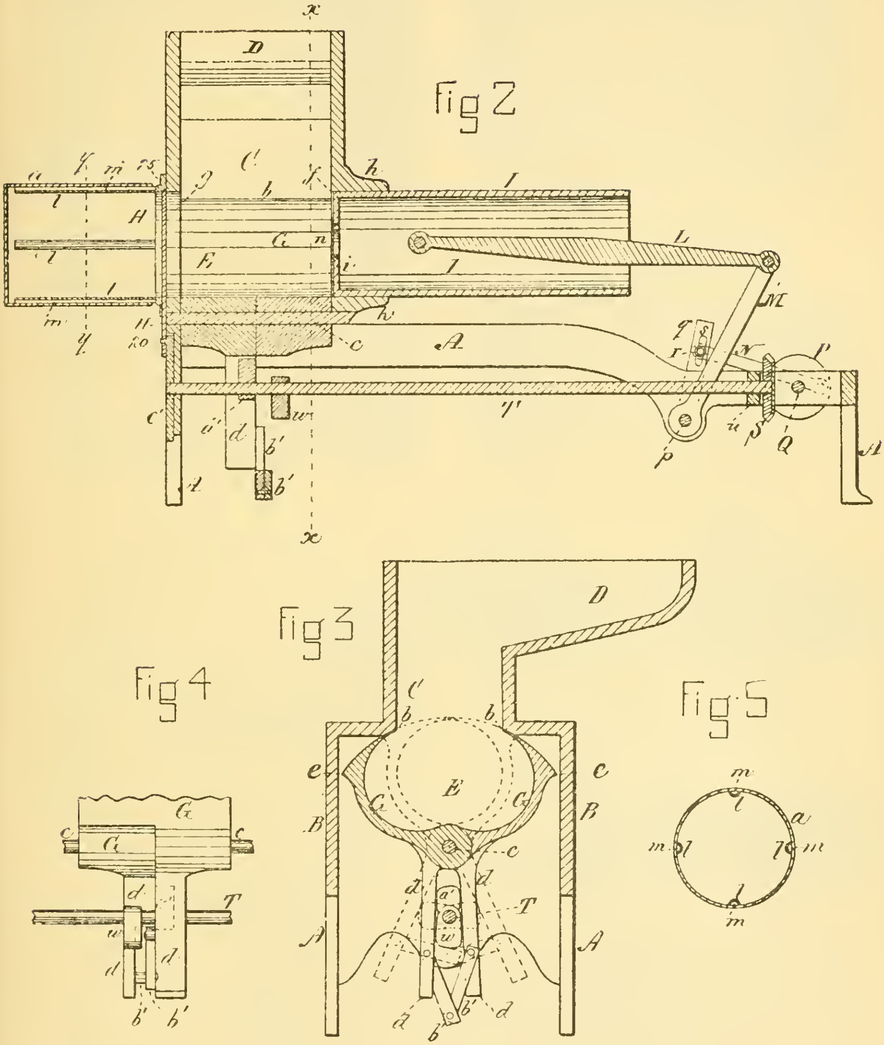
Fig. 7.



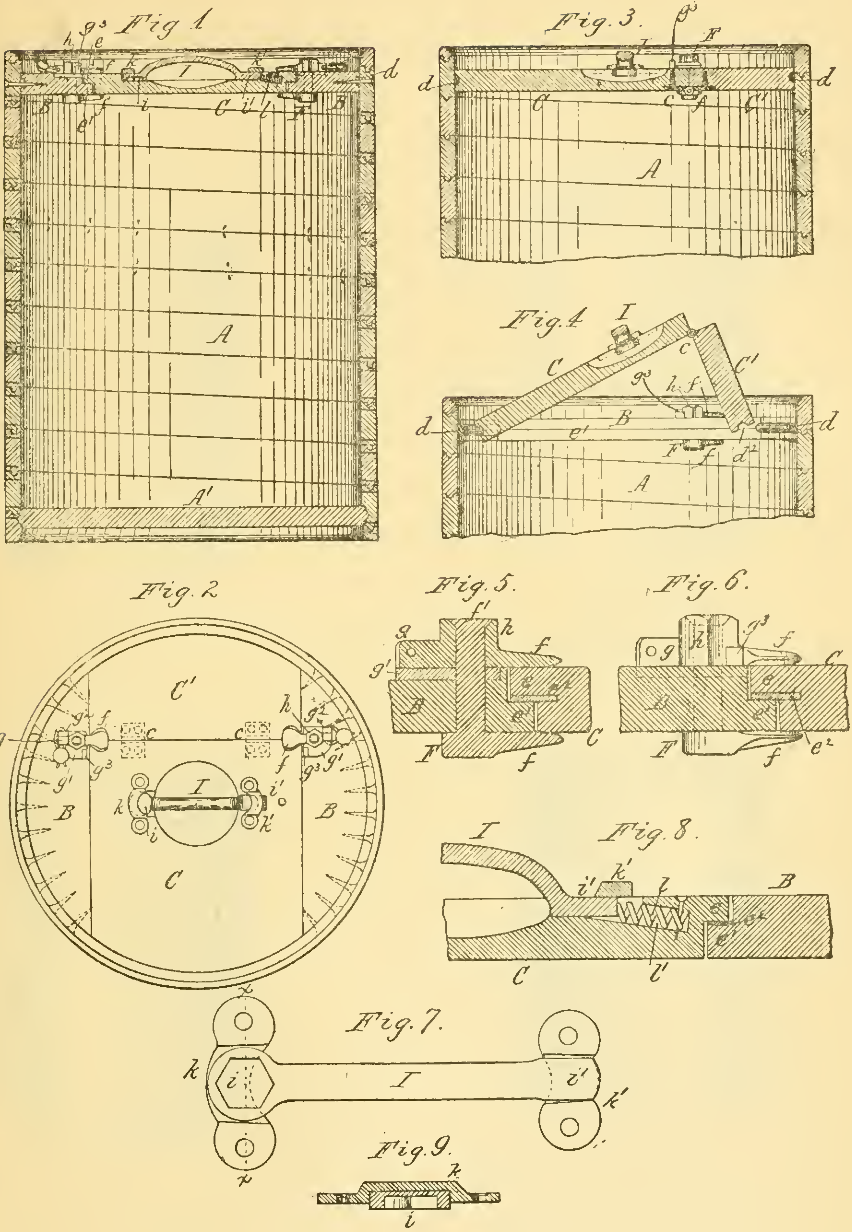
No. 259,442. Can-filling Apparatus, by W. West. See p. [97].



No. 262,575. Machine for Filling Cans with Meat, Fish, &c., by A. Crosby. See p. [101].



No. 262,575. Machine for Filling Cans with Meat, Fish, &c., by A. Crosby. See p. [101].



No. 265,137. Package for Oysters, &c., by C. L. Pond. See p. [104].

Fig. A.

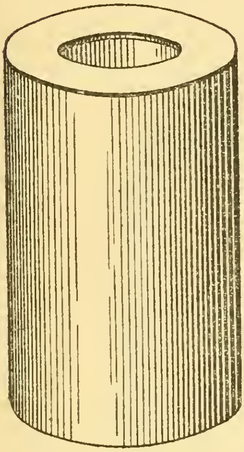


Fig. B.

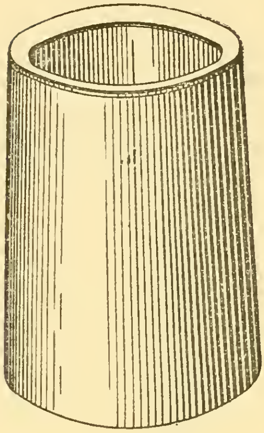


Fig. C.

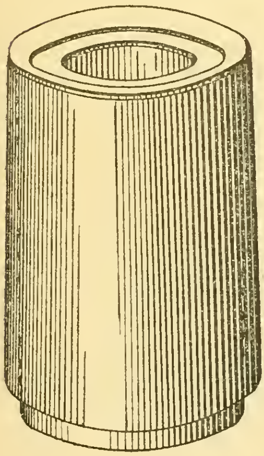
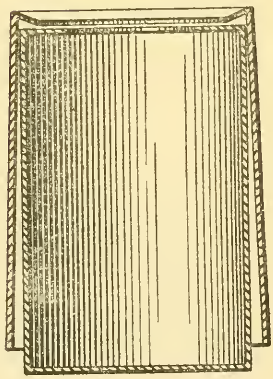


Fig. D.



No. 296,023. Device for Keeping Fish, Meat, &c., Cans Clean while being filled, by T. Levi. See p. [105].

Fig. 1.

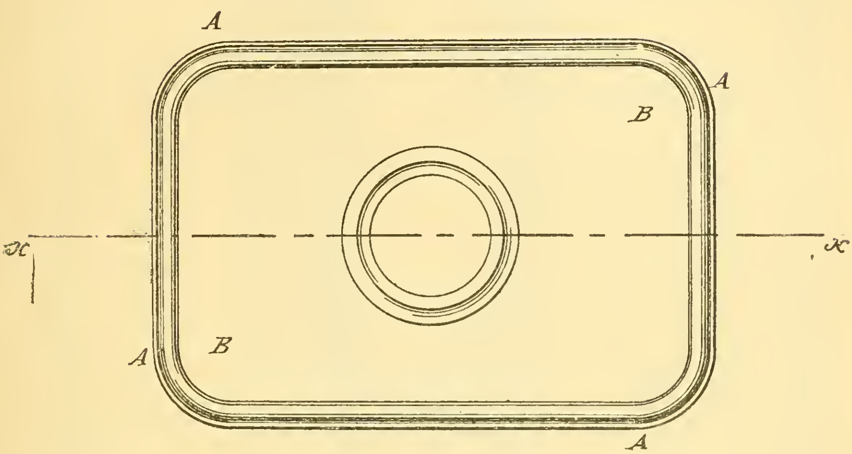
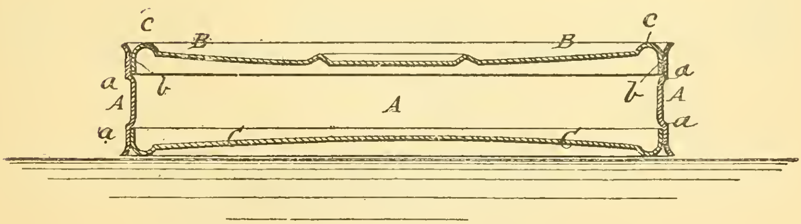
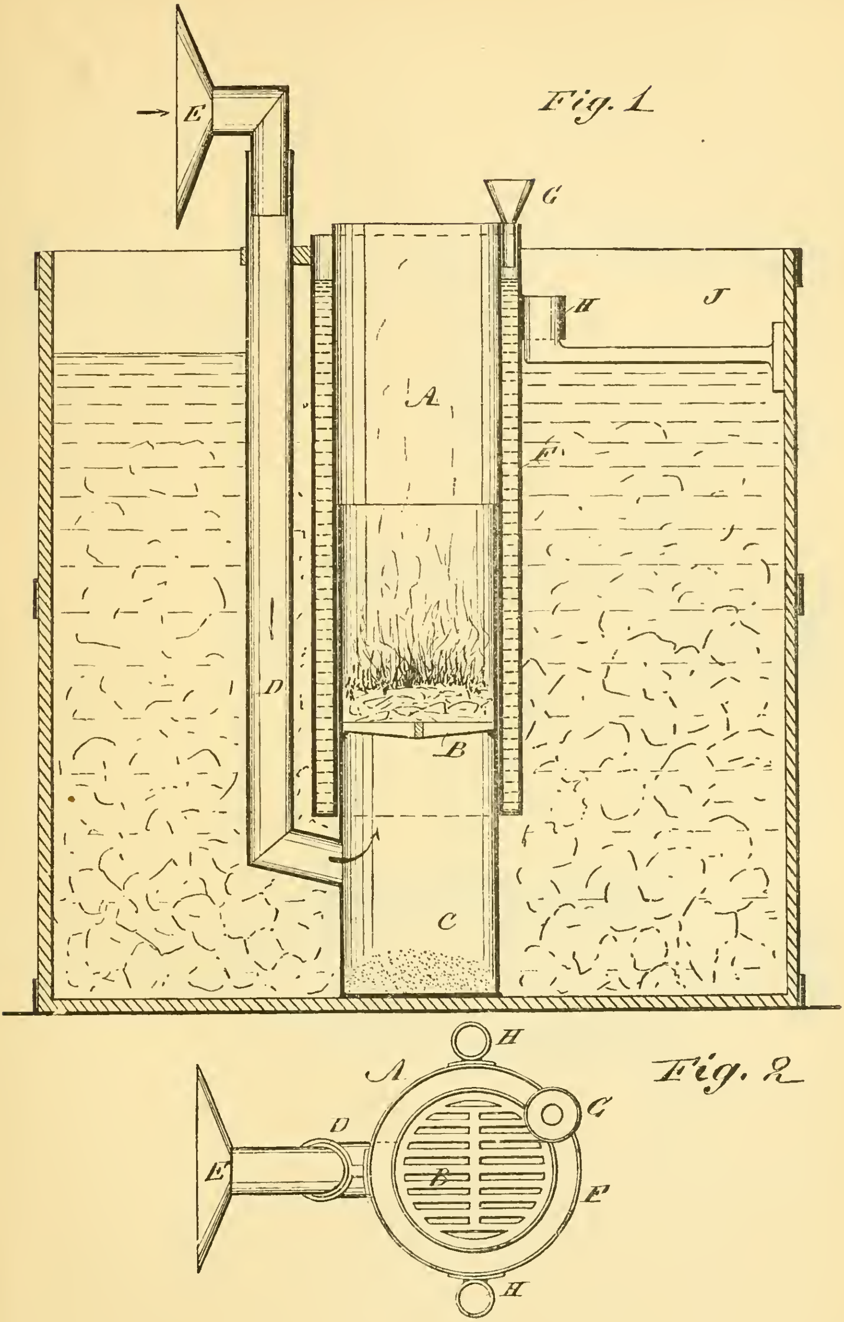


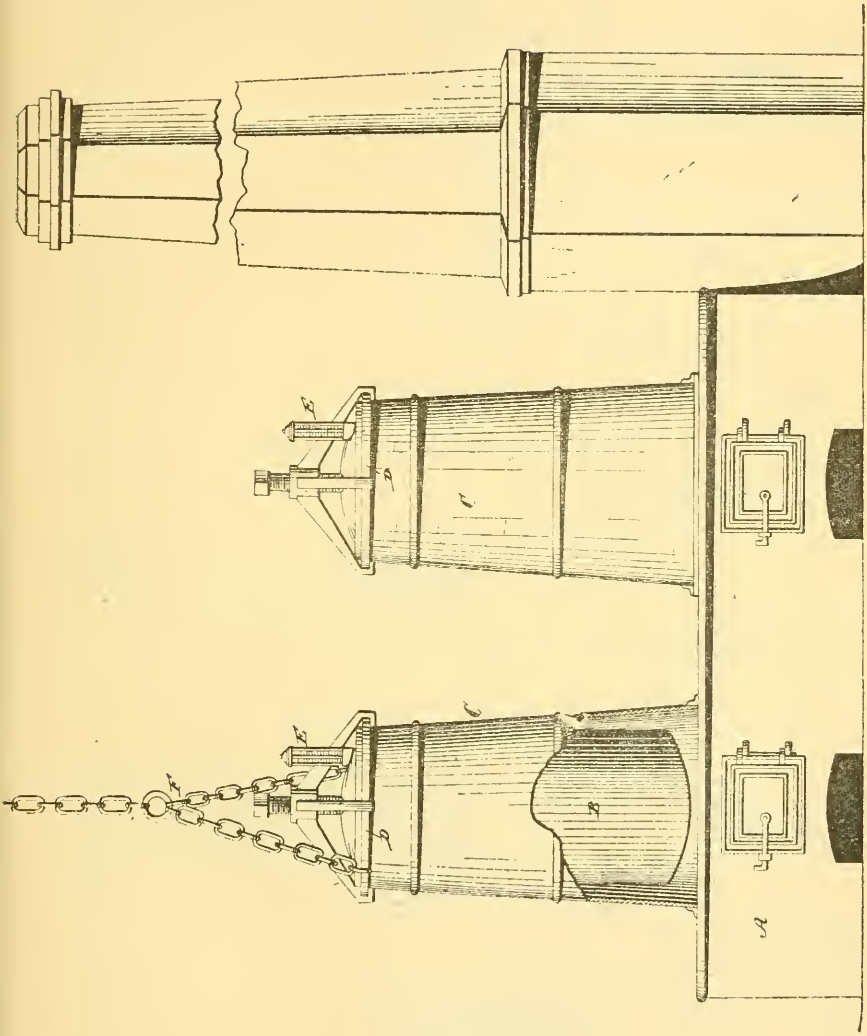
Fig. 2.



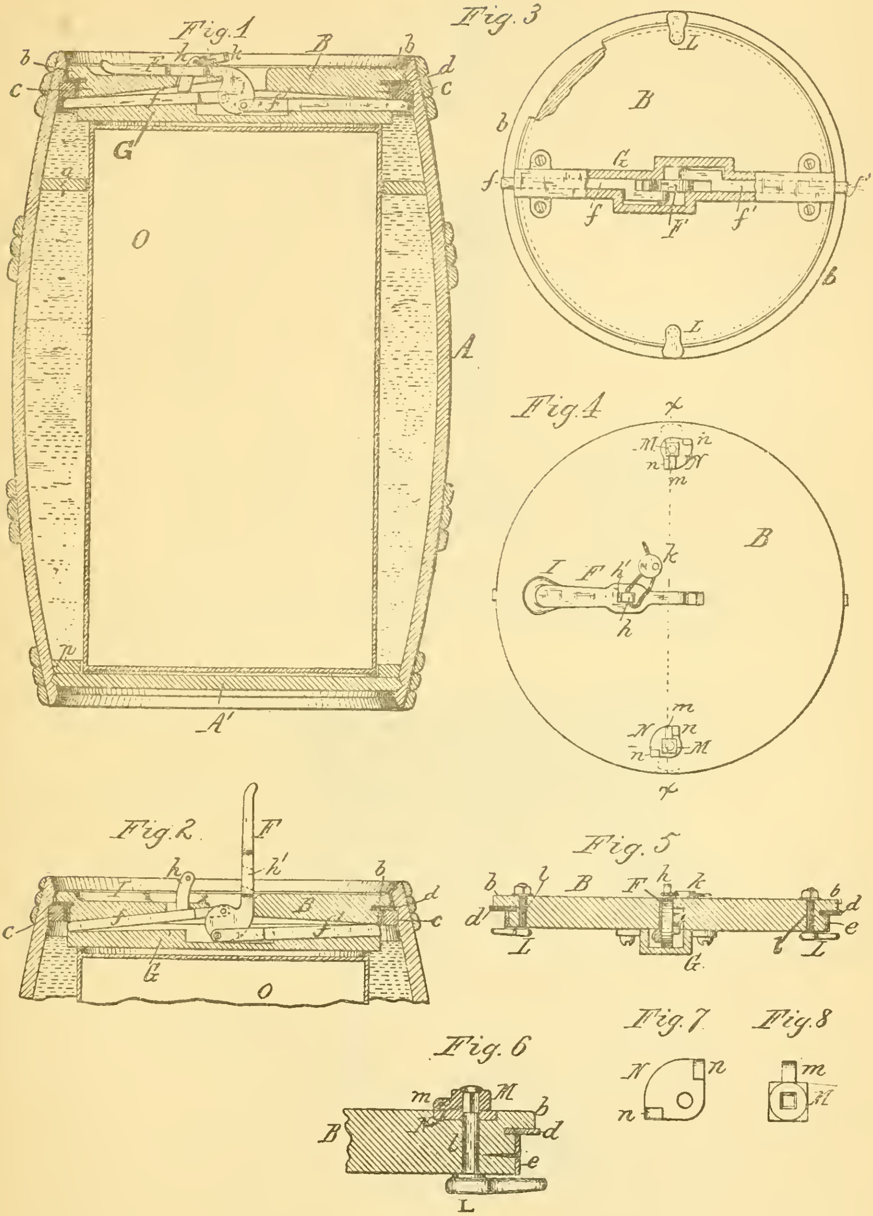
No. 299,710. Sardine-can, by J. Wolff. See p. [106].



No. 288,106. Process of and Apparatus for Extracting Oil from Fish-liver and Blubber, by F. Payzant. See p. [107].



No. 259,140. Manufacture of Fertilizing Material, by F. L. Harris. See p. [108].



No. 255,017. Package for Oysters, &c., by C. L. Pond. See p. [110].

fig. 1.

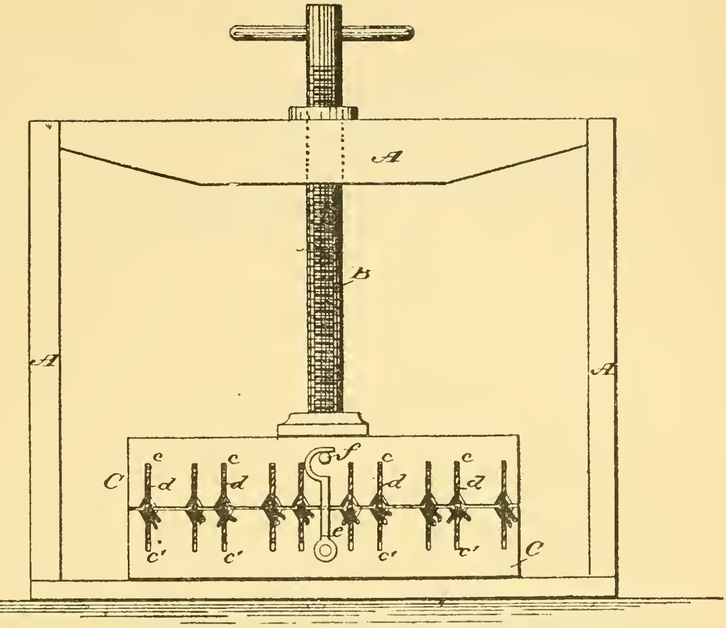


fig. 2.

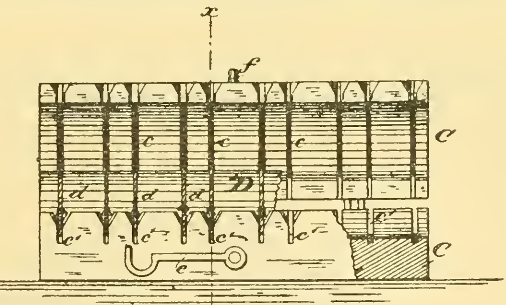
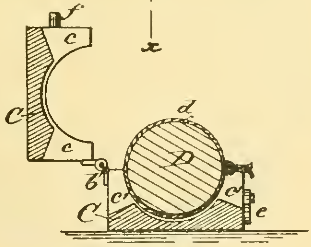
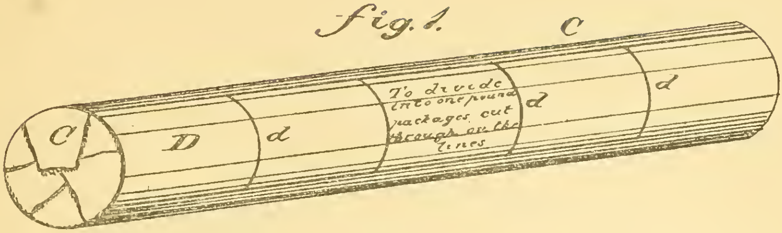
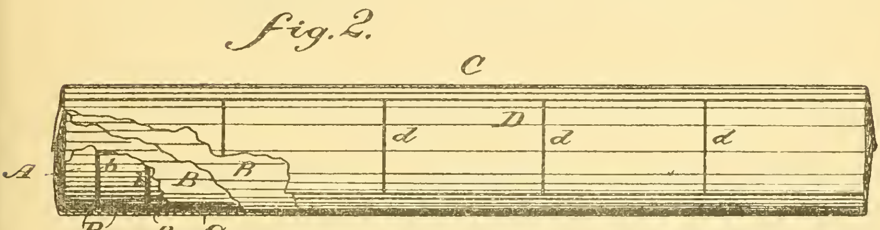


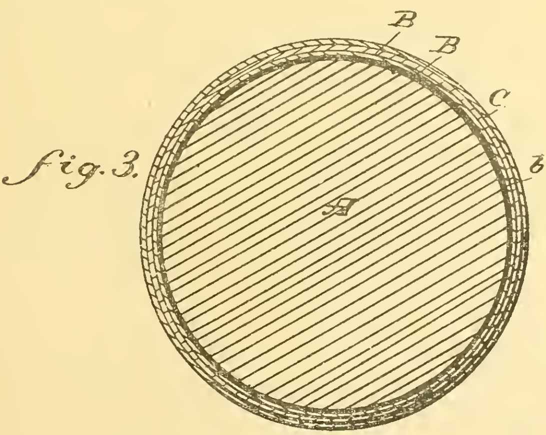
fig. 3.



No. 261,984. Apparatus for Packing Dried Fish, by J. H. Baxter. See p. [112].







No. 265,735. Putting up Dried Fish, by J. H. Baxter. See p. [112].

Fig. 1

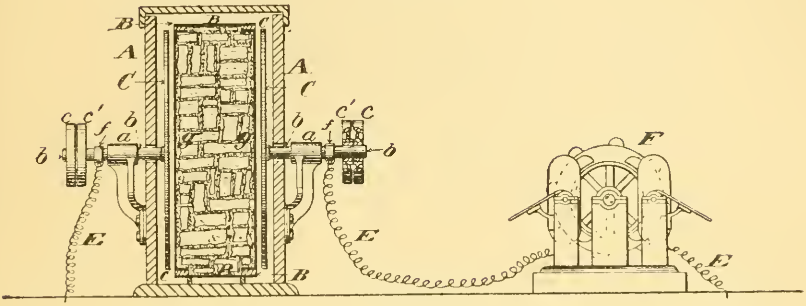
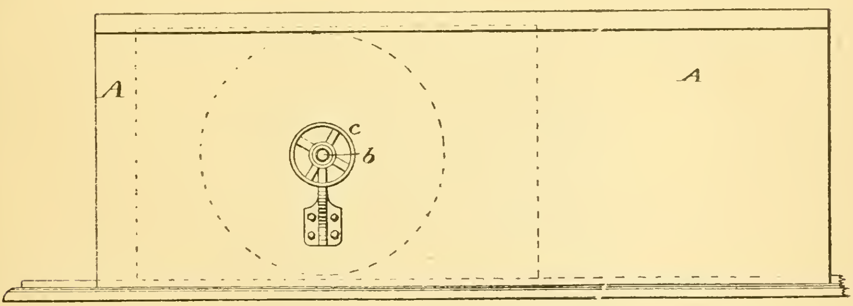


Fig. 2



No. 267,685. Apparatus for Preserving Meats, by A. Fowler. See p. [113].

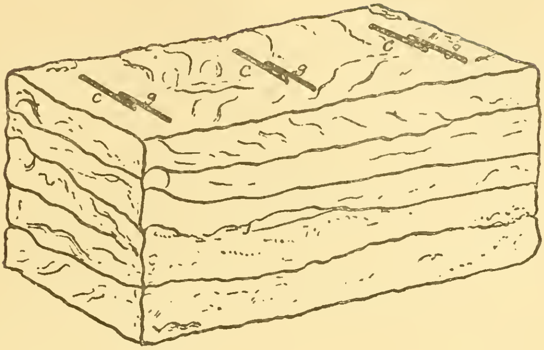


Fig. 1.

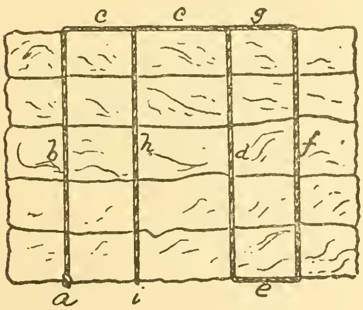
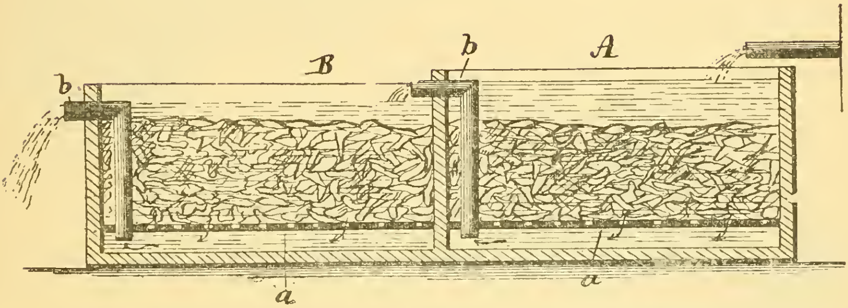


Fig. 2.

No. 275,973. Preparing Salt Fish for Market, by O. Andrews. See p. [114].



No. 299,515. Process of Treating the Waste of Salt Fish, by R. Brooks. See p. [117].

Fig. 1.

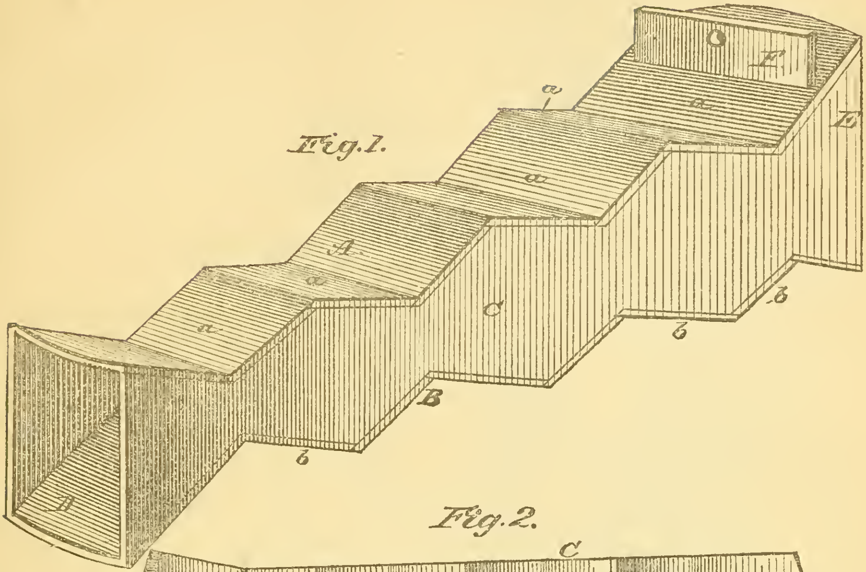


Fig. 2.

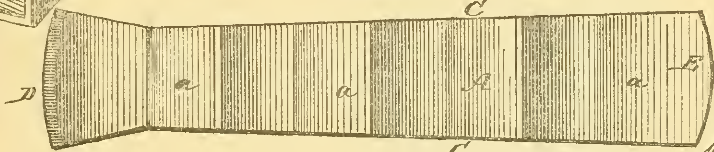
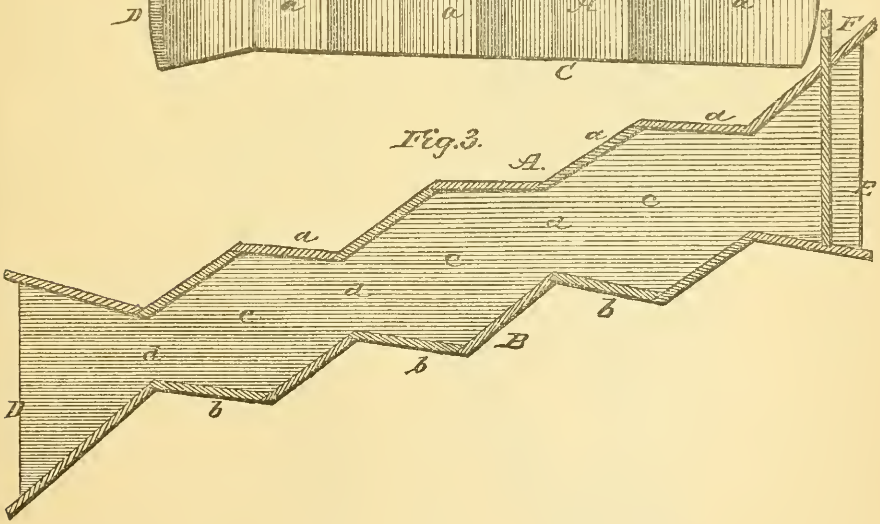
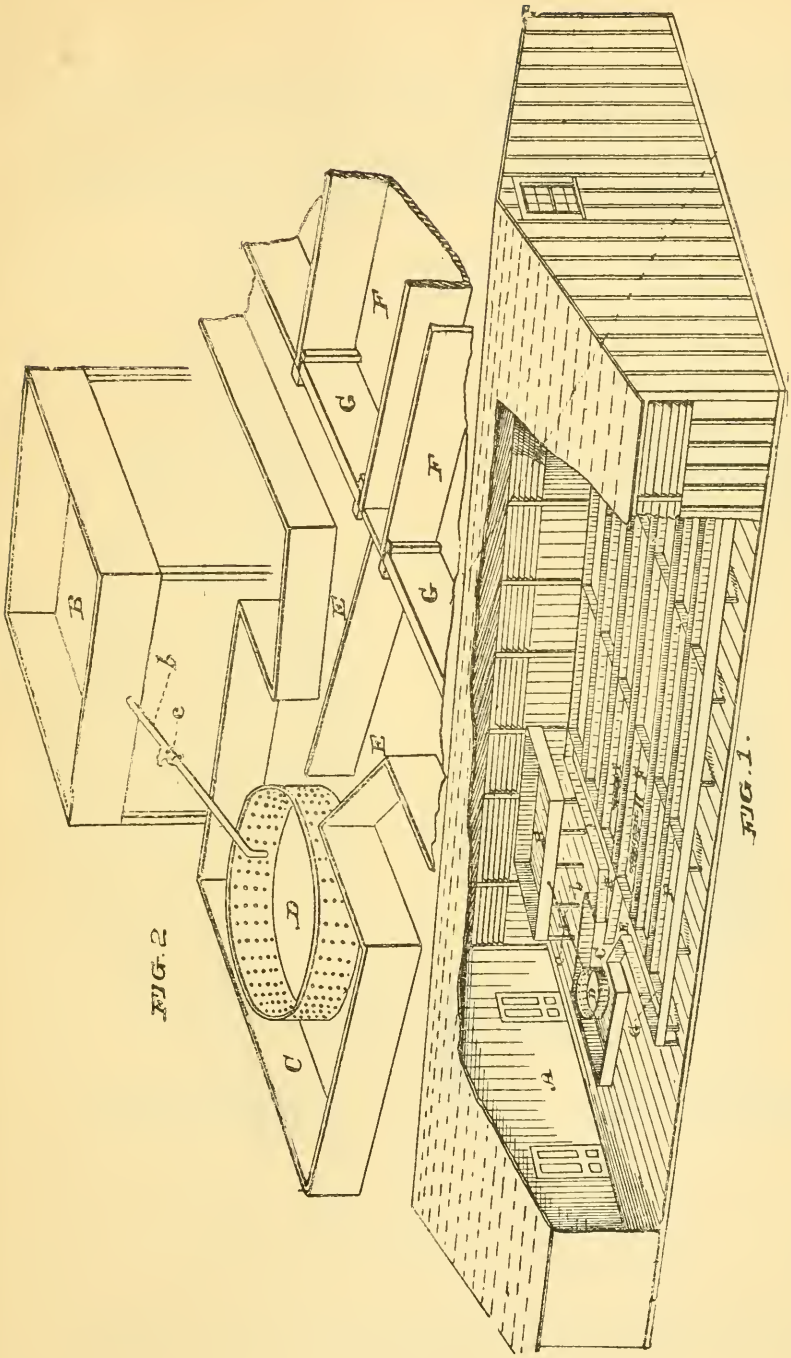


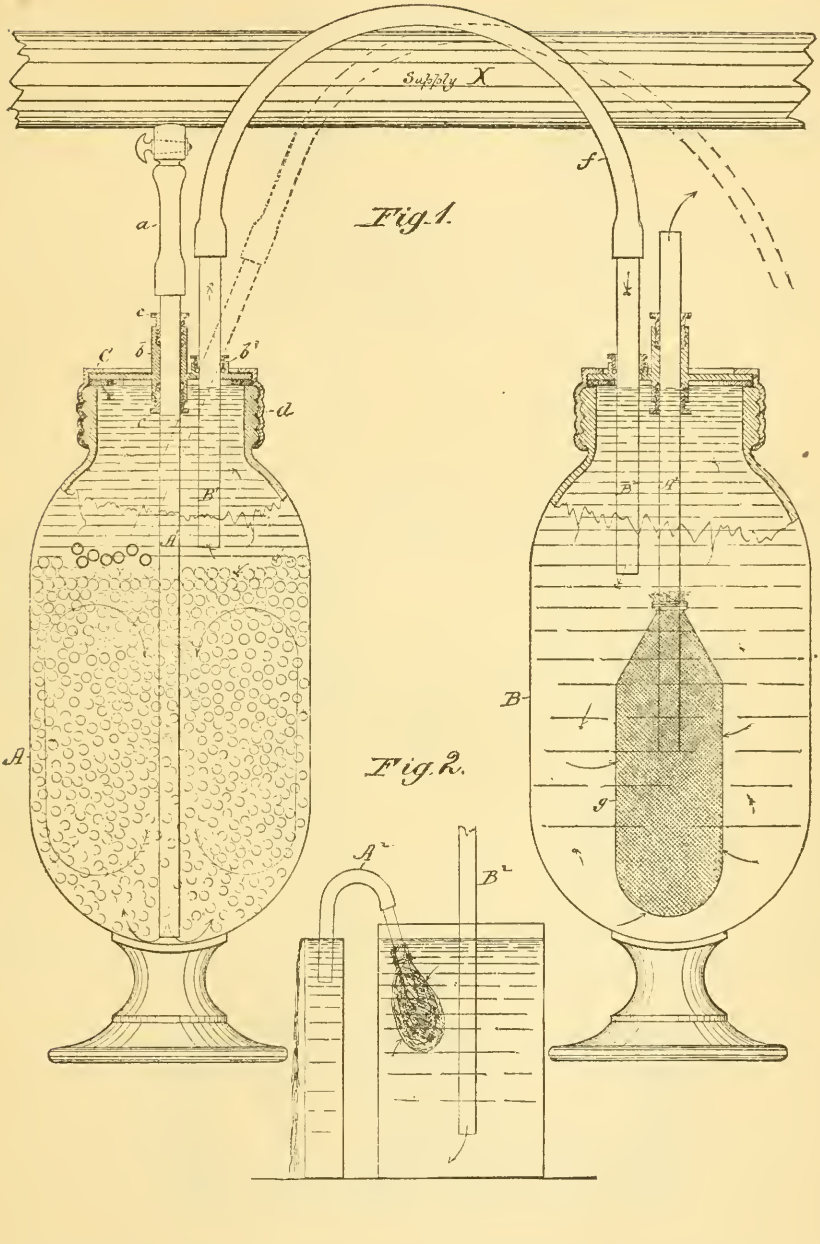
Fig. 3.



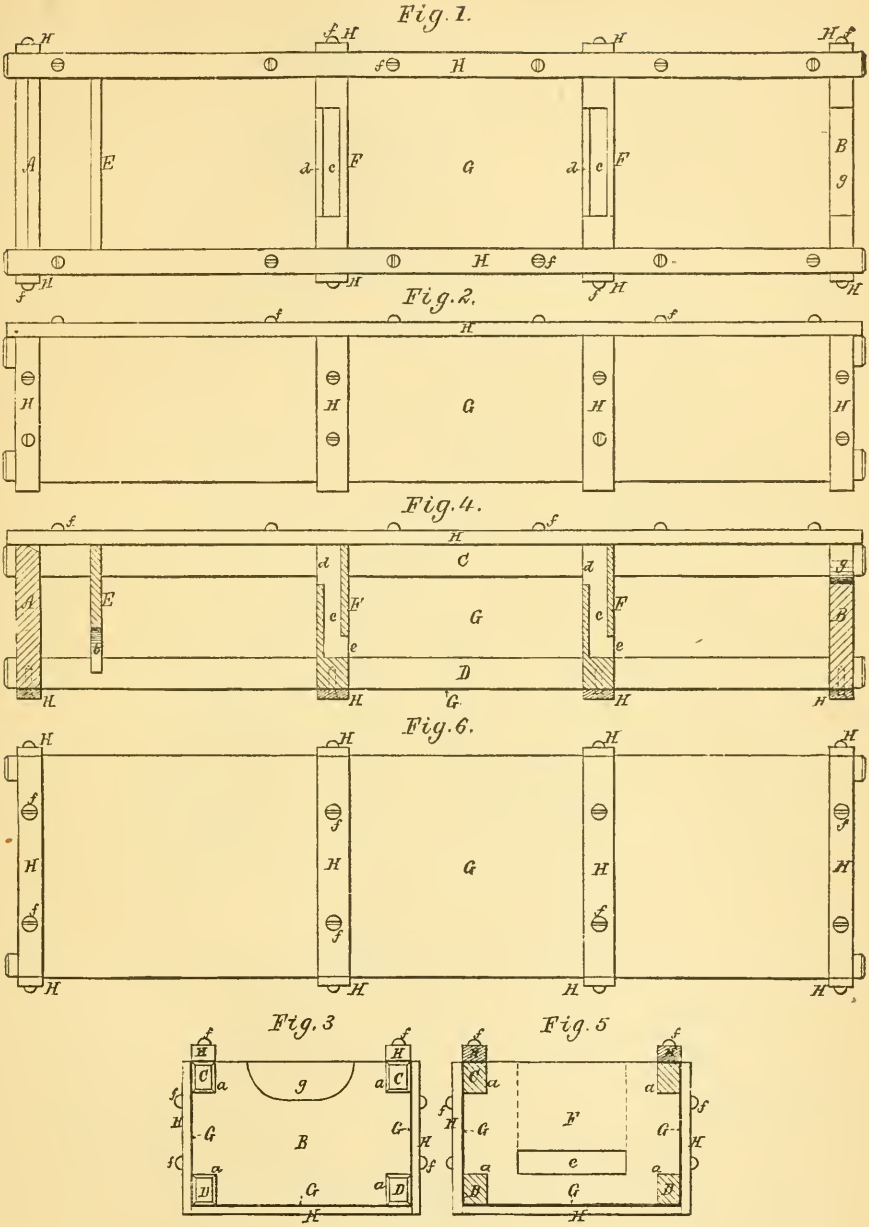
No. 286,869. Fishway, by C. W. Trammer. See p. [119].



No. 301,285. Apparatus for Oyster-culture, by C. Schmitz. See p. [119].



No. 263,933. Method of and Apparatus for Hatching Fish, by M. McDonald.
See p. [129].



No. 277,805. Fish-egg Hatching-trough, by L. Stone. See p. [123].

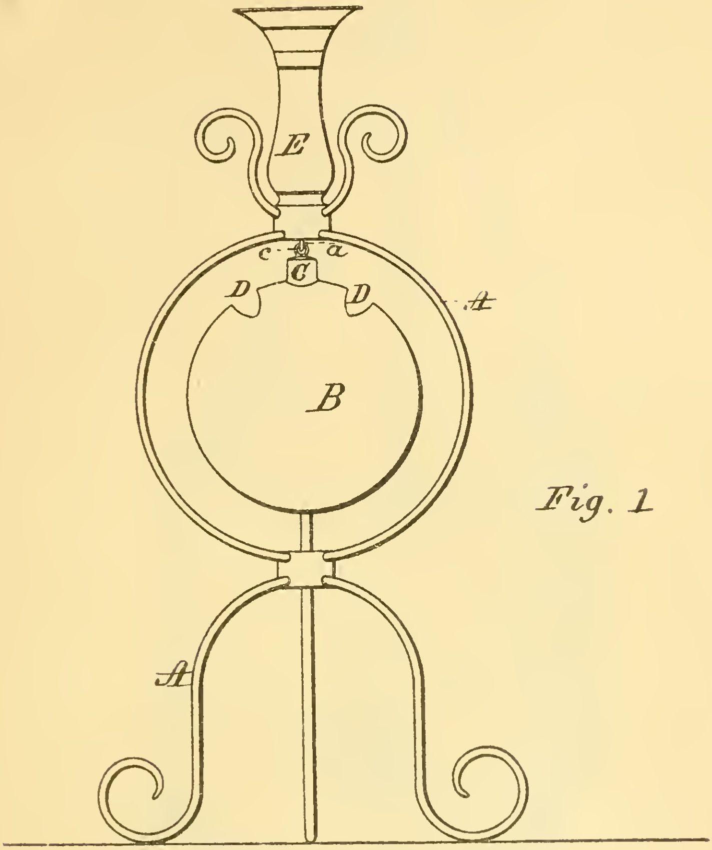


Fig. 1

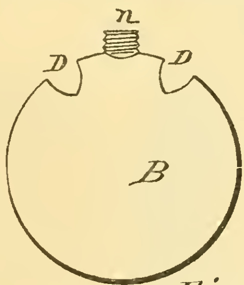


Fig. 3.

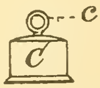
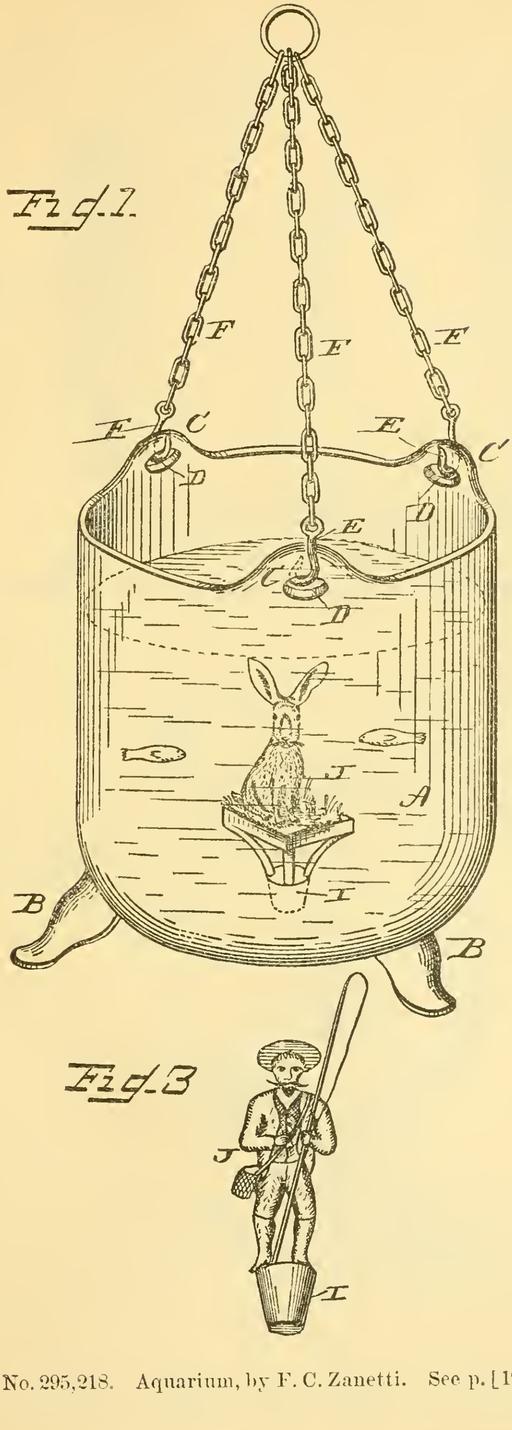


Fig. 4.

Fig. 2

No. 256,240. Aquarium, by C. N. Orpen. See p. [123].



No. 295,218. Aquarium, by F. C. Zanetti. See p. [124].

Fig 2.

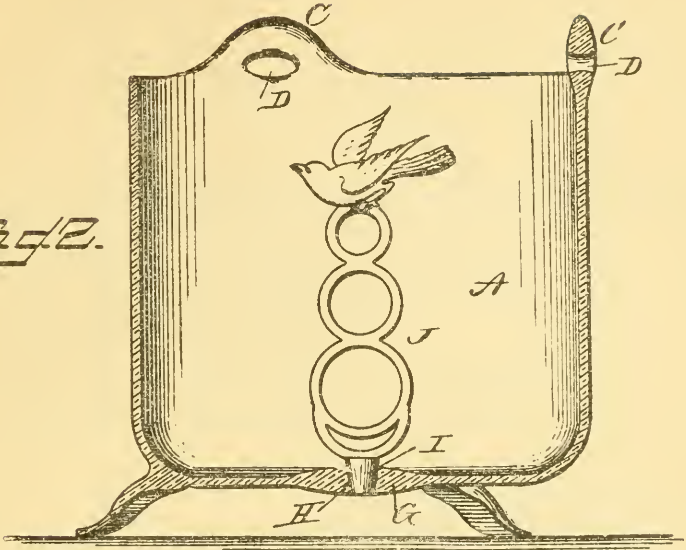
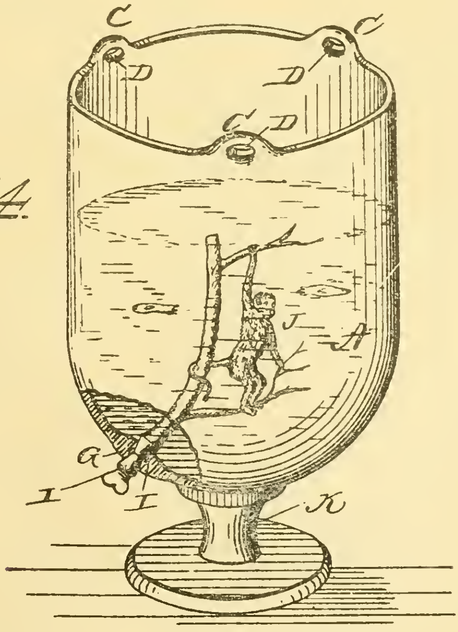


Fig 4.



No. 295,218. Aquarium, by F. C. Zanetti. See p. [124].

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NOTE.—This index contains general references to the entire volume. More detailed indexes to seven papers will be found at the pages indicated.